T E N D E R S P E C I F I C A T I O N

NO: BHE/PW/PUR/WNT2-CVL BOP/1574

(CIVIL AND ARCHITECTURAL WORK OF BOP)

All Civil and Architechural work BOP & Non Plant Buildings (But Not Limited to):- Civil work of all RCC Framed Buildings of BOP like praking,chlorination plant, clarified water & fire water pump house, clarified and fire water tank, CPU building, Ozone building, fire station bldg., DM Plant plant & chemical house , Neutralization pit, LDO/HFO Day tank fdns., dykes, FO Transfer pump house, LDO/HFO Pipe Corridor, FO pressuring pump house, store, CWTP,FOAM PH,Booster PH, balance civil work of remaining Pipe rack, chemical house, canteen building , fencing all types, Balance Civil foundation , Storm Water Sump, Service water tank, Storm Water Drain connecting outfall,SSF,Sewer System thrust block,road & drain ,watch tower,water harvesting well, Customer site office, CST & CST Pump House including piling, pilecap,pedestals with bolts,septic tanks and soak pits miscleneous items which are not covered under other Packages item rate.

AT

1X800 MW Thermal Power Station, Wanakbori, Distt- Kheda, Gujarat

Legible Version of Volume 1 E – Technical Specification Section-C and Section D (Part-1)

TENDER SPECIFICATIONS CONSISTS OF:

- **Notice Inviting Tender**
- **Volume 1 A - Technical Conditions of Contract,**
- **Volume 1 B - Special conditions of Contract,**
- **Volume 1 C - General conditions of Contract**
- **Volume 1 D - Forms & Procedures**
- **Volume 1 E – Technical Specification Section-C, Section D and Plot Plan AND Geo technical investigation Report**

Bharat Heavy Electricals Limited
(*A Government of India Undertaking*)
Power Sector - Western Region
345-Kingsway, Nagpur-440001

Date
Seal and Signature
Place

GUJARAT STATE ELECTRICITY CORPORATION LTD.

1x800 MW SUPERCRITICAL THERMAL POWER PROJECT WANAKBORI, GUJARAT

TECHNICAL SPECIFICATION (SECTION C)

DOCUMENT NO. PE-TS-J57-600-C001

REVISION 00

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
PPEI BUILDING, POWER SECTOR,
PLOT NO. 25, SECTOR-16A,
NOIDA -201031

Project Title	1x800 MW WANAKBORI SUPERCRITICAL TPS
Job no.	J57
Document No.	PE-TS-J57-600-C001
Subject	SECTION C

Rev No.	Particulars	Prepared by	Checked by	Approved by	Remarks
	Name	KN	AB	AKS	
00	Sign	-sd-	-sd-	-sd-	
	Date	15/09/2014	16/09/2014	16/09/2014	

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PART-II : SPECIFIC TECHNICAL REQUIREMENTS

PART – I

GENERAL CIVIL REQUIREMENT

1.00 GENERAL

Two Volumes – section C & Section D of this specification cover site survey, soil investigation, site development works, design and construction of Civil, Structural and Architectural works. The scope of works covers complete Civil, Structural and Architectural Works including supply of all materials, labour, tools and plants as required for successful execution of the packages. This Part-I of Section-C lists Codes and Standards to be adopted and the principal structures of the plant, and briefly describes the basic concept, requirements and features pertinent to each. If there is any ambiguity and/or contradiction between Section C and Section D, the provisions/ requirement laid in Section C shall prevail. In case of ambiguity between BOQ and Part C former shall prevail.

(Contractor shall read the parts of the specification relevant to the contract and shall ignore other parts of the specification. Relevant clauses of this section as applicable for respective package to be followed)

2.00 CODES & STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the plant. Specific applicable codes and standards will be identified in System Design descriptions/ Technical Specifications as appropriate. The latest editions/revision of the following codes and standards along with addendums/ amendments, if any, shall be followed:

2.1.0 EARTHWORK

IS: 1498	Classification and identification of soils for General Engineering Purposes.
IS: 3764	Safety Code for Excavation Work
IS: 7293	Safety Code for working with construction machinery.

2.2.0 CONCRETE

IS: 269	Ordinary and low heat Portland cement.
IS: 383	Coarse and fine aggregate from natural sources for concrete.
IS: 432	Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.

IS: 455	Portland slag cement
IS: 456	Code of practice for plain and reinforced concrete
IS: 460	Test sieves (all parts)
IS: 516	Methods of test for strength of concrete.
IS: 1199	Methods of sampling and analysis of concrete.
IS: 1566	Hard drawn steel wire fabric for concrete reinforcement
IS: 1786	High strength deformed steel bars and wires for concrete reinforcement
IS: 1834	Hot applied sealing compounds for joints in concrete.
IS: 2386	Methods of test for aggregate for concrete (all parts)
IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS: 3370	Code of practice for concrete structures for storage of liquids (all parts)
IS: 3414	Code of practice for design and installation of joints in buildings
IS: 4948	Welded steel wire fabrics for general use.
IS: 6452	High alumina cement for structural use.
IS: 7320	Concrete slump test apparatus.
IS: 7861	Code of practice for extreme weather concreting (all parts)
IS: 8041	Rapid hardening Portland cement.
IS: 8112	High strength ordinary Portland cement.
IS: 10262	Recommended guidelines for concrete mix design
IS: 458	Specifications for precast concrete pipes.
IS: 3935	Code of practice for composite construction
IS: 4995	Criteria for design of reinforced concrete bins for storage of granular and powdery materials (all parts)
IS: 5525	Recommendation for detailing of reinforced concrete works.
IS: 11384	Code of practice for composite construction in structural steel and concrete.
IS: 11682	Criteria for design of RCC staging for overhead water tanks.
IS: 13920	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces.

2.3.0 FOUNDATIONS

IS: 1080	Code of Practice for design and construction of shallow foundations on soils (other than raft, ring and shell)
IS: 1904	Code of Practice for design and construction of foundations in soils (General requirements)
IS: 2911	Code of Practice for design and construction of pile foundations (All parts)
IS: 2950	Code of Practice for design and construction of raft foundations
IS: 2974	Code of Practice for design and construction of machine foundations (All parts)
IS: 4091	Code of practice for Design and construction of foundations for transmission line towers and poles.
IS: 8009	Code of Practice for calculation of settlement of foundations (All parts)
IS: 9556	Code of Practice for design and construction of diaphragm walls
IS: 11089	Code of Practice for design and construction of ring foundation
IS: 13301	Guidelines for vibration isolation for machine foundations.

2.4.0 LOADING

IS: 875	Code of practice for structural safety of building – loading standards Bridge rules of Government of India, Ministry of Railways 9 Railway Board)
IS: 1911	Schedule of unit weights of building materials.

2.5.0 MASONRY

IS: 712	Building limes

IS: 1077	Common Burnt Clay Building bricks.
IS: 1127	Recommendations for dimensions and workmanship of natural building stones for masonry work.
IS: 1528	Methods of sampling and physical tests for refractory materials.
IS: 1597	Code of practice for construction of stone masonry (all parts)
IS: 2212	Code of practice for brickwork.
IS: 2116	Sand for masonry mortars.
IS: 2185	Concrete masonry units (all parts – hollow & solid concrete blocks)
IS: 2250	Code of practice for preparation and use of masonry mortars.
IS: 2572	Code of practice for construction of hollow concrete blocks.
IS: 2691	Burnt clay facing bricks.
IS: 3414	Code of practice for design and installation of joints in buildings.
IS: 3495	Methods of test of burnt clay building bricks.
IS: 4441	Code of practice for use of silicate type chemical resistant mortars.
IS: 4860	Acid resistant bricks.
IS: 1905	Code of practice for structural use of unreinforced masonry.
IS: 10440	Code of practice for construction of reinforced brick and reinforced brick concrete floors and roofs.
IS: 1905	. Code of Practice for structural use of unreinforced masonry
IS: 12894	Specification for Pulverized Fuel Ash (Fly Ash) Lime Bricks

2.6.0 DOORS, WINDOWS AND VENTILATORS

IS: 399	Classification of commercial timbers and their zonal distribution
IS: 883	Code of practice for design of structural timber in building.
IS: 1038	Steel doors, windows and ventilators
IS: 1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
IS: 1361	Steel windows for industrial buildings
IS: 1948	Aluminium doors windows and ventilators
IS: 1949	Aluminium windows for industrial building
IS: 2191	Wooden flush door shutters (cellular and hollow core type)
IS: 2202	Wooden flush door shutters (solid core type)
IS: 2835	Transparent sheet glass for glazing and framing purposes
IS: 3103	Code of practice for Industrial ventilation.
IS: 3548	Code of practice for glazing in buildings
IS: 3614	Specification for Fire check doors.
IS: 4021	Timber door, windows and ventilator frames.
IS: 4351	Specification for Steel door frames.
IS: 6248	Metal rolling shutters and rolling grills.

2.7.0 ROOF AND FLOORING

IS: 2204	Code of practice for construction of reinforced concrete shell roof.
IS: 3201	Criteria for the design and construction of precast concrete trusses.
IS: 2210	Criteria for design of RC shell structures and folded plates.
IS: 809	Rubber flooring materials for general purposes.
IS: 1195	Bitumen mastic for flooring.
IS: 1196	Code of practice for laying bitumen mastic flooring.
IS: 1198	Code of practice for laying, fixing and maintenance of linoleum floors.

IS: 1237	Cement concrete flooring tiles.
IS: 1443	Code of practice for laying and finishing of cement concrete flooring tiles.
IS: 2114	Code of practice for laying in situ terrazzo floor finish.
IS: 2571	Code of practice for laying in situ cement concrete flooring.
IS: 5491	Code of practice for laying in situ granolithic concrete floor topping.
IS: 5766	Code of practice for laying burnt clay brick flooring.
IS: 1197	Code of practice for laying of rubber floors.
IS: 2441	Code of practice for fixing ceilings coverings.

2.8.0 WATER PROOFING

IS: 1322	Bitumen felts for waterproofing and damp proofing
IS: 1346	Code of practice for waterproofing of roofs with bitumen felts
IS: 1609	Code of practice for laying damp proof treatment using bituminous felts.
IS: 3036	Code of practice for laying lime concrete for a waterproofed roof finish.
IS: 3037	Bitumen mastic for use in waterproofing of roofs.
IS: 3067	Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.
IS: 3384	Bitumen primer for use in water proofing and damp proofing.
IS: 4365	Code of practice for application of bitumen mastic for waterproofing of roofs.

2.9.0 SOIL ENGINEERING

IS: 1498	Classification and identification of soils for general engineering purposes.
IS: 1892	Code of practice for sub-surface investigation for foundations.
IS: 2131	Method of standard penetration test for soils.
IS: 2720	Methods of test for soils (all Parts)

2.10.0 WATER SUPPLY, DRAINAGE AND SEWERAGE

IS: 404	Lead pipes
IS: 458	Concrete pipes
IS: 651	Salt glazed stoneware pipes and fittings.
IS: 771	Glazed fire-clay sanitary appliances (all parts)
IS: 774	Flushing cisterns for water closets and urinals other than plastic cisterns.
IS: 783	Code of practice for laying of concrete pipes.
IS: 1172	Code of basic requirement for water supply, drainage and sanitation
IS: 1626	Asbestos cement building pipes, gutters and fittings (all parts)
IS: 1742	Code of practice for building drainage.
IS: 2064	Code of practice for selection, installation and maintenance of sanitary appliances.
IS: 2065	Code of practice for water supply in buildings.
IS: 2470	Code of practice for installation of septic tanks (all parts)
IS: 3114	Code of practice for laying of Cast iron pipes.
IS: 4127	Code of practice for laying of glazed stoneware pipes.
IS: 12251	Code of practice for Drainage of Building basement.
IS: 1200	Method of measurement: Laying of water and [Part-XVI] sewer lines including appurtenant items/
IS: 1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS: 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS: 3486	Cast iron spigot and socket drain pipes.
IS: 5329	Code of practice for sanitary pipe work above ground for buildings.
IS: 3076	Low density polyethylene pipes for portable water supplies.

IS: 1538	Cast iron fittings for pressure pipes for water, gas and sewage.
IS: 1230	Cast iron rainwater pipes and fittings.
IS: 1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS: 784	Prestressed concrete pipes.
IS: 1726	Cast iron manhole covers and frames.
IS: 5961	Cast iron grating for drainage purposes.
IS: 5219 (Part-I)	"P" and "S" traps.
IS: 772	General requirements for enameled cast iron sanitary appliances.
IS: 775	Cast iron brackets and supports for wash basins and sinks.
IS: 777	Glazed earthenware wall tiles.
IS: 2548	Plastic water closet seats and covers (all parts)
IS: 2527	Code of practice for fixing rainwater gutters and downpipes for roof drainage.

2.11.0 PAVING AND RAOD WORKS

IS: 73	Paving bitumen
IS: 702	Industrial bitumen
IS: 1201	Method of testing tar and bituminous material. Thru' 1220
	Practice followed by Indian Road Congress (all parts)

2.12.0 EARTHQUAKE RESISTANT DESIGN

IS: 1893	Criteria for earthquake resistant design of structures.
IS: 4326	Code of practice for earthquake resistant design and construction of buildings.

2.13.0 CHIMNEY

IS: 4998	Criteria for design of RC chimneys (all parts).

2.14.0 COOLING TOWER

BS: 4485 (part-4)	Structural design of cooling towers.

2.15.0 STRUCTURAL STEELWORK

IS: 800	Code of practice for general construction in steel
IS: 802	Code of practice for use of structural steel in Overhead Transmission Line (all parts).
IS: 806	Code of practice for use of steel tubes in general building construction.
IS: 808	Rolled steel beams, channels and angle sections.
IS: 813	Scheme of symbols for welding
IS: 814	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.
IS: 816	Code of practice for use of metal arc welding for general construction in mild steel.
IS: 817	Code of practice for training and testing of metal arc welders.
IS: 818	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS: 819	Code of practice for Resistance spot welding for light assemblies in Mild steel.
IS: 919	Recommendations for limits and fits for engineering.
IS: 1024	Code of practice for use of welding in Bridges and structures subjected to Dynamic loading.
IS: 1161	Steel tubes for structural purposes.
IS: 1182	Recommended practice for Radiographic examination of Fusion Welded Butt joints in steel Plates.
IS: 1200 (part-VIII)	Method of measurement of steelwork and ironwork.
IS: 1239	Mild steel tubes, tubulars and other wrought steel fittings (all parts)
IS: 1363	Black hexagonal bolts, nuts and locknuts (dia. 6 to 39mm) and black hexagon screws (dia. 6 to 24mm) [all parts]
IS: 1364	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. Range 6 to 39mm) [all parts]
IS: 1365	Slotted counter sunk head screws (dia. range 1.6 to 20mm)
IS: 1367	Technical supply conditions for threaded steel fasteners.
IS: 1443	Code of practice for laying and finishing of cement concrete flooring tiles.
IS: 1608	Method for tensile testing of steel products.
IS: 1730	Dimensions for steel plate, sheet and strip for structural and general engineering purpose.
IS: 1731	Dimensions for steel flats for structural and general engineering purposes.
IS: 1852	Rolling and cutting tolerance for hot rolled steel products.

IS: 1977	Structural steel (ordinary quality)
IS: 2016	Plain washers
IS: 2062	Steel for general structural purposes.
IS: 2074	Ready mix paint, air drying, red oxide zinc-chrome, priming.
IS: 2633	Methods of testing uniformity of coating of zinc coated articles.
IS: 3613	Acceptance tests for wire-flux combinations for submerged arc welding of structural steel
IS: 3664	Code of practice for Ultrasonic Pulse echo testing by contact and immersions method.
IS: 3757	High strength structural bolts.
IS: 4000	High strength bolts in steel structures.
IS: 4759	Hot dip zinc coatings on structural steel and other allied products.
IS: 5334	Code of practice for Magnetic particle flaw detection of welds.
IS: 7215	Tolerances for fabrication of steel structures.
IS: 7318 (part-I)	Approval test for welders when welding procedure approval is not required.
IS: 8500	Structural steel- micro alloyed (medium and high strength qualities)
IS: 9595	Recommendation for metal arc welding of carbon and carbon manganese steels.
AWS D.1.1	Structural welding code
IS: 8640	Recommendations for dimensional parameters for industrial building.
IS: 9178	Criteria for design of steel bins for storage of bulk material (all parts)
IS: 12843	Tolerances for erection of steel structures.

2.16.0 PAINTING

IS: 348	Specification for French polish
IS: 427	Specification for distemper, dry colour as required.
IS: 428	Specification for distemper, oil emulsion, colour as required.
IS: 1477 (part-I & II)	Code of practice for painting of ferrous metal in buildings.
IS: 2338 (I & II)	Code of practice of finishing wood and wood based materials.
IS: 2339	Specification for Aluminium paints for general purpose in dual containers.
IS: 2395	Code of practice for painting concrete, masonry and plaster surface.

IS: 2932	Specification for enamel, synthetic, exterior – a) undercoating, b) finishing
IS: 2933	Specification for enamel, exterior – a) undercoating, b) Finishing
IS: 5410	Specification for cement paint.

2.17.0 OTHER

Indian Road Congress (IRC) Bridge Codes.

Indian Railway Standard Bridge Rules.

3.0.0 GENERAL

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to. The bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications. In case of any conflict between stipulations in various portions of the specifications, most stringent stipulation would be applicable for implementation by the bidder without any extra cost to the employer.

4.0.0 LAYOUT

Before starting the work, the contractor shall carry out the setting out of foundation and structures and provide levels with reference to general existing grid and bench mark. If the contractor uses the grid, bench mark and reference pillar made by other contractors, he shall coordinate with the contractor and shall satisfy himself of the accuracy of the reference marks. If he is required to set out the foundation afresh, he shall do so independently with reference to the existing grid and bench mark which has been followed by other agency at the instruction of the Engineer. In case any discrepancy is found, it shall be immediately brought to the notice of the Engineer for any rectification/modification necessary. No complaint shall be entertained at a later stage. The contractor shall accurately set out the position for holding down bolts and inserts.

If required, in the opinion of the Engineer, he shall construct and maintain pillars for grid, references and bench marks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layouts and levels. The contractor shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Tenderer's shall take into account the cost of these in quoting their price.

5.0.0 WORKMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. in addition to the requirement specified above, if the bye laws of the local govt., Municipal or the other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

6.0.0 TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the contract shall be provided by the contractor at its own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such Temporary work shall have the prior approval of the Engineer, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by the other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and re-erection, if required, shall be carried out by the contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the contractor.

7.0.0 INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE

Modification in layout of foundation/structure during engineering stage may be necessary to avoid fouling with those under other's scope. Necessary changes on this account will be made without any extra cost to Owner.

8.0.0 SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the Contractor. A programme of work is to be submitted for the Engineer's Review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.

The Contractor shall regularly submit to the Engineer progress reports for the periods of working as specified by the Engineer showing up to date progress on all important items of work.

9.0.0 CONSTRUCTION METHODOLOGY

Construction and erection activities shall be fully mechanized from the start of the work. All excavation and back filling shall be done using excavators, dumpers, dozers, poclains, excavator mounted rock breakers, rollers, sprinklers, water tankers etc. Manual excavation can be done only on isolated places with specific approval of Engineer.

Dewatering shall be done using the combination of electrical and standby diesel pumps.

For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.

All handling of materials shall be with cranes.

Heavy trailers shall be used for the transportation. Mechanized modular units of scaffolding and shuttering shall be used.

Grouting shall be carried out using Hydraulically controlled grouting equipment.

All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.

Heavy duty hoists for lifting of construction materials shall be used.

Compressors for cleaning of foundations and other surfaces shall be used.

Field laboratory shall be provided with all modern equipment’s for survey, testing of soil, aggregates, concrete, welding etc.

All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

PART- II

SPECIAL TECHNICAL REQUIREMENTS (CIVIL & ARCHITECTURAL)

VOLUME: IIG/1

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORKS

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VOLUME: IIG/1 : GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORKS

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VOLUME: IIG/1

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORKS

1.00.00 GENERAL

This specification is intended to cover general as well as technical specification required for design, supply, execution & erection of complete Civil, Structural and Architectural and miscellaneous works required for completion of 1x800 MW Super Critical Thermal Power Plant to the satisfaction of the Owner.

The work shall include design, construction and erection activities of both underground and above ground civil and structural works and shall include all working drawing, labor, materials, plants, equipment, transportation and all incidental items not shown or specified explicitly but reasonably implied and necessary for proper completion of the project, all in strict compliance with this specification, including the revision and amendments thereto as may be required during the execution of the work.

The work shall be carried out according to the design/drawing to be developed by the Contractor and approved by the Owner. For all building, structure, foundations, roads, drainage, necessary details and layout shall be prepared by the Contractor keeping in view the functional requirement of the plant and the facilities and providing enough space and access for operation use and maintenance. The drawings and specifications attached herewith do not provide complete description of each and every system but state the minimum functional requirement for the plant as a whole or certain individual components.

All the quality of works and standards pertaining to field and laboratory testing, excavation, concreting, fabrication, erection, welding and other technical requirements covered under this specification shall strictly conform to the respective technical specifications annexed hereto. The specifications are intended for the general description of the work, quality and workmanship. The specifications are not, however, intended to cover the minutest details and the work shall be executed according to the spirit of the specification and in the absence thereof according to the relevant latest Indian Standard Codes. In absence of the later, the work shall be executed according to the local public work department practice or to the recommendation of relevant American & British Standards or to the instruction of the Owner. The IS Codes to be followed are mentioned in the relevant Technical specification for different items of works. The bidder is expected to get clarified any doubts about the specification etc., before bidding through discussion with the Owner recorded in writing in respect of interpretation of any portion of this documents. The Owner reserves the right to alter/amend any part/criteria of this specification in the interest of the project without creating any financial implication whatsoever on the part of Owner.

Before bidding the contractor shall visit the site to get themselves fully acquainted with site condition, approaches, transport facilities, off- site facilities, availability of materials, storage space, fabrication and bar bending yard, accommodation of workmen, site office, testing laboratory and other assorted facilities. The bidder or its consultants, if any, shall have well-equipped design

office with modern drafting, computing and transmission facilities to comply with high rate of drawing/document production pertaining to civil & structural system to meet the stipulated time frame laid down in the specification. No extra claim shall be entertained for any unforeseen reason.

2.00.00 SCOPE OF CIVIL AND STRUCTURAL WORKS

The scope of civil and structural work comprises all necessary investigations, survey, foundations, building, superstructures and infrastructure required for the complete operating of power station. The scope of work includes all the following works in conformity with approved Mechanical / Electrical layout drawings but not limited to the following.

A. Site preparation

- Area Grading, leveling and dressing

  a) Finished Grade Level to be raised to RL 72.0M in Power block area. FGL of CHP area will be at RL 78M. Area grading and filling work for the entire plant area to be included as per levels shown in tender drawing (K9213R-DWG-S-0002). The land filling work shall also include construction of embankment and filling for extension of coal stockyard towards existing effluent pond at 800E.

  b) All slope Protection work and other necessary works to be considered within the scope of work. Slope protection for sides of filled up area and embankment in coal stack yard area as stated above. The type and extent of slope protection is shown in tender drawing (K9213-DWGR-S-0002).

  c) The entire work to be carried out in accordance with Technical Specification as given in Volume II G3/III.

  d) Removing the trees and bushes in the plant area will be in the scope of GSECL & grading work up to the finished grade level of the new plant, which is proposed to be at 72.00M above sea level will in the scope of bidder.

- Soil investigation for entire plant area including CHP and River intake pump house.
- Demolition of existing facilities/structures including underground structure/facilities including rerouting the same, if any and site clearance., for all except as indicated in list of exclusion.
- Demolition of existing track hopper and associated accessories and auxiliaries.

B. Power Block area

- Power house building including Control room, Turbo Generator foundation and other equipment foundation
- Boiler area foundations including Boiler, ESP, Fan foundations, Duct supporting columns and other foundations (Equipment and structural steel work for boiler and auxiliaries will be covered under mechanical sections).
- Mill Building including coal bunkers.
- Mill reject storage bins or silos.
- ESP Control Room.
- RCC Chimney (Steel lining).

C. Transformer yard

- Transformer yard foundations and substructure including Transformer foundations, Rail track, fire wall, common oil pits, electrical trenches, pull pits and duct bank, drainage, fencing and surfacing with gravel etc. all complete
- All other buildings and structures as per approved electrical layout.

D. Switchyard

- Switchyard structures, foundations, drains, pits, switchyard concrete roads, RCC cable trench, fencing and surfacing with gravels etc. all complete
- All other buildings and structures as per approved electrical layout.

E. Coal Handling system

- Wagon Tippler (2 nos) : The location of wagon tipplers shall be in line with the latest Plot Plan drawing (Drg. No. K9213R-DWG-M-002). The EPC contractor has to construct 2 nos of wagon tipplers as per the specified location.
- In motion weigh bridge on proposed track for unit # 8.
- RCC tunnel
- Transfer point.
- Pent house.
- Crusher house.
- Stacker/Reclaimer.
- Crushed Coal stock pile yard including paving and drainage system.
- Control room / MCC room for coal handling plant..
- All other buildings and structures as per approved mechanical layout.

F. Ash Handling system

- Bottom Ash Slurry pit and pump house
- Ash compressor building.
- Ash handling plant control room.
- Ash water pump house.
- Ash pipe corridor
- Fly Ash Silo with concrete approach road.
- All other buildings and structures as per approved mechanical layout.

G. Fuel oil System

- LDO/HFO Day Tank foundations and dykes.
- FO pressurizing pump house
- LDO/HFO pipe corridor.
- FO Transfer pump house
- All other buildings and structures as per approved mechanical layout.

H. Raw water supply and pretreatment system including Intake

- River Intake pump house, approach bridge and shore protection work. (Also refer Section 2.01.00 for River Intake Pump House and Approach Bridge)
- Pre-Treatment Plant
- Clarified water reservoir.
- Clarified water pump house.
- Chlorination Plant.
- Side stream filter.
- All other buildings and structures as per approved mechanical layout.

I. Demineralised water supply system

- DM Plant, DMW STG Tanks, Chem. House etc
- All other buildings and structures as per approved mechanical layout.

J. CCW system

- ND cooling tower.
- Cooling water pipes and return pipes upto inlet flange of cooling tower including their supports and foundations, thrust blocks etc. wherever required.
- CW pump house.

- All other buildings and structures as per approved mechanical layout.

K. Fire fighting system

- Clarified and Fire water reservoir
- Clarified & Fire water Pump house
- Fire Station Building
- All other buildings and structures as per approved mechanical layout.

L. Other Utility services and Non-plant Building

- Effluent Treatment plant.
- Pipe and Cable rack.
- Technical and Service Building with furniture of approved make.
- DG & Compressor Building.
- Stores comprising of 5 nos of store godowns, each of approximate size of 200 sqm, one store office of approximate size 100 sqm surrounded by brick masonry compound wall and one weigh bridge of minimum 40 MT capacity.
- HCSD Pump House.
- Canteen Building with furniture of approved make.
- Watch Tower (4 nos)
- Water Harvesting Well – to be provided with every building; Additional 10 (Ten) nos shall be provided in different area.
- Miscellaneous tank foundations and dykes.
- Yard Toilets – 2 nos (one in main plant and one in CHP)
- Owner's site office of 3500 sqft area.

M. Plant roads and drainage

- Roads, culvert & pavement within the battery limit of this specification and as shown in Plot Plan. The scope shall also include modification and diversion of existing roads, where necessary. Approach road for ETP area & Ash water Clarifier area.
- Storm water drain, plant drainage and outfall structure.
- Sanitary sewer including inspection pits, manholes etc. and treatment plant. STP by others.
- Plant roads will be of Reinforced Concrete rigid pavement in general.

N. Piling work for foundations and substructures, if necessary

O. Boundary walls / Fencing around any buildings/area, if required from statutory point of view.

P. Main plant paving including plinth protections around building and structures

Q. Slope protection for embankment including required filling work in plinth and plant area and RCC retaining wall along with pile wherever required.

R. Chain link/barbed wire fencing around unit #8 as per tender drawing K9213-DWG-S-0002R and wherever else required to be included..

S. Diversions of existing Boiler drain pipe line and laying the same as per specification given in Volume IIG/3 Section XXXI.

T. Construction of 6.5m wide RCC road from proposed Ash silo to existing Brick plant (approximately 1600M long) in between 800E and 450W.

U. All buildings, facilities, equipments for unit #8 to be located beyond 200m distance from Mahi River Bank as per MOEF requirements.

V. Architectural finishing including flooring, paving, cladding, masonry works, plastering, painting, false ceiling, doors & windows, plumbing, roof treatment, anti-termite treatment etc

W. The scope shall also include all necessary civil work (mainly civil foundation) pertaining to erection of stator/any other equipment (if required).

The scope shall also include setting up by the Contractor a complete testing laboratory in the field to carry out all relevant tests required for the civil works for the project.

The Bidder shall visit the site and assess the involvement of demolition and site clearance, area grading if required, within the plant area to construct the project.

There is a nala towards North-East corner of the plot outside the plant boundary discharging into Mahi River. The proposed outfall structure for plant drainage shall be located at a suitable location on the discharge canal.

The work shall have to be carried out both below and above the ground level.

Additional site investigations, surveys, grading and leveling and other additional works shall be carried out by the Contractor, if necessary.

The layout and levels of all structures shall be made by the Contractor at his own cost from the general grid of the plot and the nearest GSI bench mark or other acceptable bench mark of Govt. Dept. The Contractor shall be solely responsible for the correctness of the layout and levels.

All necessary statutory clearances shall be obtained by the Bidder prior to execution of work under scope of this specification.

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to by the Contractor

2.01.00 **River Water Intake**

The river water intake pump house shall be on Mahi River at a location about 500 m from Plant Site. River water shall be drawn and supplied to Pump House inside plant boundary through pipe lines.

The contractor has to select the most suitable location of Intake structure and design the pump house together with water conveying system on the basis of flow of river e.g., highest and lowest water levels, discharge, river bed material, etc., its past characteristics and other parameters collected by him from concerned authorities for this work. The location of the pump house shall be governed by the maximum and minimum water depth at the river section to ensure supply of raw water throughout the year. The contractor has to submit river flow data and all other relevant information to establish his design.

The scope of work shall also include :

a) Surveying River Section, shore and pipe corridor upto plant for the above work. In river section cross sections shall be taken at right angles to the river and at 50M chainage. In every cross section the bed levels shall be taken at 10M intervals.

b) Carrying out Geotechnical investigation at river bed and shore for above work and obtain Hydraulic data for design of well and its foundation.

c) Underwater works for river bed protection around pump house, navigation aids and measures to guard water-borne structure against river-traffic.

d) Facilities on the bank such as electrical switchgear room, transformer foundations and miscellaneous associated civil works.

e) Provide and maintain safe approaches to pump house location from river bank, as necessary, to bring materials, labour, construction plants tools and machineries till successful completion of the work.

The proposed work shall be in line with approved construction drawings. Construction drawings showing complete nature of work shall be furnished to the Owner's Consultants progressively for approval during execution of the work

The materials removed from inside the well are to be disposed off in a manner and at locations as would be advised by Owner and this aspect is to be covered in the quoted price.

The work to be performed under this Contract consists of providing all labour, materials, scaffolding, construction equipment, tools & plants, supplies, transportation, all incidental items not shown or specified but reasonably implied or necessary for successful completion of the work including Contractor's supervision and in strict accordance with the approved drawings & technical specifications.

The scope of work shall also include executing of any temporary work for on-time and successful completion of entire work and removing the same after its completion.

2.02.00 **List of Exclusions**

a. New Railway Track for unit # 8

b. Dismantling and Rerouting of underground structures like Gravity Drain and waste water trench.

c. Security Gate, Security office, Time Office.

d. Sewage Treatment Plant

e. Dismantling and rerouting of 300mm dia M.S. pipe line and 400mm dia C.I. Pipe line from jack well to existing pump house and Stabilization pond no. 02 & 03

f. Green belt development

2.03.00 **Terminal Points**

Storm and Plant drainage	Upto Mahi River; Outfall structure to be constructed near existing drainage nala.
Plant Service Road	Existing Plant Road
Sanitary Facilities	Upto New Sewage Treatment Plant to be constructed by others.
Site Grading	Site Battery limits to final elevation.
Site Battery limit fencing	Site perimeter.

2.04.00 **Notes**

a) This section shall be read in conjunction with Lead Specification and General conditions of contract.

b) For Architectural requirements of the plant Volume IIG/2 shall be referred to.

c) In the event, any contradictions, confusion arises for any statement / condition / terms pertaining to design of civil engineering systems, stated elsewhere in addition to this section, the statement furnished in this section shall prevail.

d) In the event, the bidder notice any inadvertent error / mistake published in the specification, the same shall be immediately brought to notice of the Owner.

3.00.00 **CODES AND STANDARDS**

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions/Technical Specifications as appropriate. The latest editions/revision of following codes and standards along with addendums/amendments, if any, shall be followed :

3.01.00 **General**

a) Internationally accepted design Codes and Standards where Indian Codes are not available and which are equivalent to Indian Standards.

b) National Building Code of India.

c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.

d) IS-1200 : Method of measurement of Building and Civil Engineering Works.

e) IS-1256 : Code of Practice for Building Byelaws.

3.01.01 Earthwork

a) IS-1498 : Classification and identification of soils for General Engineering purposes.

b) IS-3764 : Safety Code for excavation work.

c) IS-7293 : Safety Code for working with construction machinery.

3.01.02 Concrete

a) IS-269 : Ordinary and low heat portland cement.

b) IS-383 : Coarse and fine aggregate from natural sources for concrete.

c) IS-432 : Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.

d) IS-455 : Portland Slag Cement.

e) IS-456 : Code of Practice for Plain and reinforced concrete.

f) IS-460 : Test Sieves (all parts).

g) IS-516 : Methods of test for strength of concrete.

h) IS-1199 : Methods of sampling and analysis of concrete.

i) IS-1566 : Hard drawn steel wire fabric for concrete Reinforcement.

j) IS-1786 : High strength deformed steel bars and wires for concrete reinforcement.

k) IS-1834 : Hot applied sealing compounds for joints in concrete.

l) IS-2386 : Methods of test for aggregates for concrete (all parts).

m) IS-2502 : Code of practice for bending and fixing of bars for concrete reinforcement.

n) IS-3370 : Code of practice for concrete structures for storage of liquids (all parts).

o) IS-3414 : Code of practice for design and installation of joints in buildings.

p) IS-4948 : Welded steel wire fabrics for general use.

q) IS-6452 : High Alumina Cement for Structural use.

r) IS-7320 : Concrete slump test apparatus.

s) IS-7861 : Code of practice for extreme weather concreting (all parts).

t) IS-8041 : Rapid Hardening Portland Cement.

u) IS-8112 : High strength ordinary Portland Cement.

v) IS-10262 : Recommended guidelines for concrete mix design.

w) IS-12269 : 53 grade ordinary Portland Cement

3.01.03 Foundations

a) IS-1904 : Code of practice for structural safety of buildings : Shallow foundations.

b) IS-2950 : Code of practice for design and construction of raft foundations.

c) IS-2974 : Code of practice for design and construction of Machine foundations (all parts).

d) IS 2911 : Code of practice for Design and Construction of Pile Foundation.

3.01.04 Loading

a) IS-875 : Code of practice for Structural safety of buildings - loading standards.

b) : Bridge Rules of Government of India, Ministry of Railways (Railway Board).

3.01.05 Masonry

a) IS-712 : Building limes.

b) IS-1077 : Common Burnt Clay Building Bricks.

c) IS-1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.

d) IS-1528 : Methods of sampling and physical tests for refractory materials.

e) IS-1597 : Code of practice for construction of stone masonry (all parts).

f) IS-2212 : Code of practice for brickwork.

g) IS-2116 : Sand for masonry mortars

h) IS-2185 : Concrete masonry units.
(all parts - Hollow and Solid concrete blocks).

i) IS-2250 : Code of practice for preparation and use of masonry mortars.

j) IS-2572 : Code of practice for construction of hollow concrete block masonry.

k) IS-2691 : Burnt clay facing bricks.

l) IS-3414 : Code of practice for design and installation of joints in buildings.

m) IS-3495 : Methods of tests of burnt clay building bricks.

n) IS-4441 : Code of practice for use of Silicate type chemical resistant mortars.

o) IS-4860 : Acid Resistant Bricks.

3.01.06 Doors, Windows and Ventilators

a) IS-399 : Classification of commercial timbers and their zonal distribution.

b) IS-883 : Code of practice for design of structural timber in building.

c) IS-1003 : Timber paneled and glazed shutters (all parts).

d) IS-1038 : Steel doors, windows and ventilators.

e) IS-1081 : Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.

f) IS-1361 : Steel windows for industrial buildings.

g) IS-2835 : Transparent sheet glass for glazing and framing purposes.

h)	IS-1948	:	Aluminium doors windows and ventilators.
i)	IS-1949	:	Aluminium windows for industrial building.
j)	IS-2191	:	Wooden flush door shutters (Cellular and hollow core type).
k)	IS-2202	:	Wooden flush door shutters (solid core type).
l)	IS-3103	:	Code of practice for Industrial ventilation.
m)	IS-3548	:	Code of practice for glazing in buildings.
n)	IS-3614	:	Fire check doors.
o)	IS-4021	:	Timber door, windows and ventilator frames.
p)	IS-4351	:	Steel door frames.
q)	IS-6248	:	Metal rolling shutters and rolling grills.

3.01.07 Roof and Flooring

a)	IS-2204	:	Code of practice for construction of reinforced concrete shell roof.
b)	IS-3201	:	Criteria for the design and construction of precast concrete trusses.
c)	IS-2210	:	Criteria for Design of R.C. shell structures and folded plates.
d)	IS-809	:	Rubber flooring materials for general purposes.
e)	IS-1195	:	Bitumen mastic for flooring.
f)	IS-1196	:	Code of practice for laying bitumen mastic flooring.
g)	IS-1198	:	Code of practice for laying, fixing and maintenance of linoleum floors.
h)	IS-1237	:	Cement concrete flooring tiles.
i)	IS-1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
j)	IS-2114	:	Code of practice for laying in situ terrazzo floor finish.
k)	IS-2571	:	Code of practice for laying in situ cement concrete flooring.
l)	IS-5491	:	Code of practice for laying in situ granolithic concrete floor topping.
m)	IS-5766	:	Code of practice for laying burnt clay brick flooring.

n) IS-1197 : Code of practice for laying of rubber floors.

o) IS-2441 : Code of practice for fixing ceiling coverings.

3.01.08 Waterproofing

a) IS-1322 : Bitumen felts for waterproofing and damp proofing.

b) IS-1346 : Code of practice for waterproofing of roofs with bitumen felts.

c) IS-1609 : Code of practice for laying damp proof treatment using bituminous felts.

d) IS-3036 : Code of practice for laying lime concrete for a waterproofed roof finish.

e) IS-3037 : Bitumen mastic for use in waterproofing of roofs.

f) IS-3067 : Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.

g) IS-3384 : Bitumen primer for use in water proofing and damp proofing.

h) IS-4365 : Code of practice for application of bitumen mastic for waterproofing of roofs.

3.01.09 Soil Engineering

a) IS-1498 : Classification and identification of soils for general engineering purposes.

b) IS-1892 : Code of practice for sub-surface investigation for foundations.

c) IS-2131 : Method for standard penetration test for soils.

d) IS-2720 : Methods of test for soils (all parts).

3.01.10 Water Supply, Drainage and Sewerage

a) IS-404 : Lead pipes

b) IS-458 : Concrete pipes

c) IS-651 : Salt glazed stoneware pipes and fittings.

d) IS-771 : Glazed fire-clay sanitary appliances (all parts).

e) IS-774 : Flushing cisterns for water closets and urinals other than plastic cisterns.

f)	IS-783	:	Code of practice for laying of concrete pipes.
g)	IS-1172	:	Code of basic requirements for water supply, drainage and sanitation.
h)	IS-1626	:	Asbestos cement building pipes, gutters and fittings (all parts).
i)	IS-1742	:	Code of practice for building drainage.
j)	IS-2064	:	Code of practice for selection, installation and maintenance of sanitary appliances.
k)	IS-2065	:	Code of practice for water supply in buildings.
l)	IS-2470	:	Code of practice for installation of septic tanks (all parts).
m)	IS-3114	:	Code of practice for laying of Cast Iron pipes.
n)	IS-4127	:	Code of practice for laying of glazed stoneware pipes.
o)	IS-12251	:	Code of practice for Drainage of Building Basement.
p)	IS-1200	:	Method of measurement: Laying of water and [Part-XVI] sewer lines including appurtenant items.
q)	IS-1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
r)	IS-1537	:	Vertically cast iron pressure pipe for water, gas and sewage.
s)	IS-3486	:	Cast iron spigot and socket drain pipes.
t)	IS-5329	:	Code of practice for sanitary pipe work above ground for buildings.
u)	IS-3076	:	Low density polyethylene pipes for potable water supplies.
v)	IS-1538	:	Cast iron fittings for pressure pipes for water, gas and sewage.
w)	IS-1230	:	Cast iron rainwater pipes and fittings.
x)	IS-1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
y)	IS-784	:	Prestressed concrete pipes.
z)	IS-1726	:	Cast iron manhole covers and frames.
aa)	IS-5961	:	Cast iron grating for drainage purposes.

bb) IS-5219 [Part-I] : "P" and "S" traps.

cc) IS-772 : General requirements for enamelled cast iron sanitary appliances.

dd) IS-775 : Cast iron brackets and supports for wash basins and sinks.

ee) IS-777 : Glazed earthenware wall tiles.

ff) IS-2548 : Plastic water closet seats and covers (all parts).

gg) IS-2527 : Code of practice for fixing rainwater gutters and downpipes for roof drainage.

3.01.11 Paving and Road works

a) IS-73 : Paving bitumen

b) IS-702 : Industrial Bitumen

c) IS-1201 : Method of testing tar and bituminous materials. thru' 1220

d) Practice followed by Indian Road Congress (all parts).

3.01.12 Earthquake Resistant Design

a) IS-1893 : Criteria for earthquake resistant design of structures.

b) IS-4326 : Code of practice for earthquake resistant design and construction of buildings.

3.01.13 Chimney

a) IS-4998 : Criteria for Design of R.C. Chimneys (all parts).

3.01.14 Structural Steelwork

a) IS-800 : Code of practice for general construction in steel.

b) IS-802 : Code of practice for use of structural steel in Overhead Transmission Line.

Part-I : Load and permissible stresses.

Part-II : Fabrication, Galvanizing, Inspection & Packing.

c) IS-806 : Code of practice for use of steel tubes in general building construction.

d) IS-808 : Rolled steel beams, channels and angle sections.

e)	IS-813	:	Scheme of symbols for welding.
f)	IS-814	:	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.
g)	IS-816	:	Code of practice for use of metal arc welding for general construction in mild steel.
h)	IS-817	:	Code of practice for training and testing of metal arc welders.
i)	IS-818	:	Code of practice for safety and health requirements in electric and gas welding and cutting operation.
j)	IS-819	:	Code of practice for Resistance spot welding for light assemblies in Mild Steel.
k)	IS-919	:	Recommendations for limits and fits for engineering.
l)	IS-1024	:	Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading.
m)	IS-1161	:	Steel tubes for structural purposes.
n)	IS-1182	:	Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates.
o)	IS-1200 [Part-VIII]	:	Method of measurement of steelwork and ironwork.
p)	IS-1239	:	Mild steel tubes, tubulars and other wrought steel fittings (all parts).
q)	IS-1363	:	Black hexagonal bolts, nuts and locknuts (dia. 6 to 39 mm) and black hexagon screws (dia.6 to 24 mm). [all parts]
r)	IS-1364	:	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts]
s)	IS-1365	:	Slotted counter sunk head screws (dia. range 1.6 to 20 mm).
t)	IS-1367	:	Technical supply conditions for threaded steel fasteners.
u)	IS-1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
v)	IS-1608	:	Method for tensile testing of steel products.
w)	IS-1730	:	Dimensions for steel plate, sheet and strip for structural and general engineering purpose.

x) IS-1731 : Dimensions for steel flats for structural and general engineering purposes.

y) IS-1852 : Rolling and cutting tolerances for hot rolled steel products.

z) IS-1977 : Structural steel (Ordinary quality)

aa) IS-2016 : Plain Washers

bb) IS-2062 : Steel for General structural purposes.

cc) IS-2074 : Ready mixed paint, air drying, red oxide zinc-chrome, priming.

dd) IS-2633 : Methods of testing uniformity of coating of zinc coated articles.

ee) IS-3613 : Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.

ff) IS-3664 : Code of practice for Ultrasonic Pulse echo testing by contact and immersions methods.

gg) IS-3757 : High strength structural bolts.

hh) IS-4000 : High strength bolts in steel structures.

ii) IS-4759 : Hot dip zinc coatings on structural steel and other allied products.

jj) IS-5334 : Code of practice for Magnetic Particle Flaw detection of welds.

kk) IS-7215 : Tolerances for fabrication of steel structures.

ll) IS-7280 : Base-wire electrodes for sub-merged arc welding of structural steels.

mm) IS-7318 [Part-I] : Approval test for welders when welding procedure approval is not required.

nn) IS-8500 : Structural steel - microalloyed (medium and high strength qualities).

oo) IS-9595 : Recommendation for metal arc welding of carbon and carbon manganese steels.

pp) AWS D.1.1 Structural Welding Code.

3.01.15 Painting

a) IS-348 : Specification for French Polish.

b) IS-427 : Specification for Distemper, dry colour as required.

c) IS-428 : Specification for Distemper, oil emulsion, colour as required.

d) IS-1477 [I & II] : Code of practice for painting of ferrous metal in buildings.

e) IS-2338 [I & II] : Code of practice for finishing of wood and wood based materials.

f) IS-2339 : Specification for Aluminium Paints for general purposes in dual containers.

g) IS-2395 : Code of practice for painting concrete, masonry and plaster surface.

h) IS-2932 : Specification for enamel, synthetic, exterior - a) undercoating, b) finishing.

i) IS-2933 : Specification for enamel, exterior - a) undercoating, b) finishing.

j) IS-5410 : Specification for cement paint.

3.01.16 a) Indian Road Congress (IRC) Bridge Codes

b) Indian Railway Standard Bridge Rules

3.01.17 Environmental Protection

Charter on Corporate Responsibility for Environmental Protection (CREP) published in Gazette of India dated 27.08.2003.

4.00.00 UNITS AND LANGUAGE

4.01.00 Drawings

- All dimensions will be in SI Units - Metric (English)
- Scales
  - Planning Drawings: Site Layout & Elevations will be at 1:500, Section & Elevation of each building will be at 1:200.
  - Structural and architectural Plans, sections, and elevations will generally be at 1:100 and/or 1:50; for architectural and civil details; 1:1, 1:5, 1:10, 1:20 as required will be used.
  - Site work and yard piping plans will generally be at 1:200, 1:500
- Text will be in English language

4.02.00 **Units for Calculations**

All calculations will be in SI (English) units.

Length	mm, M
Area	mm^2, M^2
Volume (solids)	mm^3, M^3
Volume (liquids)	mm^3, M^3, liter
Density	kN/M^3
Force	N, kN
Pressure (piping)	Bar
Moment	kNM
Stress	Mpa, N/mm^2
Distributed loads, ground pressures, etc.	kN/M^2

English language will be used in calculations

5.00.00 **GENERAL SITE INFORMATION**

The plant will be located inside the existing Wanakbori Thermal Power Station Complex.

The existing Wanakbori Thermal Power Plant has seven (7) nos. 210 MW units. One 800 MW supercritical unit will be installed for augmentation of total plant capacity.

On the north-eastern side of the existing plant adjacent to river Mahi, GSECL has land for the new construction. This land is unused and covered with trees and bushes. The average level of the land is approximately at 64 M above Mean Sea Level (MSL). This is below the design flood level, which is at 69.92M above MSL. The Finish grade level of the existing plant is at 78 M above MSL.

Removing the trees and bushes in the new plant area will be in the scope of GSECL. However if changes in the project is done by EPC Contractor, then tree cutting for additional area shall be in EPC Contractor scope.

Grading work upto the finish grade level, which is proposed to be at 72.0M above MSL, will be in the scope of bidder.

Meteorological Data	
Site Conditions :	
Maximum Ambient Dry Bulb Temp./Relative Humidity	40.8^oC/81.5%
Minimum Ambient Dry Bulb Temp./Relative Humidity	10.8^oC/42.5%
Average Barometric Pressure	1012 mbar
Location	North-eastern side of Wanakbori Thermal Power Station, adjacent to river Mahi.

Design Flood Level	70 M above MSL
Seismic Criteria	III
Wind Design	Basic Wind Speed, Vb = 39m/s
Average Annual Rainfall	750 mm
Rainfall Intensity Rates :	
Rainfall Intensity per Hour for Storm Water Drainage Design	90mm/hr for design purpose
Ground Snow Load	Nil

6.00.00 SITE DEVELOPMENT AND DRAINAGE

6.01.00 Plant Coordinate System

- The site will be surveyed and coordinates for all points determined
- The surveying contractor will establish plant benchmarks and North/South and East/West control lines for control of construction on the plant site. The North/South and East/West control lines will be developed based on grid systems of the existing Plant.
- To facilitate design and construction, a plant grid system and plant north will be established. The plant coordinate system will be laid out based on this grid.
- The plant coordinate system will be indicated on the Plot Plan Drawing.

6.02.00 Grading

All plant levels referred as RL will be with respect to Mean Sea Level (MSL) and all plant elevations referred as EL will be with respect to Power House Building Ground Floor elevation as 0.0M which will be equal to RL 72.30M. The site bench mark will be established by the contractor accordingly.

- Plant grading that may be required will be done considering existing site conditions. Accordingly, the finished grade level of this plant will be kept at RL 72.00 M.
- The road levels will be at 72.15 M.
- The finish floor level of ground floor of all the buildings will be at RL 72.3M.
- The top of grout (under side of equipment base/base plate) for foundations and structures outside building at grade will generally be 200 mm above finished grade. The top of grout (under side of equipment base/base plate) for all equipment foundation at ground floor within the building will generally be 150mm above finished floor unless dictated otherwise by mechanical / electrical system layout.
- Base plates for structural steel building columns will generally be 1250 mm below ground floor in order to keep enlarge portion of gusseted

base below ground. This portion shall be encased in concrete for corrosion protection.

6.03.00 **Drainage**

6.03.01 General

The plant will be provided with gravity drainage systems for the followings:

- Storm water Drainage
- Plant Drainage including Oily Water/ equipment process/chemical waste water
- Sanitary waste/ Foul water Drainage

6.03.02 Storm Water Drainage System

Storm water runoff is runoff from plant areas not subjected to contamination and will be discharged to terminal point via new lifting station if required any. Examples of such areas include building roofs, roads, paved areas, stone surfaced areas, grass surfaced areas, and other natural surfaced areas.

Storm water will be collected via a surface drainage system consisting of open drains, gulley pits or catch basins, manholes and below grade pipe system to terminal points. In general, any surface drainage will be designed so that vehicles and equipment can drive over the finished surface.

For buildings that have a gutter and downspout system, the downspouts will empty to gullies or inspection chambers with sand trap at ground level before discharge to the main drainage system. Drainage from Basements, Cable and pipe trenches will be routed to sumps and connected to the storm water drainage system by pumping system.

The storm drainage system will be designed for maximum rainfall intensity of 90 mm/hour.

For pitched roof with metal sheeting a minimum slope of 1 (V) to 5 (H) and for flat roof a minimum slope of 1(V) to 50 (H) will be provided for efficient drainage of rain water.

The maximum velocity for pipe drains and open drains will be limited to 2.4 M/sec and 1.8 M/sec respectively. However, minimum velocity for self cleansing of 0.6 M/sec will be ensured. Bed slope will not be milder than 1 in 500.

Cast iron pipes will be used below buildings and HDPE pipes will be used for below grade piping drainage system. Manhole will be provided at every 50 M interval, at connection points and at change of alignment.

6.03.03 Plant Drainage System

Oily waste water will pass thru oil water interceptor and then combined with storm water drainage system for ultimately discharged to terminal point. Oily

waste water will include surface run off from transformer compounds, building floors and drains from other oil contaminated areas

Oily waste water will be collected via a surface drainage system consisting of open drains, gulley pits or catch basins and below grade pipe system to terminal points. In general, any surface drainage will be designed so that vehicles and equipment can drive over the finished surface.

The contaminated surface water runoff from rain will be designed for maximum hourly rainfall intensity.

The drainage from transformer pit will be stored in a collecting tank and subsequently passed through oil water interceptor before connecting to the storm water drainage system.

The maximum velocity for pipe drains and open drains will be limited to 2.4 M/sec and 1.8 M/sec respectively. However, minimum velocity for self cleansing of 0.6 M/sec will be ensured. Bed slope will not be milder than 1 in 500.

Cast iron oily pipes will be used below buildings and ductile iron cement lined oily line will be used outdoors. Manhole will be provided at every 50 M interval, at connection points and at change of alignment.

6.03.04 Sanitary Waste Sewer / Foul Water Drainage System

The sanitary waste/ foul water will be discharged to gravity fed foul manhole and then to a sewage treatment plant.

HDPE pipes shall be used for drainage. Sewers will be designed for a minimum self-cleansing velocity of 0.70 m/sec and the maximum velocity will not exceed 2.4 m/sec.

Manhole will be provided at every 50 meter along the length, at connection points and at every change of alignment, gradient or diameter of sewer pipeline.

The slope of sanitary pipe within the buildings will equal 20 mm per meter (1:50). Piping outside the buildings will be designed to maintain a minimum self-cleansing velocity with slopes not milder than 1 in 500.

6.04.00 **Roads**

- All new roads, hardstands will be provided to have accessibility to the plant where required and to be connected with the existing station road network at suitable points.
- The width of all roads will be 7.5M in general except for minor roads which will be 4.0 M.
- Roads will be constructed between raised kerbs and graded to falls leading surface water into catch pits connected to drainage system.
- The roads will be of reinforced concrete rigid pavement in general.

- Roads will be designed for axle load as per IRC recommendation.
- At corners and road intersections within the plant, the minimum radius of turn will be 15.00 M where possible for all class of roads
- Maximum grade will be 5%
- Minimum cross slope will be 2%
- Minimum overhead clearance will be 7.00 M

6.04.01 Pavement/Footpaths in Other areas

Paving as required will be provided using interlocking rubber moulded pre-cast concrete block having M25 grade concrete and minimum 80mm thickness.

6.05.00 **Fencing**

Chain link fencing with gate will be provided around site. 2.4M high galvanized chain link fence with gate shall be provided around all stores and other fenced area and equipments as required.

Transformer compounds will have 2.4M high removable screen type fencing with gate made up of galvanized M.S. bar similar to existing plant.

6.06.00 **Electrical Conduit Protection**

All electrical conduits (duct bank) laid under ground will be encased in concrete. Reinforcements will be provided in the encased concrete at main traffic crossings and other areas requiring access during construction based on the final design and the Construction Sequence.

6.07.00 **Pipe and Electrical Concrete Trenches**

Generally pipe or electrical cables will be taken through concrete trenches with precast concrete covers. The trench covers will be designed for appropriate ground surcharge and vehicle load where necessary.

Generally all cableways outside building will be either thru concrete underground duct banks housing PVC pipes or overhead on pipe rack except for HV cables which will be through trench. However, any trenches located outside buildings will project 150 mm above the finished formation level to avoid ingress of storm water. The bottom of trench will be sloped suitably for draining out the collected water into sump pit.

6.08.00 **Electrical Manholes**

Cast-in-place, reinforced concrete manholes will be provided as required to meet the electrical system construction requirements.

Drainage sumps will be included in all manholes to improve ability to remove water from manholes. The use of portable pumps to remove water from manholes will be considered.

7.00.00 GEO-TECHNICAL CRITERIA

7.01.00 General Description of Soils

Will be as per Geo-Technical Report.

Boring and subsurface data regarding nature of soil, subsoil water etc. shown on drawings or otherwise furnished to the Bidder shall be taken as guidance only. The bidder shall satisfy himself of the character and volume of work under the items and expected surface and/or subsoil water to be encountered. He must satisfy himself about general conditions of the site and ascertain the existing and future obstructions likely to come up during the execution of the contract to carry out work under this scope. The information and data provided herein are for general guidance only and any variation there from shall not affect the terms of the contract. The Owner shall not assume any responsibility for any deduction, conclusion or interpretation made from the above information and data. [Preliminary Soil report to be furnished by GSECL]

7.02.00 Ground Water and Dewatering Requirements

As per Geo-Technical Report.

7.03.00 Excavation Criteria including De-watering

Unless otherwise specifically mentioned in geo-technical report this shall be followed.

Excavation shall be carried out in all types of soil including soft soil, soft moorum, hard moorum, soft rock, hard rock etc.

After excavating to the founding level, the exposed sub-grade will be inspected and proof rolled, if required, prior to placing lean concrete for subsequent placing of rebar, setting forms and placing concrete. Soft or yielding areas will be excavated and replaced with compacted backfill. Bearing grades will be cleaned and kept dry prior to placing concrete.

Excavations will be maintained and protected against earth collapse from natural causes or subsequent construction work and will have stable slopes, as appropriate, to meet local soft conditions and safety codes.

7.04.00 Backfill Criteria

Site-excavated material free from unsuitable material may be used as backfill against pit and sump walls and as structural fill beneath foundations if suitable.

Off-site material if required to be used for backfill, it will be fully tested and installed as per the project specifications.

7.05.00 Compaction Criteria

Fill and backfill material will be as recommended in the Geo-technical Report and as required by project specification requirements.

Material used as structural fill (load bearing) beneath structures and roads will be compacted to a minimum of 95% of the maximum dry density (modified Proctor). Natural moisture content of material will not deviate more than 2 percent of optimum.

Material used as backfill (non load bearing) around structures will be compacted to a minimum of 90% proctor density. Natural moisture content of material will not deviate more than 3 percent of optimum.

7.06.00 **Foundation System**

Following foundation systems will be adopted as per details of subsoil strata and recommendations given in geophysical survey and soil report .

a) Foundations resting on Piles

Steam Turbine building including steam turbine foundation, Boiler area Foundation, Stack foundations, Main & Aux. Transformer Foundations, main steam pipe rack structure, Cooling tower and all other buildings and major structures will have piled foundations.

b) Foundations resting on virgin soil

Foundations for other miscellaneous outdoor equipments and structures will be under this category. All such foundations shall rest on virgin soil. The allowable bearing capacity for foundations supporting on this soil will be taken as per geo-technical report. The minimum depth of foundation to virgin soil (silty sand/silty clay) will be 1.0 meter unless specified otherwise in geo-technical investigation and recommendation.

All excavated formation to receive foundation will be checked by an experienced Geotechnical engineer to ensure uniformity and suitability for the founding medium. Any suspect material, whether made ground or weak virgin soil, will be removed and replaced by PCC.

The foundation of storage tank will be supported on RCC ring beam foundation. The area inside ring beam will have compacted sand fill with a sand-bitumen layer on top.

c) Foundations resting on fill material

All grade slab, trenches, pits, electrical trenches & duct banks, manholes and other lightly loaded equipments & structures with bearing pressure not exceeding 50kN/Sq.M will be founded on this founding medium. A minimum of 0.5M below foundation will be of compacted sub-grade to a min. of 95% of the max. dry density (modified Proctor).

All excavated formation below sub-grade will be checked by an experienced Geotechnical engineer to ensure uniformity and suitability for the founding medium. Any suspect material, whether made ground or weak virgin soil, will be removed and replaced by PCC.

7.06.01 Allowable Settlement of Foundations

The following are the permissible limit of total settlement and differential settlement values which will be considered for design of equipment and building foundations unless more stringent criteria specified by the equipment supplier.

Item	Settlement Criteria
Steam Turbine Foundation	Maximum total long term vertical settlement after interconnecting systems are complete and the unit is placed in operation shall not exceed 25mm or limit specified by equipment manufacturer.
Boiler area foundations and Stack foundations	1. The allowable overall settlement of foundation will not exceed 25mm/ vendor requirements
	2. Max allowable differential settlement of foundation will not exceed 12.5mm./ vendor requirements
Transformer foundation (including oil fill)	1. The allowable overall settlement of foundation will not exceed 25mm / vendor requirements.
	2. Any additional long-term settlements after bus duct connections are made and transformer placed in service should not exceed 50mm
Turbine Building foundations	1. The allowable overall settlement of foundation will not exceed 25mm. 2. Max allowable differential settlement of foundation will not exceed 12.5mm.
Other building and Structures foundations.	1. The allowable overall settlement of foundation will not exceed 25mm. 2. Max allowable differential settlement of foundation will not exceed 12.5mm.
Miscellaneous Electrical Equipment foundations.	1. The allowable overall settlement of foundation will not exceed 25mm.
Misc. Mechanical Equipment • Boiler Feed Pump • Lube Oil Skid • Other major equipments	The allowable overall settlement of foundation will not exceed 25mm.
Flat Bottom above Ground Storage Tanks	1. Uniform Settlement : • Vertical settlement after filling, hydro-test will not exceed 25mm.at perimeter unless flexible shell nozzle connections used. 2. Differential Settlement of Center with respect to Edge • The center of the bottom plate floor will not exceed the settlement of the edge by more than diameter/90.

7.06.02 Minimum Founding Depth

The bottom of foundations on virgin soil will not be less than 1.0 meter from finish grade level unless specified otherwise in geo-technical investigation and recommendation. Foundations for Misc. Skids and other minor supports will be kept minimum 300 mm below finished grade unless greater depth is required by site specific requirements.

8.00.00 **LOADS**

All structures and portions thereof shall conform to the latest revision of relevant Indian Standard specifications and also to the various other technical requirements. Any structure which carries Indian Railway Loading or is situated in the vicinity of Railway Lines, the design has to conform to the Indian Railway Standard Specifications and approval must be obtained from Railway Authority including the clearance etc. All structures and foundations shall be designed for most critical combinations of dead load, live load, equipment load, pipe and cable tray loads, crane loads, wind loads, seismic loads, temperature loads and special loads as applicable as per requirement of relevant codes and standard.

A) Dead Loads

Dead load shall include the weight of all structural components and architectural appurtenances incorporated in the structures plus hung loads and any other permanent, externally applied load. This should also include equipment dead load. The content of tanks, silo, bins and hoppers shall be measured at full capacity for this purpose. Hung loads and the contents of tanks, silo, bins and hoppers shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilizing loads for uplift.

The following unit weight of material shall be considered for computation of loads. Loads given in IS:875 (part-I) shall be made use of for material not listed below.

Materials		**Unit weight**
Plain cement concrete	:	24.0 kN/cum
Reinforced cement concrete	:	25.0 kN /cum
Structural steel	:	78.5 kN /cum
Brick work	:	19.0 kN /cum
Cement plaster	:	21.0 kN /cum
Floor Finish, screed concrete, Plaster	:	24.0 kN /cum
Steel grating floor	:	0.5 kN/sq.m
Checkered plate cover	:	0.5 kN/sq.m

Materials		**Unit weight**
False floor	:	1.0 kN/sq.m
False ceiling in control and Electric rooms	:	0.4 kN/sq.m
Metal decking	:	0.15 kN/sq.m
Insulated metal siding	:	0.25 kN/sq.m
Non insulated metal siding	:	0.15 kN/sq.m
Masonry unit with plaster on both sides :		
230 mm nominal thickness	:	4.95 kN/sq.m
115 mm nominal thickness	:	2.47 kN/sq.m
Coal	:	12.0 kN /cum
Fly Ash	:	16.0 kN /cum
Bottom Ash	:	16.0 kN /cum

B) Live Loads

Live loads in different areas shall include dust loads, minor equipment loads, cable trays, small pipe racks/hangers, operation/maintenance loads etc. The loads considered shall not be less than those specified in IS: 875 (Part II).

The loads listed hereunder are minimum loads for the areas involved. Special use areas shall be investigated and loading revised upward as necessary. Hung loads shall be based on minimum loading equivalents of 1.0 kN/Sq.m for piping and 0.5 kN/Sq.m for electrical, ventilation and air conditioning. Loadings resulting from concentrations of facilities in specific areas shall be substituted where listed base loading is excluded.

i) All Buildings

a) Roofs :

Inaccessible roof	:	0.075 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
Accessible roof where equipments are placed	:	5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
Accessible roof without equipments	:	1.5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).

	b)	Stairs & Platforms	:	5.0 kN/Sq.m
	c)	Corrridors	:	5.0 kN/Sq.m
	d)	Removable gratings, chequered plates, walkways etc.	:	5.0 kN/Sq.m (for supporting beams) 7.0 kN/Sq.m (for grating/chequered plate)
	e)	Office, Laboratory, Conference rooms and other non-plant areas etc.	:	5.0 kN/Sq.m
ii)	Power House Building			
	a)	Ground Floor		
		Unloading Bay	:	50 kN/Sq.m
		Other areas	:	20 kN/Sq.m
	b)	Mezzanine Floor	:	15 kN/Sq.m plus hung loads.
	c)	Operating Floor		
		T.G. Lay-down Area	:	35 kN/Sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher
		Other Areas in Turbine Hall	:	25 kN/Sq.m plus hung loads
			:	Rotor removal area beams shall also be checked for half the rotor load at the center of the beam
		Other Areas in Operating Floor	:	15 kN/Sq.m plus hung loads
	d)	Cable Spreader Floor	:	7.5 kN/Sq.m plus hung loads
	e)	All other floors	:	15 kN/Sq.m plus hung loads
	f)	Due to anchoring of conductors on "A" row column	:	2 x 20 = 40 kN (Twin ACSR Moose Conductor) and 10 kN (Sheilding Wires) OR actual load furnished by equipment supplier

iii) Mill Building

a)	Ground Floor	:	25 kN/Sq.m
b)	Feeder Floor	:	15 kN/Sq.m + hung loads + 0.5 kN/Sq.m (dust load).
c)	Tripper Floor	:	10 kN/Sq.m + hung loads + 0.5 KN/Sq.m (dust load).

iv) Auxiliary Buildings

a)	Ground Floor	:	10 kN/Sq.m
b)	Cable Spreader Floor	:	7.5 kN/Sq.m
c)	Pump House Operating Floor	:	10 kN/Sq.m
d)	Office Floor	:	5 kN/Sq.m
e)	Switchgear room	:	15 kN/Sq.m
f)	All other Floors	:	10 kN/Sq.m

v) Non Plant Buildings

a)	Floors with equipment	:	10 kN/Sq.m
b)	All other floors	:	5 kN/Sq.m

vi) Underground Structures/Trenches/pits

Minimum surcharge shall be 10 kN/Sq.m. For structures in vicinity of roads and heavy vehicular movement, 20 kN/Sq.m surcharge shall be considered. Trenches/pits inside building shall be designed for a surcharge equal to Live Load intensity of Ground Floor or 10 kN/Sq.m whichever is greater. In Boiler area and other outdoor areas within Power Block, the minimum surcharge shall be 20 kN/Sqm.

vii) Covers for Trenches

Self-weight of top slab and a uniformly distributed load of 4.0 kN/Sqm on each panel or one 0.75 kN central point load, whichever is critical, shall be considered. At road crossings, the covers shall be designed for vehicular movements as per IRC standards.

viii) Roads

Design of roads shall be in accordance with Indian Road Congress standard IRC 37.

ix) Road Culverts

Road culverts shall be designed for Class `AA' loading (wheeled and tracked both) & to be checked for Class `A' loading as per IRC standards.

x) Reduction in Live Load

Reduction in Live load as per provision of IS:875 shall not be permitted.

The areas covered with equipment shall be designed on the basis of weight of equipment (flooded/operating) in addition to an uniform live load of 5.0 kN/Sqm or specifically defined live load whichever is greater.

Foundations and fixing arrangements for items of equipment, which generates vibration, will be designed to prevent transfer of such vibrations to the adjoining structures.

For loads caused by moving equipment over the floor for installation, consideration shall be given to the shoring of beams and floor from floors below.

C) Equipment Loads

i) Loadings (both static and dynamic) of major equipments, including boiler, turbine-generator, boiler feed pumps, feed water heaters, de-aerator, PA, FD & ID fans, Coal Mill obtained from the manufacturer's certified drawings of the specified equipment to be furnished. Where design of structures supporting minor equipment other than those included above has to proceed, the loadings will be estimated from similar jobs or catalog data.

ii) All equipment, tank and piping design loadings will include Hydraulic Testing loads.

iii) Air & gas duct loadings will include weight of insulation, duct attach-ments, dust accumulation loads, seismic, wind and other loads as applicable.

iv) Crane girders and supporting columns will be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads. Unless otherwise specified, the vertical and horizontal loadings will conform to the applicable sections of the IS specifications.

v) Weight of equipments, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.

vi) All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for most critical condition.

vii) Jet forces resulting from guillotine type pipe ruptures shall be considered in the design, if it is of high magnitude. Jet force to be considered shall be equal to the product of the pipe cross section and the internal design pressure applied on an area equal to the pipe cross section.

viii) Lay down areas in the Turbine Hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. Where live load allowance is inadequate to permit storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying lay down areas for specific components, each area to be identified by permanent marking.

D) Wind Loading

Wind loading will be in accordance with Indian Standard Code IS:875 (Part 3) for a basic wind speed of 39 m/s upto a height of 10 metres above mean ground level. Terrain Category-2 shall be considered for all structures.

E) Seismic Loading

The lateral forces will be established in accordance with the recommendations of IS:1893 (Latest Version only). The site falls in Zone-III as identified in the map in IS:1893-2002. Importance factor shall be taken in accordance with IS:1893-2002, Part-IV.

F) Temperature Loads

The structures shall be designed to withstand stresses due to fifty (50) percent of the total temperature variation. The total temperature variation for temperature loading should be taken as two thirds (2/3) of the average annual variation in temperature. The average maximum annual variation for this purpose will be taken as the difference between the mean daily minimum temperature during the coldest month of the year and mean daily maximum temperature during the hottest month of the year.

Mean Daily minimum ambient temperature during coldest month of the year = 10.8° C

Mean Daily maximum ambient temperature during hottest month of the year = 40.8° C

Expansion and contraction due to changes of temperature of materials of a structure shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

G) Steam Piping Load

Minimum intensity of steam piping load shall be 6.0 kN/Sqm for the areas at different levels through which steam piping is routed. However, the bidder shall check the loading as per static/dynamic analysis for steam piping or load data supplied by piping vendor and the worst loading shall be considered in design. Horizontal anchor loads, if any, shall also have to be considered in design.

H) Earth Pressure Load

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of sub-structure of pump house, cold water basin of cooling water and under ground liquid storage tanks earth pressure at rest shall be considered.

In addition to earth pressure and ground water pressure, etc., surcharge load shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Intensity of Surcharge Load shall be as described elsewhere in this specification.

I) Crane, Monorail & Elevator Loads

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter.

Impact Factor

Loads for cranes, hoists and elevators shall be taken as per IS:875. The minimum impact factor to be used in design shall be as follows:

Crane loads :

a) For vertical force, an impact factor of 25% of the maximum crane wheel load

b) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail

c) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction.

Monorail loads

a) Impact factor of 10% of lifted load of hoist for monorail and support design

b) Impact factor of 25% of the lifted load for electrical pulley and support design

Elevator

A 100% of the lifted load including elevator live load plus the cab weight for the elevator support beams.

J) Construction Loads

The integrity of the structures shall be maintained without use of temporary framing struts or ties and bracing so far as possible. However, construction or crane access considerations may dictate the use of temporary structural systems. Special studies shall be made and documented by bidder to ensure stability and integrity of the structures during any periods involving use of temporary bracing systems.

K) Other Loads

Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance load, creep and shrinkage shall also be considered in design of all structures.

All Power House columns adjacent to first row of Boiler columns shall be designed for an additional load of 500 kN to account for piping/cable rack loads.

All structures situated in the vicinity of railway lines shall be designed conforming to the Indian Railway Standard Specification.

L) Thrust Load

Thrust blocks will be designed against the thrust load from pipe lines considering the test pressure in the pipe lines.

M) Ash Silo

The following densities shall be considered for design of coal bunkers

a)	For volume calculation of bottom ash silo	:	6.5 kN/cum
b)	For volume calculation of fly ash silo	:	7.5 kN/cum
c)	For load calculation of both types of silos	:	16.0 kN/cum

The ash silo shall be designed generally as per the criteria laid down in IS:4995 (Part I&II). The static pressure calculated at rest shall be multiplied by an over pressure factor of 1.35 for the top 1/3 rd portion and by a factor of 1.75 for the bottom 2/3 rd portion. Special attention shall be given in assessing the effect of hot temperature of ash on the wall. Temperature of ash shall be considered in design.

8.01.00 **Stability of Structures**

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like under ground tanks, pits, trenches, basements, etc. Minimum factor of safety of 1.25 against buoyancy shall be ensured considering empty condition inside and ignoring the

superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken into consideration.

All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS:456 and other relevant IS codes However, following minimum factor of safety shall be followed.

a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.

b) Factor of safety against sliding shall be 1.5 minimum.

c) Factor of safety against uplift due to hydrostatic forces shall be 1.25 and due to any other loads shall be 1.5.

Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

Ground water table shall be considered as per Final Geotechnical Investigation Report for design of foundations and all underground structures.

9.00.00 LOADING COMBINATIONS

Buildings and structures, will be designed to resist the load stated in the previous section and the worst combinations of the basic load cases stated below. The combinations stated here are the minimum load combinations to be considered in design. The contractor is to establish all the possible load combinations which may arise during the life of the structure. The structural adequacy and serviceability shall be checked accordingly.

9.01.00 Basic Load Cases

1.	DLS	[Only self weight]
2.	DLE	[Self weight of equipment]
3.	LLR	[Roof live load]
4.	LLF	[Floor live load]
5.	CL-L+CLHx(+)	[Maxm. Crane load on left col. plus horizontal surge in (+) X-direction]
6.	CL-L+CLHx(-)	[Maxm. Crane load on left col. plus horizontal surge in (-) X-direction]

7.	CL-R+CLHx(+)	[Maxm. Crane load on right col. plus horizontal surge in (+) X-direction]
8.	CL-R+CLHx(-)	[Maxm. Crane load on right col. plus horizontal surge in (-) X-direction]
9.	WLx(+)	[Wind load in (+) X-direction]
10.	WLx(-)	[Wind load in (-) X-direction]
11.	WLY	[Wind load in (+) Y-direction)
12.	SLx	[Seismic load in (+) X-direction]
13.	SLy	[Seismic load in (+) Y-direction]
14.	CL	[Crane self weight]
15.	TL	[Temperature load]
16.	CLI-L+CLIHx(+)	[Maximum crane load on left col with 50% lifting wt. Plus horizontal surge in (+) X-direction]
17.	CLI-L+CL1Hx(-)	[Maximum crane load on left col. with 50% lifting wt. Plus horizontal surge in (-) X-direction]
18.	CLI-R+CLIHx(+)	[Maximum crane load on right col. with 50% lifting wt. Plus horizontal surge in (+) X-direction]
19.	CLI-R+CLIHx(-)	[Maximum crane load on right col. with 50% lifting wt. Plus horizontal surge in (-) X-direction]

Note:
(X-direction is towards the cross direction of the building from left to right).

9.02.00 **Load Combination for Steel & RCC Structure**

Comb	1 = 1	
	2 = 0.9(1) + 9	For anchor bolt and uplift of foundation
	3 = 0.9(1) + 10	
	4 = 0.9(1) ± 11	
	5 = 0.9(1) + 12	
	6 = 0.9(1) – 12	
	7 = 0.9(1) ± 13	
Comb	8 = [(1+2)+(3+4)+16+9]	For super structure & foundation
	9 = [(1+2)+(3+4)+17+10]	
	10 = [(1+2)+(3+4)+18+9]	
	11 = [(1+2)+(3+4)+19+10]	
	12 = [(1+2)+(3+4)+5]	
	13 = [(1+2)+(3+4)+6]	
	14 = [(1+2)+(3+4)+7]	
	15 = [(1+2)+(3+4)+8]	
	16 = [(1+2)+0.5(4)+14+12]	

17 = [(1+2)+0.5(4)+14-12] 18 = [(1+2)+0.5(4)+14±13] 19 = [(1+2)+(3+4)] 20 = [(1+2)+0.5(4)+14] 21 = [(1+2)+(3+4)+5+0.5(9)] 22 = [(1+2)+(3+4)+6+0.5(10)] 23 = [(1+2)+(3+4)+7+0.5(9)] 24 = [(1+2)+(3+4)+8+0.5(10)]	For super structure & foundation

Load combinations for individual building will be taken suitably from above load combination.

For structure with no crane but monorail hoist the loading from monorail hoist will be included in live load case.

Note:

Temperature Loads (15) will be added with all above load combination.

Appropriate allowable increase in permissible stresses as per IS codes, may be taken.

Applicable load factors to be used for design of RCC structures by Limit State Method as per IS 456.

Load Combinations for Underground Structures

Following loading conditions shall be considered in addition to the loading from super structure for the design of sub-structure of pump house, channels, sumps, tanks, reservoirs, trenches and other underground structures.

Only liquid pressure from inside and no earth pressure and ground water pressure, and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).

Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Base slab of the pump house shall be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water table. Intermediate dividing piers of sump pumps and partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.

Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS : 3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

10.00.00 BUILDING DESIGN CONCEPT

10.01.00 Framing System and Method of Analysis

Analytical model of the building structure will be either two dimensional or a three dimensional space frame. Analysis of models shall be done using STAAD Pro Software.

For Steel frame structure, it will be either (1) Simple frames with vertical diagonal bracings at column lines in both directions and horizontal bracing at the roof and major floor levels or (2) Moment resisting frame in transverse direction with braced frames in longitudinal direction. For Concrete frame structure, it will be Moment resisting frame in both directions.

For composite framed building moment resisting frame will be provided in transverse and longitudinal direction with reinforced concrete columns and steel roof truss/girder framing members in transverse direction and reinforced concrete framing members in longitudinal direction.

10.02.00 Method of Design

The Strength design of Steel members will be done by allowable stress method using IS:800 (Latest Edition) where as the Strength design of Concrete members will be done by limit state method using IS:456 (Latest Edition).

Un-braced lengths for steel beams will be as per code or as determined from following criteria

- Beams supporting concrete slab with shear connectors will be considered continuously supported.
- Beams supporting metal roof deck attached with welding washers plug welded will be considered continuously supported.
- Beams supporting metal deck or concrete slabs formed with metal decking will have an un-braced length based on framing member locations.
- Beams supporting grating floor will be considered continuously unsupported.
- Beams which are part of a truss will use the distance between panel points as their un-braced length or, if the panel has connecting major members, the un-braced length will be based on the distance between panel points or connecting members, whichever is the shorter distance.
- In grating floor, for two parallel, interconnected beams, the beam with greater load will be considered as un-braced and the other beam as braced at the points of interconnection
- In grating floor, for three or more parallel, interconnected beams with loads of same order or magnitude, all beams will be considered as braced at points of intersections. When the beams are loaded

disproportionately, the un-braced lengths will be determined as stated above.

10.03.00 **Acceptance Criteria**

10.03.01 Structural system and Foundations

All buildings will be of framed structures. Foundations for all buildings will be piled/spread/raft footings resting on soil as stated in Section 12 except ground floor slab of all buildings which will be resting on grades.

10.03.02 Member Strength

As per IS:800 for steel members and as per IS:456 for concrete members.

10.03.03 Member Stiffness

As per IS 800 for steel members and as per IS:456 for concrete members except as noted here in after.

- Required Depth
  - For steel members, minimum depth equals to 1/24 of span unless clearance requirements will dictate lower depth in certain areas.
  - For Concrete members, minimum depth equals to 1/16 of span unless clearance requirements will dictate lower depth in certain areas.
  - Members will be framed into members of equal or greater depth
- Maximum deflections – As per Table 6 of latest edition of IS 800.

10.03.04 Foundation

Maximum Allowable Pile Load or Allowable Soil Bearing Pressure will be as per Geotechnical Investigation Report. The Foundation settlement will be limited to the allowable settlements as specified for different systems and equipments.

10.03.05 Dynamic Criteria

For Foundations of rotating major equipments, the natural frequency and allowable vibrating amplitude/velocity will be as per criteria furnished by the Vendor. In absence of such criteria, the foundation will satisfy the criteria set forth in IS 2974, DIN 4024 and VDI 2056.

For the foundations supporting minor equipments weighing less than 10 kN or if the mass of the rotating part is less than one-hundredth of mass of the foundation, no dynamic analysis will be carried out.

A. Steam Turbine Generator Foundation Design Criteria

The Steam Turbine Generator shall be rigid RCC frame structure supported on pile foundations. The concrete outline and embedments/ inserts/pockets detail shall be supplied by machine manufacturer.

Detailed static and dynamic analysis shall be performed both for normal operating condition & abnormal condition such as short-circuit, accidental loss of blades & earthquake. At any event of time any two transient loading (short circuit, seismic) need not be assumed to act in the same direction simultaneously. Seismic analysis shall be done by response spectrum method.

The dynamic analysis shall consist of free-vibration and forced vibration analysis. Frequency separation criteria and amplitude criteria as laid down in IS-2974 and or VDI 2056 and/or as required by machine manufacturer whichever is more stringent shall be satisfied.

Elaborate mathematical model shall be considered. Due regard shall be given to pile stiffness in lateral and vertical direction and pile-soil interaction.

Stress for thermal load, shrinkage and creep shall be properly accounted for. Minimum reinforcement shall be governed by IS-2974 as well as IS-456.

For appropriate load combinations or any other information, stipulations of IS-2974 shall be satisfied.

B. Boiler Feed Pump Foundation

This is generally a RCC block foundation resting on pile. It shall be isolated from the building to reduce the transmission of vibration. Concrete outline and details of pipe sleeves/pockets/embedments shall conform to the data provided by machine manufacturer. The mass of the RCC block shall not be less than three times the mass of the machine. All block foundations resting on piles shall be designed using elastic half space theory.

Dynamic analysis shall be carried out to calculate natural frequencies in all possible modes. Frequency and amplitude criteria shall be as per relevant IS codes/or VDI and/or as per requirements of machine manufacturer.

11.00.00 STRUCTURAL MATERIALS

Following materials will be used in design and construction of the structure and foundation:

11.01.00 Structural Steel

Designation of Structural Steel	Minimum Yield Strength
IS 2062	250 N/mm^2

11.01.01 Rolled Joists, Tee, Channel and Angle conforming to IS 2062 (Grade A).

11.01.02 Structural pipes conforming to IS 806 (YST 25)

11.01.03 Structural hollow sections (square & rectangular) conforming to IS:4923

11.01.04 Pipes of hand rail conforming to IS:1161 (Medium class Grade YST=240)

11.01.05 Plates, Flats, Ordinary steel washers conforming to IS:2062 (Grade A, B & C).

11.01.06 Steel Gratings – Carbon steel conforming to IS:2062.

11.01.07 Checkered Plates (6 mm thick) – Carbon steel conforming to IS:3502.

11.01.08 Anchor Bolts, Studs or Threaded Bars – Mild Steel of grade 4.6 conforming to IS:5624.

11.01.09 Connection Bolts – All High strength connection Bolts shall be of grade 8.8 conforming to IS:1367 and shall be supplied conforming to IS:3757. All mild steel connection bolts shall be of grade 4.6 conforming to IS:1367.

11.01.10 All nuts shall be of heavy duty hexagonal type and shall be compatible with the bolts.

11.01.11 All nuts & washers for high strength bolts shall conform to IS:6623 & IS:6649 respectively.

11.01.12 Washers for mild steel bolts shall be of mild steel conforming to IS:5369/IS:5372 or IS:5374 as the case may be.

11.01.13 Welding Electrodes – Low Hydrogen electrodes conforming to IS:814.

11.02.00 **Concrete**

11.02.01 Cement

All cement will be of Ordinary Portland quality conforming to IS:8112 (43 grade) / IS 12269 (53 grade). Fly ash based cement can be used for non structural concrete work.

11.02.02 Leveling Concrete

All non structural concrete used for leveling, filling, blinding layer etc. shall be 1:3:6 nominal mix.

11.02.03 Structural Concrete

Grade of structural concrete shall not be less than M25 grade unless stated otherwise.

- All structural concrete in contact with soil shall be of grade M25.
- All structural concrete for duct bank and pavements shall be of grade M20.

11.03.00 **Concrete Reinforcing Steel**

11.03.01 Material

All Reinforcing steel for concrete shall be high strength deformed TMT bars (fy = 500 N/MM2) conforming to IS:1786.

11.03.02 Concrete Cover

Following minimum clear concrete cover to steel reinforcement will be provided.

A.	**Substructure Works**	Bottom	Sides	Top	Ends
i)	Foundation	75	50	50	50
ii)	Columns, Pedestals, Grade Beams/Tie Beam	50	50	50	50
iii)	Trenches, Pits, Walls, Duct Bank etc. in contact with				
	Earth	50	50	50	50
	Water	50	50	50	50
	Others	25	25	25	40
iv)	Equipment Foundations	50	50	50	50
v)	Slab on Grade	25	50	25	50
B.	**Super structure Works**				
i)	Columns	-	40	-	-
ii)	Beams	35	35	35	50
iii)	Slabs/Walls	20	20	20	40
iv)	Lintel, Chajja, Bands etc.	20	20	20	25
v)	Pre-cast Concrete	20	20	20	20

12.00.00 **GENERAL DESCRIPTION**

Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/ Structure	Foundation	Roof	Floors	Cladding
1.	Power House Building						Structural Steel	RCC pile cap on pile	RCC (metal deck form over TG Hall)	RCC	For details refer K9213-EPC-SPC-001-IIG/2 section 3.03.01.
2.	Turbo Generator foundation, Boiler Feed Pump Foundation and all other major equipment foundations						RCC	RCC foundation on pile			
3.	Boiler Foundation						RCC	RCC pile cap on pile			
4.	ESP & Duct Supporting Foundation						RCC	RCC pile cap on pile			
5.	ESP Control Room						RCC	RCC pile cap on pile	RCC	RCC	For details refer K9213-EPC-SPC-001-IIG/2 section 3.03.01.
6.	RCC Chimney & Foundation						RCC	RCC Foundation on pile			
7.	Transformer Yard Foundations including Oil Pits						RCC	RCC Foundation on pile / RCC Trench			
8.	Switchyard Structures, Foundation & Trenches						RCC/ Structural Steel	Pile Foundation			For details refer K9213-EPC-SPC-001-IIG/2 section 3.03.01 .

Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/ Structure	Foundation	Roof	Floors	Cladding
9.	Switchyard Control Room Building						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
10.	DM Plant, DMW STG. Tanks, Chemical House etc.						RCC	Pile Foundation	RCC	RCC	-DO-
11.	CW Pump House						RCC	RCC Pile foundation/RCC Spread	RCC	RCC	-DO-
12.	Chlorination Plant						RCC	Pile Foundation	RCC	RCC	-DO-
13.	ND Cooling Tower						RCC	Pile Foundation	RCC	RCC	
14.	B.A. Slurry Pit & Pump House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
15.	Ash Compressor Building						RCC	Pile Foundation	RCC	RCC	-DO-
16.	Ash Handling Plant Control Building						RCC	Pile Foundation	RCC	RCC	-DO-
17.	Ash Water Pump House						RCC	Pile Foundation	RCC	RCC	-DO-
18.	Ash Pipe Rack						Structural Steel	Pile Foundation			
19.	Service & Technical Building						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01 .

Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/ Structure	Foundation	Roof	Floors	Cladding
20.	Clarified Water & Fire Water Reservoir						RCC	Pile Foundation	RCC	RCC	-DO-
21.	LFO/HFO Day Tank Foundation						RCC	RCC Ring Wall Foundation			
22.	FO Pressurizing Pump House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
23.	Diesel Generator & Compressor Building						RCC	Pile Foundation	Colour coated galvanized sheeting	RCC	-DO-
24.	Side Stream Filter						RCC	RCC Raft on Pile			
25.	Store						RCC	RCC Spread	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
26.	Fly Ash Silo						RCC	Pile Foundation			
27.	HCSD Pump House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
28.	LDO/HFO Pipe Corridor						RCC/ Structural Steel	Pile Foundation			
29.	Fire Water Tank						RCC	RCC Ring Wall Foundation			
30.	Fire Water/Clarified water Pump House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-

Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/ Structure	Foundation	Roof	Floors	Cladding
											SPC-001-IIG/2 section 3.03.01.
31.	Wagon Tippler						Structural Steel	RCC	Metal cladding		Metal cladding
32.	Transfer Point						Structural Steel	Pile Foundation	Metal cladding		Metal cladding
33.	Pent House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
34.	Crusher House						RCC	Pile Foundation	RCC	RCC	-DO-
35.	Stacker/Reclaimer						RCC	Pile Foundation/ Spread			
36.	Equipment Laydown Space						RCC	RCC Paving			
37.	RCC Retaining Wall						RCC	RCC Wall Foundation			
38.	FO Transfer Pump House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
39.	Pipe Rack						Structural Steel	Pile Foundation			
40.	River Intake Pump house & Approach Bridge						Structural Steel	Well Foundation & Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.

13.00.00 **MISCELLANEOUS REQUIREMENTS**

Further to all requirements described in the preceding clauses, the following criteria shall be strictly complied with pertaining to analysis, design, layout & construction of aforesaid power plant.

13.01.00 Dense concrete with controlled water cement ratio preferably 0.45 shall be used for all underground concrete structure such as basement, pump houses, water-retaining structure, cable & pipe trenches etc., for achieving water tightness.

13.02.00 All joints, including construction and expansion joints for the water retaining structure shall be made watertight by using 230 mm (minimum) PVC ribbed water stops with central bulb. However, kicker type (Externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting.

13.03.00 Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc., as per IS-6313 and other relevant standards.

13.04.00 Minimum 100 mm thick lean concrete 1 : 3 : 6 shall be provided below all underground structure, trenches etc., to provide a base for construction.

13.05.00 Not used.

13.06.00 Good quality fly ash bricks having compressive strength of minimum 50 kg/sqm shall be used. Ordinary clay burnt bricks of class designation 35 may be used for masonry work, if specified in Approved Architectural drawing. Bidder shall ascertain himself at site regarding the availability of clay bricks of minimum 35 kg/cm^2 compressive strength before submitting his offer.

13.07.00 All stairs shall have a maximum riser height of 175mm and a minimum tread width of 250mm. Minimum width of stairs in all buildings shall be 1200 mm.

13.08.00 All masonry walls from ground floor shall be placed on reinforced concrete grade beams. However, light internal partitions may be placed on ground floor slab.

13.09.00 Each building shall be provided with minimum 1.0m wide reinforced concrete paving all round unless specified otherwise. Paving shall be sloped to provide a rapid run off of rainwater away from building.

13.10.00 The steel column base plate along with stiffening gusset plates shall not be protruded above floor level.

13.11.00 The steel columns below ground floors and upto minimum 100mm above finished floor level shall be encased in concrete.

13.12.00 Steel chequered plates and gratings shall be hot double dip galvanised. Thickness of coating will be 610gm/sq.m (minimum).

13.13.00 Angles 50 x 50 x 6 mm (min.) with lugs shall be provided for edge protection all round of cut-outs/opening in floors, edge of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes

supporting covers, supporting edges of pre-cast covers and any other places where breakage of corners of concrete is expected.

13.14.00 All drains inside the building shall have minimum 40 mm thick grating covers and in areas where heavy equipment loads would be coming, pre-cast RCC covers shall be used in place of steel grating.

13.15.00 All steel platforms above grade shall be constructed with kick plates at edge of platform to prevent tools or materials from falling off from platform.

13.16.00 For all buildings suitable arrangements for draining out of water collected from equipment blowdowns, leakage, floor washing, fire-fighting etc., shall be provided for each floor.

13.17.00 Finished ground floor level (plinth level) of all buildings shall be minimum 300mm above formation/grade level.

13.18.00 Duct banks consisting of PVC/GI conduits for cables shall be provided with concrete filling of M20 grade conforming to IS-456. The minimum depth of top of duct bank from grade level shall be 500mm.

13.19.00 All upstands and parapet walls on roof shall be of RCC construction for all buildings. Minimum height of parapet shall be 750 mm.

13.20.00 All architectural fins for the elevation of building shall be of RCC. Minimum thickness shall be 75mm.

13.21.00 All sand filling shall be compacted to minimum 95% of the relative density. For Tank foundation the compaction shall not be less than 85% relative density. Sand filling in Pit and trenches around structures refer Cl. No. 3.07.02,Volume IIG3, Section IV of tech. specification.

13.22.00 Back filled earth material shall be compacted as per design requirement subject to a minimum of 90% of the standard proctor's density at OMC.

13.23.00 All buildings shall have framed super structure. All walls shall be non-load bearing infilled panel walls.

13.24.00 50mm thick DPC shall be provided at plinth level before starting the masonry work.

13.25.00 Increased cover to reinforcement for all RCC structures as per IS-456 - 1978 shall be provided to withstand corrosive environment if there be any.

13.26.00 Not used.

13.27.00 All gates and stop-logs shall be of structural steel, which shall be hot double dip galvanised. Thickness of coating shall be 1000 gm/sq.m (minimum).

13.28.00 All mild steel parts used in the water retaining structures shall be hot double dip galvanised. Galvanising shall be checked and tested in accordance with IS-2629.

13.29.00 A screed of concrete layer not less than 100 mm thick and of grade not weaken than M10 conforming to IS-456 shall be provided below all water retaining

structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structure.

13.30.00 Stairway in a single run shall have the same slope. The vertical rise of the stairways shall not exceed 3.0 mm for a single flight.

13.31.00 Hand railing minimum 1000 mm high shall be provided around all floors/ roof openings, projections, balconies, walkways, platforms, steel stairs etc. All hand rails and ladder pipes shall be 40mm nominal bores MS pipe (medium class) and shall be galvanised (as per IS-277). All rungs for ladder shall also be galvanised as per IS-277 (medium class).

13.32.00 For RCC stairs, hand railing with 25mm square MS bar balustrades with suitable MS flats & aluminium hand rails (40mm) shall be provided.

13.33.00 All underground concrete structure like basements, pump house, water retaining structure etc., shall have plasticizer cum waterproofing cement additive conforming to IS-9103. In addition limit on permeability as given in IS-2645 shall also be met with. The concrete surface of these structures in contact with earth shall also be provided with two coats of bituminous painting for water/damp proofing. In case of water leakage in the above structures, injection method shall be applied for repairing the leakage.

13.34.00 The ground surface treatment in the switchyard area and in area around transformers shall be minimum 150 thick good quality pebbles / gravel with top layer of soil treated with antiweed chemical as per specification.

13.35.00 In the event the bidder encounter a difficult sub-soil condition which requires significant improvement incurring substantial expenditure, the bidder may adopt any patented method of soil improvement subject to Owner's approval. No extra cost shall be borne by the Owner in this respect.

13.36.00 For steel pipes encased in concrete, concrete encasement to steel pipe shall be with M20 grade of concrete and shall be of minimum 150 mm thickness all around pipe.

13.37.00 Ramps for building entrance shall be cast in situ RCC slab designed as a slab spanning over supports or rigid pavement resting on subgrade provided that the thickness of slab and the property of subgrade shall be such to ensure of its being treated as rigid pavement. The slope of ramps will not be more than 20°. Minimum thickness of slab shall be 150mm.

13.38.00 Only sewage and drainage pipe may run below road. Any other pipe like system water pipe may run beyond 1.0m from the edge of road along its longitudinal direction.

13.39.00 Provisions of safety, health & welfare according to factories Act shall be complied with. These shall include provision of continuous walkway of minimum 600mm wide along the crane girder at crane girder level on both sides of the building, comfortable approach to EOT crane cabin, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc.

13.40.00 Minimum 2.4 M high fencing above toe wall shall be provided around switchyard, transformer yard, and other area, where fencing is necessary due to statutory requirements. Fencing shall comprise of 2.4m high PVC coated galvanised chain link fencing of minimum 8 gauge (including PVC coating) and minimum 11 gauge (without PVC coating) and of mesh size 75mm and galvanised barbed wire for switchyard and other areas upto a height of 0.6 m above chain link fencing excluding PVC coating shall not be less than 12 gauge. Steel entry gate shall be provided for all fenced areas. Top of toe wall shall be minimum 200 mm above the formation level.

For Unit #8 plant periphery fencing, above chain link fencing 750mm height concertina coil fencing shall be provided.

13.41.00 Trenches located outside building shall project at least 150mm above the finished formation level so that no storm water shall enter into the trench. The bottom of the trench shall be sloped suitably for draining out the collected water into the sump pit. The pre-cast covers shall be of min. M-25 grade and shall not weigh more than 65 kg. Lifting hooks shall be provided in the pre-cast covers.

13.42.00 All cables & pipes in outlying area shall run above ground over steel trestle or other supporting structures for easy inspection and maintenance except in transformer yard area and some other local area where the same can run in RCC trenches. However laying of cables will be as per approved Electrical layout. In case of trestles with overhead racks and bridges minimum 7.0m head clearance shall be provided for road crossing.

13.43.00 For all trench structures, the bottom slope perpendicular to the run of the trench shall be minimum 1 in 200 and shall be minimum 1 in 500 for slope along the length of the trench.

13.44.00 Top of CW ducts shall be minimum 1.0 m below grade level.

13.45.00 For open horizontal drains, reservoirs concrete lining of minimum M15 grade on sides & bottom shall be provided. The thickness of lining shall be minimum 100mm or as per design consideration whichever is higher.

13.46.00 Provision for fire proof doors, nos. of staircases, fire separation walls etc., shall be made according to the recommendations of TAC.

13.47.00 Minimum size of structural elements shall be as follows:

13.47.01 **Concrete Slab & beam**

a)	Floor & roof slab	-	120mm
b)	Miscellaneous	-	50mm
c)	Ground floor slab	-	150mm
d)	Pre-cast cover	-	40mm
e)	Width of beam	-	150mm

13.47.02 **Structural steel**

For Joists	-	I - 150
For Channels	-	MC - 100
For Angles	-	L 50 x 50 x 6
Gusset plates	-	8mm thick

14.00.00 **STATUTORY REQUIREMENTS**

The Civil Engineering and building works shall comply with all appropriate statutory requirements including all current Building Control regulations, and with all planning or other conditions as required by the relevant local, state, and National authorities.

14.01.00 The contractor shall provide full general arrangement drawing (Civil, Structural & Architectural) of all buildings, structures and facilities to the Owner for comment. The Contractor shall not proceed with these drawings further without such comment. Any work carried out by the Contractor using drawings unacceptable by the Owner shall be at the Contractor risk.

14.02.00 The Contractor shall seek and obtain all necessary approvals and detailed planning consents outstanding at the time of placing the contract and shall be responsible for all necessary liaison with such authorities to obtain the same and for the payment of due fees for such approvals.

14.03.00 The Contractor shall obtain approval from the appropriate authority regarding the safe means of escape in the event of fire or other hazard before relevant construction work proceeds. As a minimum, the Contractor is required to ensure that the works shall comply with all statutory requirements including:

i) Central Government/State Government - for all building control regulation

ii) State factories act - For Safety, health & welfare, use of hazardous substance – including obtaining stability certificate and drawings to be approved by factory inspection.

iii) Central and State Pollution Board - For limits on pollution levels.

iv) Central Water Authority/State Irrigation Department - For Water obstruction/supply for withdrawal of water from local source, location of Intake pump house / Jack well.

v) State Water & Disposal Department - for waste & Foul Water disposal.

vi) Ministry of Environment - for all matters relating to environment.

vii) Ministry of Railway - for all matters for railway line construction.

viii) Traffic Advisory Committee - for regulation concerning fire safety/means of escape.

ix) Aviation Authorities - for clearance of tall structure like stack etc.

x) State Public Works Department - for regulations on Civil work/road works.

xi) Ministry of Forestry - for deforestation, if any, for site development.

14.04.00 The Contractor shall make due allowance for all necessary negotiation/ administration required and the time needed to obtain these permission and approvals in his programme. Failure to obtain such approvals in a timely manner shall not be a reason for extension of the programme.

15.00.00 **DOCUMENTS TO BE SUBMITTED**

The Contractor shall be required to prepare a `Basis of Design' for each Elements/Structures of Civil Works expanding on the information given in the specification. The `Basis of Design' shall include the following:

i) A concise description of the form of Structure considered.

ii) A statement of salient assumptions made.

iii) Codes of practice and references used

iv) A description of the design approach

v) Detail Calculations including Computer inputs & results with conclusion.

vi) Working drawings showing necessary details

These documents shall be submitted to Owner for review at least 12 weeks prior to the commencement of the relevant construction activity.

15.01.00 The submission shall be in accordance with dates set down in Contractors civil works design and construction programme.

15.02.00 The Contractor shall be required to carry out at his own cost, any rectification, alteration or replacement of works progressed within 12 weeks of submission of the design basis and drawings and resulting from engineers comments on the design submission.

15.03.00 Acceptance of the Contractor `Basis of Design' calculations or drawings by the Owner shall not relieve the Contractor of any of his obligations to meet all the requirements of the Contract or relieve the Contractor's responsibility for the correctness of design and safety of the structure for the design life of the plant. The Contractor shall make any changes in the design/drawing in the form of DCN without any financial implication, which are necessary to make the work comply with the contract.

15.04.00 **Calculations, Reports & Drawings**

The Contractor shall prepare detailed calculations for all structure / elements in accordance with cl. no. The Contractor shall also make available any additional calculations, other than routine structural calculation, as requested by the Owner during the period of Contract.

15.05.00 In addition to Geotechnical investigation report, the Contractor shall arrange and make available any other reports and investigations the Owner deems necessary for safety & stability of plant. The investigations shall be carried out in any standard laboratory of repute and as recommended by the Owner. All laboratory tests shall be carried out in the presence of Owner's engineer.

15.06.00 In the event, the Contractor adopts any patented method of design and Construction, not popular or practiced in this country; the Contractor shall sought prior approval of Owner in writing. The Contractor shall forward appropriate literatures, documents, certificates, case histories etc., to establish the viability of the method.

15.07.00 The bidder shall submit the tender with a schedule of proposed sub contractors for different construction packages (if necessary), structural consultants, (if any), any hired personnel for expertise, along with their name address, etc.

15.08.00 Each calculation document shall include the following

i) Contractor's name
ii) Package identification (if any)
iii) Designer's name/initials
iv) Checker's name/initials
v) Reference No.
vi) Index
vii) Date & Revision No.
viii) Revision identification mark
ix) Detail calculations including computer input data and output.

Calculation packages shall preferably be bound at A4 size sheets.

15.10.00 All working & construction drawings shall be drawn by CAD system, and shall be issued in A0/A1 size. The drawing shall include:

i) Name of Project, Owner, Consultant & Contractor.
ii) Title of the Drawing
iii) Drawing No. Issue Date, Revision No.
iv) Statement for Revision
v) Revision Identification Mark
vi) Release Status
vii) Designer/Checker’s/Draughtsman's name/initial

15.11.00 The Contractor, who shall maintain an upto date drawing & document register, shall monitor drawing & document issue. This register shall list all drawings & documents used in the design and construction for civil and structural works. The drawing register shall be a controlled document and shall be kept updated/revised and shall be issued on A4 size sheets.

15.12.00 All numerical analysis shall be done through computer. The bidder shall have either their own system or have access in other system outside their premises.

The Contractor shall be a bonafide license holder of any software package used in this project. Any in-house developed software may also be used subject to the approval of the Owner through validation with standard computer programme. Any pirated & unlawful use of software shall not be permitted. The Contractor shall furnish:

i) Name of Software

ii) Developing Agency

iii) A write-up/overview of the programme. As supplied by the copyrighter.

iv) Relevant documents verifying users right for using this software in this country.

15.13.00 All drawings, design documents, reports, correspondence pertaining to civil structural works shall be in `English Language'. Documents in any other language shall be translated in English before submitting to Owner.

All drawings, documents shall be forwarded in three (3) copies to Owner for approval/record.

16.00.00 **LAYOUT**

Before starting the work, the Contractor shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and bench mark. If the Contractor uses the grid, bench mark and reference pillar made by other Contractors, he shall co-ordinate with the Contractor and shall satisfy himself of the accuracy of the reference marks. If he is required to set out the foundation afresh, he shall do so independently with reference to the one existing grid and bench mark which has been followed by other agency at the instruction of the Engineer. In case any discrepancy be found, it shall be immediately brought to the notice of the Engineer for any rectification/modification necessary. No complaint shall be entertained at a later stage. The Contractor shall accurately set out the position for holding down bolts and inserts.

If required, in the option of the Engineer, he shall construct and maintain pillars for grid, references and bench marks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layouts and levels. The Contractor shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Tenderers shall take into account the cost of these in quoting their price.

17.00.00 **WORKMANSHIP**

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops

having proper equipment for accurate edge lanning and milling of column shaft ends, base plate surfaces etc., and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye-laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

18.00.00 TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such Temporary work shall have the prior approval of the Engineer, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and re-erection, if required, shall be carried out by the Contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor.

19.00.00 INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE

Modification in layout of foundation/structure during detail engineering stage may be necessary to avoid fouling with those under other's scope. Necessary changes on this account will be made without any extra cost to Owner.

20.00.00 SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the Contractor. Contractor shall furnish quality assurance and quality control plan. A programme of work is to be submitted for the Engineer's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.

The Contractor shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing upto date progress on all important items of work.

21.00.00 ARCHITECTURAL WORK

For general specification and design criteria for Architectural work refer Volume IIG/2.

ANNEXURE-1

PRELIMINARY GEOTECHNICAL INVESTIGATION DATA

(Preliminary investigation work under progress. Investigation data will be made available by GSECL after completion of field investigation work)

VOLUME: IIG/2

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORK

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VOLUME: IIG/2 : GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORK

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VOLUME: IIG/2

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORK

1.00.00 INTRODUCTION

This specification covers design, preparation of necessary drawings for approval and construction of all Architectural work associated with 1x800 MW Super Critical Thermal Power Plant to the satisfaction of the Owner. The scope of work covers complete Architectural Work including supply of all materials, labour, tools and plants as required for successful execution of the turnkey Contract.

The architectural work & services shall cover wall Cladding and finishing work of Plant buildings and non Plant buildings as listed in this documents but not limited to those buildings.

Architectural work are mainly Anti termite treatment work of the foundations, ground and other required surface areas, brick work for external walls and partition walls, Damp proof treatment course, pre coated metal cladding work and work for roof protection treatment, finishing of walls, painting, flooring & ceiling, false ceiling, false floor as required, doors, windows, ventilators and louvers, potable water supply system, sanitary, plumbing, landscaping and all other related work required for completion of the buildings & surrounding areas in all respect to render the premises acceptable to the satisfaction of the owner.

2.00.00 MAIN PLANT STRUCTURES/COMPONENTS

The general description of some of the major structures/components covered under this Contract have been given else where in this specification.

2.01.00 All buildings, structures shall be designed to meet its structural & functional requirements as stated in the relevant section of this document.

3.00.00 DESIGN REQUIREMENTS

3.01.00 The indicative location of various buildings have been shown in the plot plan drawing. Conceptual design for some of the important buildings have also been annexed with this document. The contractor shall develop the final architectural drawings of all plant buildings as per the final approved equipment layout and considering other related layout indicated elsewhere in this specification and the guide line drawings attached herewith. All non plant buildings shall be designed as per organizational chart of man power required for respective building and its functional requirements. All drawings shall need the approval of the owner before construction. The contractor shall also have to submit conceptual drawings of all important plant buildings prior to detailing work and coloured perspective view of the plant. Obtain approval from

statutory authorities, e.g., Factories Inspector, Explosives Inspector, Loss & Prevention association of India/Tariff Advisory Committee or any other statutory bodies as required shall be the responsibility of the contractor without any obligation to the owner.

All Architectural Work shall be done by a team of qualified Architects registered with the Council of Architecture.

3.02.00 The entire complex shall have an architectural character and style of its Own and shall also be visually and functionally integrated with the landscape Design.

The bidders must visit the site and study the environment prior to submission of the bid so that a harmonious as well as integrated architectural concept of the proposed phase of development is achieved. Special care must be given to enhance the visual and technological quality of the development by adopting latest state–of-the–art technology, materials and finishes.

Architectural concepts of the buildings shall offer its own identity and shall be aesthetically blended with the surroundings to give a pleasing appearance keeping an eye to the functional needs of the building.

Special attention shall be given in developing architectural design of the Power house, Technical and O&M building. Architectural design, selection of materials, its use and finishes shall take care of its visual quality as landmark, Aesthetic balance in its composition particularly in façade design with appropriate physical and functional integration.

Main Entrance of all buildings shall be inviting with projecting canopies and suitably and aesthetically designed lobby spaces.

Brief description of these buildings are given in this document.

3.03.00 Contractor shall comply with all applicable statutory rules for

a) Factories Act of the State.

b) Fire safety rules of TAC.

c) Act of the Pollution Control Board of the State.

d) All other statutory rules not mentioned but are to be observed for implementation of the project.

e) Laws/acts concerning control of Industrial effluents, Waste disposal and gaseous emissions.

3.03.01 Generally flat R.C.C. roof or RCC roof over metal deck in steel/RCC frame structure shall be provided for plant buildings. Cladding shall be either with brick work in cement, sand mortar or pre coated cladding over partly masonry wall up to a certain height as indicated below/or as approved during final detail engineering stage .

External Wall Cladding and roofing for the buildings shall be as follow:

Sl. No.	Name of the Building	External wall cladding	Roof
1.	Power house building	Brick wall up to 3.0 M from finish floor level above that pre colour coated galvalume (min. 0.6 mm total coated thickness) steel sheet with super polyester or Silicon polyester or Fluoro polymer (PVF2) coated insulated sandwitch sheet cladding of approved brand.	RCC roof over pre coated metal deck of total coated thickness 0,8mm with Roof water proofing treatment and necessary roof drainage slope.
2.	ESP Control Building	Brick Masonry Wall upto full height.	RCC roof with roof water proofing treatment & necessary roof drainage slope.
3.	Switchyard Control Room Building	- do -	- do -
4.	CW Pump House	Brick masonry wall up to full height	- do -
5.	Chlorination Plant Building	Brick masonry wall up to full height	- do -
6.	B.A. Slurry Pit and Pump House	Brick masonry wall up to full height.	- do -
7.	Ash Compressor Building	Brick Masonry Wall upto full height.	- do -
8.	Ash Handling Plant Control Building	- do -	- do -
9.	Ash Water Pump House	- do -	- do -
10.	Service and Technical Building	Brick wall up to full height of the building on all four sides.	- do -
11.	Clarified Water & Fire Water Pump House	Brick masonry wall up to full height.	- do -
12.	DM Plant & Chemical House	Brick masonry wall up to full height.	-do-
13.	FO Pressurizing Pump House	- do -	- do -
14.	Diesel Generator & Compressor House	Brick masonry wall up to full height.	RCC roof with roof water proofing treatment & necessary roof drainage slope.
15.	Store	- do -	- do -
16	Chemical House for pre treatment Plant	-do-	-do-
17.	Wagon Tippler	Shed type steel structure partly enclosed with cladding from top. Cladding shall be single sheet pre coated Galvalume profiled sheet	Slope roof with pre coated single Galvalume profiled sheet.

Sl. No.	Name of the Building	External wall cladding	Roof
18.	Transfer Point	Brick wall upto 3.0 M from finish floor level above that pre colour coated galvalume single sheet cladding similar to Power house cladding.	- do -
19.	Pent House	- do -	- do -
20.	Crusher House	Brick masonry wall upto full height.	- do -
21.	FO Transfer Pump House	Brick masonry wall upto full height.	- do -
22.	River Intake Pump House and approach bridge.	- do -	- do -
23.	Canteen Building	-do-	RCC slope roof finish with cement sand plaster in pattern of common clay tiles over Roof water proofing treatment. For RCC flat roof portion with water proofing treatment and necessary roof drainage slope.
24.	Yard Toilets	-Do-	RCC Roof with Roof water proofing treatment and necessary roof drainage slope.
25.	Watch Tower	Steel structure with Brick cladding for watch booth.	RCC roof for the watch booth
26.	HCSD Pump House	Brick wall upto 3.0 M from finish floor level above that pre colour coated galvalume single sheet cladding similar to Power House Cladding.	- do -
27.	CHP Control room	Brick masonry wall up to full height.	RCC Roof with Roof water proofing treatment and necessary roof drainage slope.
28	Fire Station Building	Brick Masonry wall up to full height.	RCC Roof with Roof water proofing treatment and necessary roof drainage slope

External brick wall for all buildings shall be one full brick thick wall except for fire wall. Fire wall shall be either one and half brick thick wall or RCC wall equivalent thickness of one and half brick wall or as approved by the owner and shall be provided where required to protect the building from fire hazards. Cladding shall be permanently pre coated metal cladding trough profile or as approved by the owner including its colours.

3.03.02 Brief Description of Service & Technical Building, Control Room and Canteen and Yard Toilets, Store Building.

a) **Service and Technical Building**

The Service and Technical building shall be of RCC frame structure building with RCC floor 4 storied building. Building shall be fully air conditioned Area of each Floor will be 400 Sq.M. It will have brick wall cladding on all four sides up to full height from finish ground level. Building is located adjacent to the Power House Building as shown in the Plot Plan. All weather access covered corridor shall be provided with powerhouse building at operating floor mezzanine and ground floor level or as required during final design stage. Ground floor shall house Maintenance shop, Tool store, Store for Mechanical and Electrical parts, Locker room with toilet facilities, Pantry, Supervisor, Maintenance In charge room, First Aid, PBX room, Spacious entrance lobby with one no Lifts for 8 passengers connecting all the four floors and at least two stair cases connecting all the floors and roof. Stair cases shall be so arranged that these are clearly connected with the fire escape/emergency escape route of each floor and satisfy the fire rule of the state and National Building Code. Fire rule of the state and National Building Code shall be guiding for designing the building. Fire doors as required as per Fire rule shall be provided.

Mezzanine floor shall accommodate Technical Staff office, Rooms for Maintenance in charge, Seminar room, Record room, Senior manager rooms, Room for Printer, Xerox and Fax M/C, Plotter M/C, Toilets for both Male and female and also for Physically impaired persons, Pantry, lift and stair lobbies.

First floor shall accommodate conference room, office for maintenance staff, Technical in charge rooms, Senior Mangers' room, Library, Document storage space, Service room, Ladies and gents toilet and also for Physically impaired persons, Pantry, lift and stair lobbies.

Floor at operating floor level/ Second floor shall accommodate Station in charge (O&M) chamber with attached toilet and P.A room, conference room, General office space, Accounts Department, small cash counter, Toilets for both ladies and gents and one toilet for physically impaired personnel, Pantry, lift and staircase lobbies.

Basic requirements floor wise are given above but not limited to the same. Changes of requirement as will be necessary during detail engineering stage shall have to be accommodated.

All the toilets and other Wet areas shall be connected with potable water connection.

Pantry of all floors shall have water cooler with RO system for drinking water facilities.

It is an important building for operation and maintenance of the plant as such shall have state of the art facilities and a highly sophisticated hi-tech expression and ambience with careful landscaped space around the building.

Building shall be provided with structural glazing for ample natural light penetration and other hard surfaces shall have finish with ACP veneering. Poly Carbonate canopy of Vault or Dome shape shall be provided at the main entrance. Main entrance shall be provided with large structural glazed panels with seam less double leaf door.

List of furniture to be provided in this building are given in Section No 12.000.

Floors plans are annexed for preliminary guide lines of the building.

b) **Control Room**

The Control Room of the Turbine Building is located at Operating Floor level. It is the Heart of the turbine building and shall be architecturally treated with state of the art facilities and technology.

The room will be fully air conditioned and have access from T.G hall Side. Access shall be provided through an airlock space with two glazed doors with an ante room in between. Glazed partitions shall be provided for clear visibility of the turbine hall as well as other ancillary rooms where visibility from control room are required. Type of glazed partitions single or double are as indicated in Cl. No. 7.07.01.

False ceiling of control room shall be as stated in Cl. No. 3.08.00.

Separate toilet in main control room shall be provided for Ladies & Gents and a exclusive pantry for control area. All wet areas like pantry and toilet shall be connected with potable water. Water cooler with RO water plant of 50 L capacity shall be provided. Minimum two years free maintenance & guarantee are to be ensured for such RO facility.

c) **Canteen Building**.

Canteen building shall be provided for the staff with dining and Kitchen facilities. Area of Canteen building shall be approximately 220 Sq.M. The building will house a large dining hall for sitting of 60 persons at a time and shall be provided with an entrance lobby with 6mm thick clear float glass partition with glazed double leaf door in anodized aluminium frame. Large glazed windows in aluminium frame in all facade for Natural light shall be provided. Kitchen sufficiently large for cooking food with arrangement of Provision store, cold storage, Pot wash, Rest room for Cooking staff with locker and toilet facilities, Service entry for kitchen, Pantry for serving food from counter, hand wash room, Dish wash room.

Building shall be different from other buildings and shall be provided with RCC slope roof and finish with plaster in local clay tile pattern. Roof for Kitchen and other rooms may be flat RCC roof with Waterproof and roof water drainage system. Water proof treatment as per roof water proof treatment indicated in CL.No3.05.00 shall be provided in flat roof and slope roof. In slope roof treatment shall be provided below tile pattern finish and insulation shall not be provided. Under deck insulation shall be provided for slope roof portion. Kitchen shall be provided with smoke extractor chimney.

Entrance canopy with Poly carbonate vault shall be provided.

List of dining hall furniture to be provided in Canteen building are given in section 12.000.
All wet areas like pantry and toilet shall be connected with potable water. Water cooler with RO water plant of 50 L capacity shall be provided. Minimum two years free maintenance & guarantee are to be ensured for such RO facility.

d) **Yard Toilets.**

Four (4) no of Yard toilets both for ladies and gents. shall be provided in the campus. Locations will be as decided by GSECL Each Yard toilet shall contain facilities for ladies and gents. In Gents toilet three no of WCs, two no baths with shower, three no Wash basins three no Urinals and a common space for drinking water facilities both for male and female shall be provided. In ladies toilet two no of WCs, two no wash basins shall be provided. One of the WC both in ladies and gents toilet shall be Western type WC.

e) **Store Building**

Store building shall be RCC framed structure building with RCC roof. Approximately total carpet area for store building shall be 1100 Sq.M. Store inside space shall be free from columns for free movement of the forck lift and bulk materials. In general 5 no storage space each approximately 200 Sq.M size shall be provided. In addition to the storage area approximately 100 Sq.m area shall be provided for Store office. Store office shall have accommodation for, store in charge, general office, Issue and delivery counter, Material receipt area, Toilet with 2 no WCs, 2 no wash basin, 2no urinals,1 no janitor room, and space for water cooler, Electrical service room etc. Storage area shall be provided for Heavy materials, Light materials and Costly materials. Storage spaces shall be designed in such a way that each storage area is internally connected with the store office area.

Open hard standing yard for Loading unloading bay, open stack yard and weigh bridge of 40 M.T capacity with a control booth shall also be provided. The entire store complex area shall be provided with 2.0M high brick masonry compound wall in RCC frame plastered and painted. M.S gates for vehicular entry and pedestrian entry shall also be provided.

All wet areas like pantry and toilet shall be connected with potable water. Water cooler with RO water plant of 50 L capacity shall be provided. Minimum two years free maintenance & guarantee are to be ensured for such RO facility

3.03.03 Windows, ventilators and louvers shall be in general as per the requirements of National Building code for natural light penetration and air flow. This may vary as per functional requirements. The sill height for low level windows shall be approximately 1000 mm above finish floor level.

3.03.04 Stairs & platforms shall be provided as required for maximum utility & safety and as per statutory requirements and relevant code of practice.

3.03.05 Damp proof course

50 thick DPC shall be provided at finish ground floor level.

3.03.06 Plinth protection

100 mm thick PCC 1:2:4 Plinth protection laid over compacted 75 mm brick balast with top smooth finish shall be provided all along the periphery of buildings with surface drain. Minimum 1000 mm wide plinth protection shall be provided for ancillary buildings. For power house building RCC Pavement of required width but not less than 2.0 M with surface drain shall be provided.

3.03.09 Miscellaneous Metal railing

Railing shall be provided as required from safety point of view and shall be as specified else where in the document.

3.03.10 All floors generally shall be of RCC with hatch-ways as required with 50 thick floor finish except for false floor.

3.03.11 Painting

Exterior masonry surfaces of all ancillary plant buildings excluding Power house building and Technical building shall be painted with exterior grade Acrylic emulsion paint of ICI/Dulux weather shield max/Asian apex Ultima over plaster. Exterior finish of power house and technical building shall be with structural glazing, ACP and sandwich cladding in general as shown in the drawing.

All structural steel work shall be painted with a Primer coat of epoxy resin based zinc phosphate with DFT 100 micron thickness.

Intermediate coat with epoxy resin based paint pigmented with titanium dioxide of DFT 100 micron thickness.

Top coat epoxy paint suitably pigmented of approved colour and shade with glossy finish of 75 micron thick with finishing coat of polyurethane of 25 micron thick.

All steel doors. Windows, ventilators, louvers etc and stair case MS railing and other railing shall be painted with epoxy paint 250 micron thick.

Wooden doors without lamination and wooden frame shall be painted with two coats of first grade synthetic enamel paint of Asian apcolite/ Neorolac/ Berger Luxol high gloss over a coat of primer.

Refer finish schedule Cl.No 3.18.00 for other painting details.

3.03.12 Miscellaneous Work

a) Counter tops in kitchen, washbasin ,pantry & similar areas shall be polished granite.

b) Pavement and walk ways unless otherwise specified else where in the document shall be with not less than 80 mm thick plastic molded interlocking concrete pavers suitable for heavy vehicle.

c) M.S grill in windows shall be provided as required from security point of view as per approved design.

d) Suitable arrangement of floor drains with trap shall be provided in floor where spillage of water may occur.

e) Covered car parking with RCC pavement for 10 no of cars and one shed for 20 no of two wheelers shall be provided. Structure shall be tubular vault structure with translucent PVC sheet similar to ONDEX bi-stretched PVC sheet.

f) All roofs shall be accessible from grade level by at least one staircase and for single storied buildings steel cage ladders shall be provided in case the roof is not earmarked for any equipment.

g) All external doors, windows, ventilators and rolling shutters shall be provided with sun and rain control device either by projecting RCC chajja or by recessing the windows, ventilators at least by 400 to 500 mm from external surface. Minimum 750 mm projection from external surface shall be provided for Doors and rolling shutters with vertical fins. For windows projection shall be minimum 500 mm from exterior surface and at least 150 extra projection from window jamb in each side shall be kept. Continuous chajja shall be provided where doors or rolling shutter and windows are provided side by side. RCC chajja over openings shall have Architectural feature to create a pleasing impact on the façade elevation.

h) Chain link fencing shall be provided as required from safety point of view.

Fencing shall be 3.0m high.

3.04.00 **Roof Insulation and Ventilation**

The RCC roof of all buildings shall be insulated with Expanded high density extruded polystyrene block. For roof ventilation relevant section of the specification shall be referred.

3.05.00 **Roof Waterproofing**

Generally all RCC roofs of all buildings other than power house and Service and Technical Building shall be provided with water proofing treatment comprising of concrete screed 1:2:4 in slope not less than 1:100. Top of Screed shall be provided with water proof treatment comprising of one coat of water proof chemicals of rubberized modified bituminous emulsion similar to EMUFAL TE of TEXSA or approved equivalent and 1.5 mm thick Self adhesive water proof membrane similar to Texself H.D of TEXSA or approved equivalent over chemical treatment. Top of water proof membrane shall be protected with 25 mm thick cement concrete 1:2:4 with 0.56 dia. chicken wire mesh. Top of protective layer shall be covered with extruded high density polystyrene insulation as per HVAC requirement but not less than 50mm thick. Top of insulation shall be protected with 25 mm thick cement concrete 1:2:4 with 0.56 dia. chicken wire mesh in panels of maximum size 1.2Mx1.2M. Joints shall be sealed with polysulphide sealant. Walk way where required shall be provided over roof surface for maintenance purpose and shall be with minimum 20 mm thick pressed pre cast concrete tiles on 15 mm thick Cement: Sand (1:4) mortar. Minimum 20% area of the roof shall be considered for walk way.

China mosaic finish flooring instead of Pressed precast concrete tiles shall be provided where cooling towers are located over terrace with proper drainage system.

3.06.00 **Partition Wall**

Generally full brick thick partition wall in 1:6 cement, sand mortar shall be provided except for toilet internal walls which shall be half brick thick in 1:4 cement sand mortar. 2 Nos. 6 mm dia. Rod shall be provided at every third layer. Full Glazed partition in anodized aluminium frame shall be provided for control room area so that clear view of the operating equipment and turbine hall is available from control room and various ancillary rooms in control room area.

3.07.00 **Plastering**

Exterior masonry wall, concrete surfaces and internal masonry and concrete surfaces shall be plastered with cement sand mortar.

3.08.00 **False Ceiling**

Control room in Power house and control room of other buildings including other air conditioning spaces shall have suspended ceiling with 84 x 12.5 deep x 0.5 mm thick inter-locking pre coated Aluminium alloy linear ceiling (LUXALON) on aluminium carrier.

Suspended ceiling shall take care of all illumination system, fire detection and fighting system, HVAC diffusers and other service system. Where required under deck insulation with fiber glass wool with aluminum foil backing shall be provided.

3.09.00 **Special Finish**

The main entrance of power house, control room and other important buildings like Technical & O&M building along with main stairs, lift lobby, entrance lobbies etc. shall be specially considered with interior design and finishes with special materials. Entrance to all buildings shall have special architectural features.

3.10.00 **Doors**

a) Generally hollow metal (steel) flush doors with pressed steel frame shall be provided for plant and utility areas unless otherwise owner recommended for some other doors.

b) Rolling steel shutters shall be used where frequent use is not envisaged and large openings are required.

c) Special areas like control rooms shall be provided with aluminum glazed partitions and double doors with air lock i.e., two sets of doors with an air space. In between two doors an ante space shall be provided.

d) seamless double leaf fully glazed doors with 12 mm thick glass shall be provided in entrance door of Service and technical building.

e) Fire proof doors with panic bar devices shall be provided in cable spreader rooms and other areas having fire hazard and shall be provided as per LPA/ TAC requirements. Fire door shall be of approved manufacture and of minimum 2 hours fire ratings.

f) Doors shall be provided at appropriate location to prevent dust ingress from outside. Weather strip shall be provided to all external doors as well as in all air conditioned area.

g) Panel doors in teak wood stiles and rails and panel with 12 mm thick marine ply wood shall be provided with both side laminations for toilets and other wet areas. Factory made flush door in BWR grade ply with both side laminated shall be provided in offices and other rooms of non plant building as per suitability and owners approval shall be provided all wooden doors shall be provided in Teak wood door frame. Aluminum frame glazed internal doors in some rooms of office as per owner's requirements shall be provided.

h) Specially fabricated sliding or double leaf side hung steel door shall be provided in mono rail location.

3.11.00 **Windows & Ventilators**

Generally for all plant buildings Aluminum casement windows and ventilators with 6mm thick clear float glass both for open able and fixed windows shall be provided. Aluminum casement windows shall be of approved Hindalco series and shall be minimum 15 micron thick anodized.

6mm thick clear wired glass shall be provided as required from safety point of view at higher elevation not less than 3.0M from finish floor level of the respective floor of the building.

Windows in Control room and air conditioned area shall be double glazed fixed windows hermetically sealed similar to glazed partition below. The exterior glass shall be bronze tinted heat reflecting glass as per approved sample.

3.12.00 **Glazing and Glazed Partition**

Glazing between A.C and non A.C areas shall be Insulating glass consisting of two 6mm thick clear float glass with a separating gap of 10 mm for thermal insulation. Both the glasses shall be hermetically sealed. Glazing between two A.C area shall be with 6mm thick clear float glass. All glazed partition shall be in aluminium 15 micron thick anodized frame.

3.13.00 **Sealant**

Silicon sealant shall be provided in all joints around exterior doors, windows, ventilators with masonry and concrete surfaces. Expansion joints shall be sealed with polysulphide sealant with back up rod and compressible filler.

3.14.00 **Landscaping**

Both soft and hard landscaping shall be developed for a pleasing environment.

Generally the natural contour shall be retained except where modifications needed for drainage or other technical reasons. Trees shrubs, hedges, earth mound, grass lawn shall be provided to suit the climate. Necessary irrigation system shall be provided for watering of the landscape area.

3.15.00 **Facilities in Buildings**

Facilities in each building shall be developed on the basis of requirements. Proper circulations and safety requirements shall be considered in each case. Plenty of natural light penetration through Windows, Structural glazing shall be one of the prime objective for each building. Architectural design shall ensure this aspect.

Adequate toilet and drinking water facilities with RO Plant system shall be provided for personnel working in each building. Each building and each manned floor shall have toilet facilities according to occupancy requirement as per NBC (National Building Code).

Ladies toilet shall be provided in each building as per requirements of the female occupancy in that building. Toilets for physically impaired personnel shall also be provided as per requirement of the owner.

3.16.00 **Potable Water System and Plumbing**

3.16.01 This system for various buildings shall be connected to the drinking water and service water system.

3.16.02 Water outlets shall be provided for an instantaneous flow rate of approximately 1.2 Cu.M/Hr. (5 GPM).

3.16.03 System will satisfy the state and local plumbing codes and regulations. In absence of the same NBC norms shall be followed.

3.16.04 Following I.S. Codes for the system shall be followed :

a) IS-2065 : Code of Practice for water supply in buildings.

b) IS-1172 : Code of basic requirements for water supply, drainage and sanitation.

c) IS-1200 : Laying of water and sewer lines (Pt.XVI) including appurtenant items.

d) IS-1239 : Specification for mild steel tubes and mild steel tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter).

e) IS-3589 : Specification for electrically welded steel pipes for water, gas and sewage (220 mm to 2000 mm nominal diameter).

3.16.05 Potable water shall be supplied to basins, water closets, urinals, sinks, water coolers, showers and other plumbing fixtures as required. Soil and waste water piping shall drain through traps to the yard sanitary sewer system. All wash basins shall be connected to waste water disposal pipe through bottle trap.

3.17.00 **Roof Drainage Systems**

3.17.01 The system shall be provided for removal of water from roof surface to avoid damage to the roof structure of all buildings and shall consist of the following:

a) Roof Drain Heads

b) Rain Water Down pipes

c) Fixtures

IS-1742: Code of practice for building drainage shall be followed for this purpose.

Multiple drains (min.2) shall be provided for all roof areas. System will be designed to handle rainfall at a rate of 90 mm per hour and in accordance with stipulations of IS-1742.

Roof drains will dispose rain water to storm water drain. Rain water pipes **shall run unexposed.**

All roofs shall be provided with access at least by one staircase. Cage ladder for single storied building may be provided where staircase is not provided in the building for maintenance of the roof drains and roof.

3.18.00 **Finish Schedule**

Sl. No.	Building/Area	Floor/Skirting/ Dado	Wall	Ceiling
1.	All Turbine hall floors, (except operating floor of Power house building and floors of control building and any area requires special finish), AC plant, AHU room, Unloading bays, main-tenance & work-shop area, Fire tender area, Bulk Storage area of Store building. Loading un-loading area, ramp and loading dock and unless otherwise indicated ground floor of all plant buildings.	Heavy duty floor finish with non metallic hardener & suitable aluminium dividing strips.	Plastered & painted with acrylic washable distemper	RCC ceiling plastered & painted with min. two coats of acrylic washable distemper over coat of primer.
2.	Operating floor of Power house building. and Switchgear room and Following area of Store building: Store for costly, light & special materials, offices, entrance in front of office, locker room.	25 mm thick mirror polished Kota stone flooring over 1:4 mortar and required concrete under bed 1:2:4.	Plastered & painted with acrylic washable distemper	Metal deck ceiling / RCC ceiling Plastered & Painted with Acrylic Wash-able distemper.
3.	General circulation areas. Like passages, lobbies, corridors,Lift & stair entrance lobbies and corridors in all impor-tant areas like service & Technical building. Laboratories,	20 mm thick Mirror polished colour granite in large slab as per Owner's choice in 1:3 cement sand mortar & required concrete under bed 1:2:4.	Plastered & painted with acrylic emulsion paint Over wall putty. Lift front shall be finished with 20mm thick mirror polished pink or any approved coloured granite slab of approved texture.	RCC ceiling plastered & painted with acrylic emulsion over wall putty. False ceiling if required shall be provided with Luxalon.

Sl. No.	Building/Area	Floor/Skirting/ Dado	Wall	Ceiling
	Passage, lobbies and other areas of all non plant buildings.	Skirting on stair treads shall be with coloured granite as per Owner's choice.	.	.
4.	Cable vault, cable spreader,, all Pump houses, DG room & similar other areas.	Heavy duty floor finish with metallic hardener & dividing strips	Plastered & painted with acrylic washable distemper.	RCC ceiling plastered & painted with acrylic wash-able distemper.
5.	RCC stair case in all buildings except Service and Technical building. For Service Building	20 mm thick mirror polished coloured granite slabs in treads and risers in 1:3 mortar and cement slurry & required concrete under bed. Granite slab shall be in one single slab for stair width up to 1500 both for treads & risers. Three no grooves 6 x 5 mm along the length of the tread shall be provided for grip. Granite shall be as per owner's choice. 20 mm thick mirror polished granite in cement sand mortar 1:3 with cement slurry and required under bed. Granite slab shall be in one single slab for stair width both for tread and riser. Three no grooves 6 x 5 mm along the length of the tread shall be provided for grip Skirting shall be as stated in Sl no 3	Plastered and painted with acrylic emulsion paint Over wall putty.	RCC slab/ceiling plastered & painted with acrylic emulsion over wall putty.
6.	Control room and other areas where false floors are required.	False floor min. 600 high from base slab removable type with steel hollow panels coated with	Plastered & painted with acrylic emulsion paint Over wall putty.	False ceiling with aluminum linear false ceiling of Luxalon..

Sl. No.	Building/Area	Floor/Skirting/ Dado	Wall	Ceiling
		epoxy paint on exposed surface and factory laminated antistatic HPL/PVC at top with 6mm beading on all sides for edge protection..Panels shall be mounted on detachable steel pedestal and grid system as per specification.		
7.	All air conditioned areas in control room where false floors are not required, MCC room, office areas, conference room, shift in charge room, Engineers' room.	10mm thick 600 x 600 vitrified tiles over 1:3 mortar including cement slurry and concrete under bed 1:2:4 as required.	Plastered & painted with acrylic emulsion paint Over wall putty.	False ceiling with Aluminum. linear ceiling of Luxalon as per approved lay out.
8.	Battery & battery Charger room and Acid prone similar areas.	Min. 20mm thick acid alkali resistant tiles set in & jointed in Silica based epoxy mortar. 2100 high Dado of similar tiles.	Acid resistant resin based epoxy coating over two coat of Deckurds-s manu-factured by fosrocks or equivalent paint over remaining wall surfaces.	.Acid resistant resin based epoxy coating over two coat of Deckurds-s manufactured by fosrocks or equivalent paint
9.	Toilet, pantry, Yard toilets, Kitchen, Pot wash of Kitchen, hand wash and dish wash area & other similar wet areas of all buildings (plant and non plant)	Mat finish coloured designed ceramic tiles in 1: 3 cement sand mortar/title size 300 x 300 x 7.2 mm. Glazed coloured designed ceramic wall tiles dado 300x 450 x 8mm thick up to full height	Plastered & painted with acrylic emulsion paint over wall putty.	Plastered & painted with acrylic emul-sion paint over wall putty. False ceiling shall be provided with Luxalon to reduce the ceiling height of Toilet where required as per requirement of owner. Height of toilet shall be 3000 mm from finish floor level.
10.	Sunken floor in toilets	Sub floor painted with EMUFAL T.E of TEXSA or eqv. and one layer of Water proof 1.5 mm thick self adhesive water proof	Side walls of sunken floor similar to floor treatment.	-

Sl. No.	Building/Area	Floor/Skirting/ Dado	Wall	Ceiling
		membrane of TEXSA or Eqv. Including 50 mm thick PCC 1:2:4 protection layer (Treatment similar to roof water proofing) Hydro test shall be carried out after completion of water proofing by filling water for 48 hours.		
11.	Floors and RCC stair in areas prone to slippage	Antiskid finish with neat cement with chequered tile pattern.	-	-

Skirting in all floors shall be 150 mm high and shall be of similar material of floor

1.5 mm thick wall putty finish shall be provided where Acrylic Emulsion paint is indicated.

All internal M.S components, doors both wooden and steel shall be painted with two coats of paint over a coat of primer/wood primer for wood surface.

Fire door shall be painted with Post office red shade.

All aluminum Doors and windows sills, jambs and heads shall be provided with Minimum 12 mm thick large granite slab in 1:3 mortar. Such finishes shall be provided in all important buildings as per owner's choice

False flooring area and toilet area shall be provided with Sunken slab to get false floor finish at same level as adjacent floor. Sunken floor below false floor shall be given two coats of synthetic enamel paint over one coat of primer.

3.18.01 During execution of the contract, the contractor shall take approval from the owner of all building materials and finishing items (e.g. various tiles, doors, and windows, paints etc.) to be used for the contract by submitting samples and/or product literature as appropriate.

4.00.00 WORKMANSHIP

Workmanship for architectural work shall be of the best possible quality and all work shall be carried out by skilled workmen except for those work which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. In addition to the requirement specified above, if the by laws of the local Govt., Municipal or other authorities require the employment of licensed or

registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the representative of the manufacturers to ensure that the work is being done according to the manufacturer's specifications and details.

5.00.00 DOCUMENT SUBMISSION

Design and Construction documents including architectural drawings & finish schedule pertaining to all Architectural work shall be required to be submitted to Owner/Owner's Consultant for their approval. Approval of these documents by the Owner/Consultant shall not relieve the Contractor of his responsibility for any errors and fulfillment of Contract requirements. No of documents to be submitted shall be as mentioned elsewhere in the tender document

5.01.00 As Built Drawings

"As-built" drawings shall be prepared by the Contractor after completion of construction/erection incorporating all the changes, if any, done on Engineer's instruction/approval. The number of prints and film based reproducible transparency and CD to be submitted for Design, Construction documents and As- Built drawings mentioned elsewhere in the specification, stipulations made in Section G-0 shall prevail. No of documents to be submitted shall be as mentioned elsewhere in the tender document.

6.00.00 CODES AND STANDARDS

Following is a general list of Codes and Standards to be used in the design of the Plant. Specifically applicable codes and standards shall be identified in System Design Descriptions/Technical Specifications as appropriate. The latest editions/revision of following codes and standards along with addendums/ amendments, if any, shall be followed.

6.01.00 General

a) Internationally accepted design Codes and Standards which are equivalent or more stringent than corresponding Indian Standards.

b) National Building Codes of India.

c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.

d) IS-1200 : Method of measurement of Building and Civil Engineering Work.

e) IS-1256 : Code of Practice for Building Bylaws.

6.01.01 Masonry

a)	IS-712	:	Building limes.
b)	IS-1077	:	Common Burnt Clay Building Bricks.
c)	IS-1127	:	Recommendations for dimensions and workmanship of natural building stones for masonry work.
d)	IS-1528	:	Methods of sampling and physical tests for refractory materials.
e)	IS-1597	:	Code of practice for construction of stone masonry (all parts).
f)	IS-2212	:	Code of practice for brickwork.
g)	IS-2116	:	Sand for masonry mortars.
h)	IS-2185	:	Concrete masonry units. (all parts - Hollow and Solid concrete blocks).
i)	IS-2250	:	Code of practice for preparation and use of masonry mortars.
j)	IS-2572	:	Code of practice for construction of hollow concrete block masonry.
k)	IS-2691	:	Burnt clay facing bricks.
l)	IS-3414	:	Code of practice for design and installation of joints in buildings.
m)	IS-3495	:	Methods of tests of burnt clay building bricks.
n)	IS-4441	:	Code of practice for use of Silicate type chemical resistant mortars.
o)	IS-4860	:	Acid Resistant Bricks.

6.01.02 **Doors, Windows and Ventilators**

a)	IS-399	:	Classification of commercial timbers and their zonal distribution.
b)	IS-883	:	Code of practice for design of structural timber in building.
c)	IS-1003	:	Timber panelled and glazed shutters (all parts).
d)	IS-1038	:	Steel doors, windows and ventilators.
e)	IS-1081	:	Code of practice for fixing and glazing of metal

(steel and aluminium) doors, windows and ventilators.

f)	IS-1361	:	Steel windows for industrial buildings.
g)	IS-2835	:	Transparent sheet glass for glazing and framing purposes.
h)	IS-1948	:	Aluminium doors windows and ventilators.
i)	IS-1949	:	Aluminium windows for industrial building.
j)	IS-2191	:	Wooden flush door shutters (Cellular and hollow core type).
k)	IS-2202	:	Wooden flush door shutters solid core type).
l)	IS-3103	:	Code of practice for Industrial ventilation.
m)	IS-3548	:	Code of practice for glazing in buildings.
n)	IS-3614	:	Fire check doors.
o)	IS-4021	:	Timber door, windows and ventilator frames.
p)	IS-4351	:	Steel door frames.
q)	IS-6248	:	Metal rolling shutters and rolling grills.

6.01.03 **Roof and Flooring**

a)	IS-2204	:	Code of practice for construction of reinforced concrete shell roof.
b)	IS-3201	:	Criteria for the design and construction of precast concrete trusses.
c)	IS-2210	:	Criteria for Design of R.C. shell structures and folded plates.
d)	IS-809	:	Rubber flooring materials for general purposes.
e)	IS-1195	:	Bitumen mastic for flooring.
f)	IS-1196	:	Code of practice for laying bitumen mastic flooring.
g)	IS-1198	:	Code of practice for laying, fixing and maintenance of linoleum floors.
h)	IS-1237	:	Cement concrete flooring tiles.
i)	IS-1443	:	Code of practice for laying and finishing of

cement concrete flooring tiles.

j)	IS-2114	:	Code of practice for laying in situ terrazzo floor finish.
k)	IS-2571	:	Code of practice for laying in situ cement concrete flooring.
l)	IS-5491	:	Code of practice for laying in situ granolithic concrete floor topping.
m)	IS-5766	:	Code of practice for laying burnt clay brick flooring.
n)	IS-1197	:	Code of practice for laying of rubber floors.
o)	IS-2441	:	Code of practice for fixing ceiling coverings.

6.01.04 **Waterproofing**

a)	IS-1322	:	Bitumen felts for waterproofing and damp proofing.
b)	IS-1346	:	Code of practice for waterproofing of roofs with bitumen felts.
c)	IS-1609	:	Code of practice for laying damp proof treatment using bituminous felts.
d)	IS-3036	:	Code of practice for laying lime concrete for a waterproofed roof finish.
e)	IS-3037	:	Bitumen mastic for use in waterproofing of roofs.
f)	IS-3067	:	Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.
g)	IS-3384	:	Bitumen primer for use in water proofing and damp proofing.
h)	IS-4365	:	Code of practice for application of bitumen mastic for waterproofing of roofs.

6.01.05 **Water Supply, Drainage and Sewerage**

a)	IS-404	:	Lead pipes.
b)	IS-458	:	Concrete pipes.
c)	IS-651	:	Salt glazed stoneware pipes and fittings.
d)	IS-771	:	Glazed fire-clay sanitary appliances (all parts).

e)	IS-774	:	Flushing cisterns for water closets and urinals other than plastic cisterns.
f)	IS-783	:	Code of practice for laying of concrete pipes.
g)	IS-1172	:	Code of basic requirements for water supply, drainage and sanitation.
h)	IS-1626	:	Asbestos cement building pipes, gutters and fittings (all parts).
i)	IS-1742	:	Code of practice for building drainage.
j)	IS-2064	:	Code of practice for selection, installation and maintenance of sanitary appliances.
k)	IS-2065	:	Code of practice for water supply in buildings.
l)	IS-2470	:	Code of practice for installation of septic tanks (all parts).
m)	IS-3114	:	Code of practice for laying of Cast Iron pipes.
n)	IS-4127	:	Code of practice for laying of glazed stoneware pipes.
o)	IS-12251	:	Code of practice for Drainage of Building Basement.
p)	IS-1200	:	Method of measurement : Laying of [Part XVI] water and sewer lines including appurtenant items.
q)	IS-1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
r)	IS-1537	:	Vertically cast iron pressure pipe for water, gas and sewage.
s)	IS-3486	:	Cast iron spigot and socket drain pipes.
t)	IS-5329	:	Code of practice for sanitary pipe work above ground for buildings.
u)	IS-3076	:	Low density polyethylene pipes for potable water supplies.
v)	IS-1230	:	Cast iron fittings for pressure pipes for water, gas and sewage.

w)	IS-1230	:	Cast iron rainwater pipes and fittings.
x)	IS-1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
y)	IS-784	:	Prestressed concrete pipes.
z)	IS-1726	:	Cast iron manhole covers and frames.
aa)	IS-5961	:	Cast iron grating for drainage purposes.
bb)	IS-5219 [Part-I]	:	"P" and "S" traps.
cc)	IS-772	:	General requirements for enamelled cast iron sanitary appliances.
dd)	IS-775	:	Cast iron brackets and supports for wash basins and sinks.
ee)	IS-777	:	Glazed earthenware wall tiles.
ff)	IS-2548	:	Plastic water closet seats and covers (all parts).
gg)	IS-2527	:	Code of practice for fixing rainwater gutters and downpipes for roof drainage.

6.01.06 **Painting**

a)	IS-348	:	Specification for French Polish.
b)	IS-427	:	Specification for Distemper, dry colour as required.
c)	IS-428	:	Specification for Distemper, oil emulsion, colour as required.
d)	IS-1477	:	Code of practice for painting of ferrous metal in buildings.
e)	IS-2328	:	Code of practice for finishing of [I & II]wood and wood based materials.
f)	IS-2339	:	Specification for Aluminium Paints for general purposes in dual containers.
g)	IS-2395	:	Code of practice for painting concrete, masonry and plaster surface.
h)	IS-2932	:	Specification for enamel, synthetic, exterior: i) Undercoating ii) Finishing

i) IS-2933 : Specification for enamel, exterior:

i) Undercoating

ii) Finishing

j) IS-5410 : Specification for cement paint.

Any other code which is not indicated above but may be required in course of design, construction, and review shall also be referred.

7.00.00 BRIEF SPECIFICATION OF ARCHITECTURAL WORK

7.01.00	Anti termite Treatment	:	Anti termite treatment as per IS 6313 Part (ii) with chlorepyriphos emulsifiable concentrate conforming to IS:8944 with 1% concentration or approved equal as per manufacturer specification.
7.02.00	Brick work	:	230 mm thick fly ash brick wall with 1:6 Cement : Sand mortar. Compressive strength shall not be less than 100 Kg/ Sq. Cm.
7.02.01	Half brick thick walls for toilets' internal walls and other small partition wall.	:	1:4 Cement & Sand Mortar with 2 Nos. 6 mm M.S. bars at every 3rd course.
7.03.00	Damp proof course	:	50 mm thick 1:1.5:3 concrete with a minimum of 2% admixture of water proofing compound and shall be provided at plinth level. Plinth level of all buildings shall be minimum 300 mm above finished grade level or as approved at the final stage of design work.
7.04.00	Plaster :		
7.04.01	Internal	:	12 mm thick 1:6 Cement Sand plaster for even side of the wall and 15 mm at the rough side of the wall.
7.04.02	External	:	20 mm thick cement sand plaster to be laid in two layers. Bottom layer 12 mm thick with 1:3 cement sand mortar and top layer 8 mm thick with 1:1 cement sand mortar with fine sand. 20 mm thick external plaster with similar mix cement sand plaster shall be provided where specially required or as per manufacturer's specification for any special decorative finish.
7.04.03	Ceiling	:	10 mm thick 1:4 Ceiling plaster over concrete surfaces except in cable vault area.
7.04.04	Punning over plaster	:	1.5 mm thick wall putty punning over plaster. In general wall putty shall be provided over plaster

for all air conditioned rooms, entrances and lobbies, offices, conference room and all special areas which are to be painted with acrylic emulsion paint and as indicated in finish schedule.

7.05.00 Cladding for Power house, and other buildings where cladding shall be provided. : a) Exterior walls shall be of 230mm thick brick wall up to 3000 mm height in general from finish ground floor level. Fire wall where required shall be provided for 2 to 3 hours fire resistance and of required height as per statutory code or TAC/LPA rule for particular equipment and particularly in transformer yard portion. Other sides unless required by any specific rule or codes height of Brick wall shall be up to 3000 height from finished floor level. In case of Power house Wall in boiler side ie along C row shall be brick wall up to full height. Wall in service and technical building will be brick wall up to full height. Power house wall at that gable end above the height of service building shall be sandwich metal cladding.

The upper part of the external wall above brick wall single sheet/insulated sandwich metal cladding (profiled) shall be provided. Metal cladding shall be permanently pre coated with Fluro polymer (PVF-2) over zinc aluminium high tensile (550MPA) steel profiled sheet of minimum 0.6mm TCT thick (total coated thickness) and shall be of approved manufacturer. For uniformity metal cladding wall along 'A' row in power house and gable end not adjacent to service building shall be from 3000 height. Metal cladding over parapet and brick wall shall be single sheet cladding.

7.06.00 Filler Wall : a) 150 high curb of half brick thick shall be provided between edge of floor slab and cladding. curb wall where required shall be provided up to window sill.

b) control equipment room and other Air conditioned rooms in the operating floor shall be provided with half brick thick curb wall up to window sill and Remaining surfaces up to false ceiling/structural slab shall be provided with Double layer 12.5 mm thick Gypsum board over Gyp steel channel, all steel columns shall be covered with Double layer Gypsum board over Gyp channel.50 mm rock wool insulation shall be

provided at back in air conditioned area. Other control rooms with cladding shall have similar treatment.

For special interior finish in control room for Power house Aluminium Composite panel (ACP) 4mm thick Fixed in aluminium frame shall be provided. ACP shall be with 0.5mm toping of pre-coated aluminium foil on both side with 3mm core and of approved manufacturer & approved shade. Steel column encasement shall also be with similar materials and details with necessary backing as required.
In toilet block brick walls shall be provided up to false ceiling height. Battery room, battery charger room shall have brick wall up to dado height ie 2250 high.

c) The upper floor slabs shall be extended up to cladding with a gap of 25 mm. The gap between RCC floor slab and Cladding in air conditioned area shall be sealed with Extruded Polystyrene block. In other areas shall be provided only if required by HVAC.

7.07.00 **Doors & Windows**

7.07.01 Doors : a) Doors shall be steel doors consisting of double plated hollow flush door shutters with pressed steel door frame and shall be provided for plant and utility areas. Doors shall be minimum.1000 wide and 2100mm height. For single leaf door. For double leaf door width shall be 1500 mm minimum. Equipment entry door shall be as per the requirement of Equipment movement through door.

b) Door shutter shall be 45 mm thick with two outer sheets of 1.25 mm thick steel sheet rigidly connected with continuous vertical & horizontal stiffeners 1 mm thick @ 150C/C top and edges of shutter shall also be reinforced by continuous stiffener channel.

c) Doors shall be sound deadened by filling the inside with Mineral wool insulation.

d) Door frame shall be pressed steel frame from 1.6 mm thick sheet and shall be filled with concrete/cement sand mortar 1:6

e) Large door in monorail location shall be specially fabricated and provided where required.

f) Fire proof doors shall be provided on division walls of cable spreader rooms and at all fire exit points as per recommendation of Tariff Advisory Committee/LPA. These shall be as per IS:3614. Fire resistance grade of the doors shall be as per LPA/TAC requirements. However, minimum fire resistance grade shall be for 2 (two) hours.

g) Doors of control room, control equipment room, computer room, and other important rooms and entrance doors of all important buildings shall be aluminium glazed doors. Doors shall be of double swing type with floor spring. For control room, control equipment room, etc. glazed wall panels with aluminium frame shall be provided between air-conditioned and non-air-conditioned areas and on the side of control room facing the operating floor to have a clear view.

Glazed door as required shall be provided in glazed partition.

Single Glazed panel with aluminium frame work shall be provided as partition between two air-conditioned areas where clear view is necessary. All aluminium frame shall be 15 micron thick anodizing coating. Main entrance door to control room and control equipment room shall be with air locked lobby by providing two Aluminium Glazed doors with a ante room/space in between.

All aluminium section shall be of approved HINDALCO sections.

h) Internal Doors of W.C and bathrooms shall be wooden panel door with teak wood frame. Refer Cl. 3.10.00 frame shall be 100x60 mm size.

i) Vision panel in door with 6 mm thick clear glass of size 250 x 400 shall be provided where required.

j) All doors shall be provided with necessary approved quality hardware. Hardware schedule for both door and windows shall be furnished for approval.

7.07.02 Windows

a) All windows and ventilators shall be aluminium casement glazed windows and ventilators. Aluminium sections shall be of

HINDALCO approved series of minimum 15 micron thick. anodize coating.

b) Hardware of approved quality shall be provided as required.

c) Fixed M.S. grill shall be provided in all windows in MCC room in ground floor and other rooms where required from security point of view.

d) P.S. louvre shall be provided as per requirement of HVAC.

7.07.03 Rolling shutters : Rolling shutters with suitable operating arrangement (mechanical and/or electrical) according to size shall be provided in buildings to facilitate handling & transportation of equipment. All rolling shutter shall be of approved manufacturer. All Rolling shutter shall be Electrically & Mechanically operated.

7.07.04 Glazing and glazed partition & Structural glazing, polycarbonate vault canopy : a) Thickness of glazing shall be 6 mm thick clear float glass according to panel sizes and shall be provided in all windows which are within 3000 height from finish floor level. All other fixed windows at upper level shall be provided with 6 mm thick clear wired glass or as approved during final design stage.

b) All external windows in control room at operating floor shall be double glazed hermetically sealed with 10mm gap. Both the glasses shall be 6mm thick toughened float glass. Inner glass shall be 6 mm thick clear glass and outer glass shall be 6 mm thick tinted heat reflecting glass.

c) FIXED glazed window between A/C and non A/C area shall be double glazed aluminium casement windows. With 6 mm thick clear float toughened glass.

d) Glazing in control room between two AC areas shall be with single glazed wall panels with 6 mm thick toughened clear glass with aluminium frame. Glazing between A.C and non A.C area shall be double glazed with two clear toughened glass similar to window above and shall be hermetically sealed.

e) 4 mm thick ground glass shall be provided for toilets.

f) 6.0 mm thick float glass shall be provided for doors. For control room door clear float

toughened glass 6.0 mm thick shall be provided.

g) Structural glazing in facade treatment of Power house/Technical and Service building shall be provided for special Architectural treatment of the façade. Structural glazing shall be 6 mm thick tinted heat reflecting toughened glass fixed over aluminium frame backing using structural silicon 995 grade or as approved of DOWCORNING or equivalent and ensuring weather sealing using 789 DOW CORNING OR AS APPROVED. The system shall be capable to withstand the most aggressive climate of the area. All brackets and supports shall be of stainless steel and shall be fixed by HILTI fastener system. Shadow box as required shall be provided to hide the beams from vision. Stainless steel capping shall be provided at top to prevent ingress of water. The work shall be carried out through approved vendor expertise in this type of work.

h) Clear translucent vault cover with lexan thermo clear multi wall polycarbonate sheet of G.E. plastic with both sides UV protection and thermal insulation properties and 6 mm thick with all necessary structure, EPDM gasket with aluminium flats etc. shall be provided for entrance canopy/porch for Power house/Technical and O&M Building.

7.07.05 False Ceiling for air-conditioned areas : a) Control room in power house, Conference room and special rooms in Technical building shall) suspended from steel members or RCC slab/beam with anchor fastener by concealed suspending system as per manufacturer's detail. Filler vertical panel shall be provided to hide the metal cladding member of control room and its allied areas. Lighting shall be indirect lighting. AC diffusers shall be continuous type.

False ceiling for other area shall be as per Cl. No. 3.08.00

c) Resin Bonded glass wool insulation minimum 25/50 mm thick as per HVAC requirement in aluminium foil backing shall be provided over false ceiling for thermal and acoustical insulation. The density of

glass wool shall be 32 kg/cu.m (minimum) and shall conform to IS 8183. Maximum value shall be 1.0 W/sq.m/deg.C.

d) Underdeck insulation as per HVAC requirement minimum 50 mm thick High density polystyrene blocks 30kg/CuM density shall be provided.

7.07.06 Floor finish : Floor finish shall be in general 50mm thick shall be as per floor finish details. Refer finish schedule Cl. 3.18.00.

7.07.07 Roof : a) All roofs shall be provided with water proofing treatment as indicated in Cl. 3.05.00.

b) The slope shall be 1:100 for quick disposal of rainwater. Grading under bed 1:2:4 & 1:4 cement sand plaster shall be provided where structural slopes are not provided. 1:4 plaster at end slope shall only be provided if required at end to maintain the slope.

c) The contractor shall give guarantee in writing for all work executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water proofing treatment work. The guarantee shall be for materials and workmanship for ten (10) years. The mode of execution of the guarantee shall have to be acceptable to the owner.

d) In general Heavy duty 110/150 dia. as required PVC rain water down comers with water tight as per manufacturer specification and medium class galvanized mild steel pipes conforming to IS:1239/ IS:3589 shall be provided particularly to drain off rain water from the roof. The numbers and size of down comers shall be governed by IS:1742 & IS:2527. Galvanized rain water down comer shall only be provided in Power house shall have threaded joint.

7.07.08 Painting : a) External masonry surfaces of all buildings shall have two coats of exterior grade acrylic emulsion paint of Asian Paint/ICI/Berger over a primer except service & technical building External masonry surfaces of these buildings shall be finished with minimum 2 coats of exterior grade acrylic emulsion paint over coat of primer. External surface of

service building shall be finished mainly with ACP (Aluminium Composite panel) veneering and structural glazing

b) Internal surfaces shall be finished as per finish schedule Cl. 3.18.00.

c) Oil resistant paint shall be provided in oil equipment room, oil canal, fuel oil pump house, etc.

d) Fire-proof putty in cable penetration on walls of cable spreader rooms shall be provided.

7.07.09 Stairs : a) All RCC stairs shall have not more than fourteen (14) risers in one flight. Height of risers and width of treads shall be 150 mm to 167 (max) and 300 mm respectively. Min. width of stairs shall be 1500 mm for RCC Main stair-case. For other emergency/fire escape staircase maximum steps in each flight shall be 13 nos. Tread 250mm and riser 180 max width of staircase 1200 clear.

b) Hand railing min. 1.0 meter high shall be provided around all floor/roof openings, projections/balconies, walkways platforms & steel stairs. All hand rail shall be min. 40mm nominal bore MS pipe (medium class) and shall be galvanized as per relevant IS code and shall not be less than 450g/m^2. All rungs for ladder shall be min. 16 dia. and galvanized with 650gm/ zinc/sq.m.

c) For all RCC stairs 25 mm square MS bar balustrades with 30x6 mm thick MS flats and aluminium handrail of INDAL SECTION NO. 5116 shall be provided and fixed to MS flat brass shoe for each balustrade shall be provided.
Stainless steel railing as per approved design shall be provided in Service & Technical building.

7.07.10 Draining out water from floors : For all buildings, suitable arrangement for draining out water collected from equipment, blow down, leakages, floor washings, fire fighting etc. shall be provided for each floor, complete up to station sewers. All drain out pipe shall be provided with Floor traps at the end.

List of Products which are to be used in the buildings are given in

Cl.11.00.00 and List of furniture which are to be provided in Service and

Technical Building and Canteen building are given in Cl.no 12.00.00

8.00.00 **WORK**

8.01.00 **Fencing**

Minimum 3.0 metre high fencing above toe wall shall be provided around switch yard, transformer yard, building transformer area, and other areas where fencing is necessary due to statutory requirements. Fencing shall comprise 2.4 metre high PVC quoted galvanized chain link fencing of minimum 12 gauge (including PVC coating) of mesh size 75 mm and galvanized barbed wire for switchyard/transformer yard.

Galvanized barbed wires of a height of 0.6 metre shall be provided above the chain link fence. The diameter of steel wire for chain link fencing excluding PVC coating shall not be less than 12 gauge. Steel entry gate shall be provided for all fenced areas. Top of toe wall shall be minimum 200 mm above the formation level.

Periphery fencing of unit # 8 shall be provided with GI concertina of 750 dia in Y shape angle MS post.

The fence around switchyard area shall comprise of 12 gauge G.I. PVC coated chain link fencing of mesh size 75 mm to a height of 2.4 m above the toe wall with a 600 mm high galvanized barbed wire at the top such that total fence height of 3.0 m above toe wall level is achieved. Toe wall shall be minimum 200 mm above the formation level.

The chain link will be stretched and attached by `C' clips at 0.5 m intervals to 3 strands of high tensile spring steel wire (HTSSW) of 12 gauge interwoven in chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip will be threaded through the links of chain link and bolted to the fence post with the help of security nuts and bolts.

Above the chain link fence 600 mm high Barbed wire fencing shall be provided. Three prong standard barbed wire in four lines at equal division shall be fixed with M.S angle post bent to 45 degree angle towards inside.

All fence posts shall be 75 x 75 x 6 MS angles spaced at 2.5 m C/C distance. All straining posts i.e., end posts shall be 75 x 75 x 6 MS angles. All corner posts will have two stay posts of size 65 x 65 x 6 MS angles and every tenth post will have a transverse stay post. Suitable concrete foundations for the angle iron posts and stays shall be provided based on the prevailing soil conditions. Toe walls either of brick masonry with bricks of minimum 50 kg/cm^2 compressive strength shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200 mm above the switchyard grade formation level with PCC coping (1:2:4). All gates shall be of hot dipped galvanized structural steel as per specification.

Chain link gate with M.S. angle frame, MS flats, `T' metal track, roller, gun metal shoe etc. shall be provided as required in the fence for vehicular and man access gate.

All structural steel work for the fencing shall be painted with synthetic enamel paint over a suitable primer.

9.00.00 WATER SUPPLY AND SANITARY WORK

9.01.00 Water Supply and Sanitary Work :

a) PVC roof water tank of adequate capacity depending on the number of users for 8 hours storage shall be provided for each building. Tank shall be Sintax tank or approved equal.

b) Galvanised MS pipe of heavy duty class shall be provided for internal concealed piping. Piping work for potable water supply. Exposed GI pipe may be medium class. All water supply line in internal wall shall be concealed pipe work.

c) Heavy duty PVC pipe conforming to IS 15328 with joints as per manufacturer specification shall be used for sanitary work below ground.

d) Heavy duty PVC pipe conforming to IS 15328 with joints as per manufacturer specification shall be provided for sanitary work above ground.

e) 100 mm thick 1000 mm wide plinth protection with plain cement concrete 1:2:4 with top smooth finish over an under bed of 75 mm thick (nominal) over 40 mm (nominal) dry brick ballast well compacted & grouted with sand.

f) Brick/RCC surface drain shall be provided all around the building with slope 1:250 to 300 & connected to area drain. 40 thick. M.S. gratings/RCC slab shall be provided over surface drain at the location of entry, vehicular crossing etc. Size of drain shall be as per quantity of rain water to be disposed off and shall not be less than 300 wide x 300 depth.

g) All underground pipeline should be provided with bituminous paint & wrapping coating prior to Hydro test

9.02.00 Toilets

Minimum one toilet shall be provided in each building. The no. of WC, wash hand basin, urinals etc. shall be as per the no. of users. Toilet blocks in control room building shall have arrangement for both Gents & Ladies toilet.

For toilet block with two or more W.C.S at least one toilet shall be of Indian type.

For multilevel toilet block & toilet in upper floor ventilation shaft/pipe duct shall be provided. An eye & face fountain conforming to IS-10592 shall be provided in battery room, DM plant and chlorination Plant building.

Each toilet shall contain following min. fittings :

- Raised type 1 No. W.C. (Western pattern)
- Incase in a toilet block two or more WCs are provided one of the WC shall be Orissa type squatting WC.
- Urinals 2 Nos. (590x400x380)

  Urinals in Service & technical building in upper three floors and control room floors in Power House shall be
- Wash Basin 2 Nos. (550x440)
- Shower 1 No. for chlorination building/Control room area.
- Bathroom mirror 2 Nos. (600x450x5.5MM)
- Glass Shelves 2 Nos.
  (610mm x 127 mm x 6mm thk)
- Towel rail 1 No. 600x20mm dia CP Brass
- Liquid Soap Holder (stainless steel) 1 No.
- Toilet paper holder 1 No.
- Janitor 1 No.
- Water cooler RO system with 1 No.
- Septic tank including all accessories and laying of 150 mm or as per required dia. heavy cast iron soil lines.
- Effluent shall be treated through up flow filter system from septic tank and will pass through chlorination chamber before disposal to nearest area drain or through sewerage treatment plant as will be decided at the detail engineering stage.

10.00.00 **RULES AND BYE LAWS**

10.01.00 Statutory rules : a) Vendor shall comply with all applicable statutory rules pertaining to Factories Act as applicable for the State of Gujarat, Rules of Tariff Advisory Committee (TAC), Water Act for pollution control, Building by laws, Factory rules etc. of the State.

b) Provision of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkway, minimum 600 mm wide, along the crane girder at crane girder level on both sides, comfortable approach to EOT crane cabin, fire escape, locker room for workmen, pantry, toilets, rest rooms etc.

c) Provision for fire proof doors, number of staircases, fire separation walls, encasing of structural members (in fire prone areas) etc. shall be made according to the recommend-ation of Tariff Advisory Committee.

11.00.00 LIST OF PRODUCTS TO BE USED IN THE BUILDING

Following products shall be provided for the project.

Sl. No.	Name of the Product	Name of the manufacturer	Remarks
1.	Flush door (Solid Core)	Green Ply/ Century Ply wood	
2.	Laminates over flush door	Green Lam/Royal Challenge	
3.	Aluminium doors, windows and partitions	Extruded section of HIDALCO	
4.	Glass	Modi Float Glass for windows and Saint Gobins for partition, door and structural glazing.	
5.	Fire Door	Godrej or approved equal	
6.	Hydraulic Door Closer	Godrej or approved equal	
7.	Mortice Lock (heavy duty)	Godrej or approved equal	
8.	Floor Spring for Aluminium Door	Garnish/Godrej or approved equal	
9.	For seamless glazed door	Dorma/Ozone or approved equal	
10.	Non metallic Hardener	Sika Chapdor or approved equal	
11.	Ceramic Tiles	Euro/Johnson or approved equal	
12.	Vitrified tiles	Euro/Johnson or approved equal	
13.	PVC Soil and Waste water Pipe	Finolex/Supreme or approved equal	
14.	Western type water Closet	Hindware 20011+21001 or approved equal of Parry ware	White colour. For all buildings except Technical building and control room area
15.	Western type water closet	Hindware 20050+21033 or approved equal of Parry ware	Ivory colour for Technical building and Control room area
16.	Eastern type WC	Hindware 20042 with vitreous china flashing cistern or	White colour

Sl. No.	Name of the Product	Name of the manufacturer	Remarks
		approved equal of Parry ware	
17.	Urinal	Hindware 6002 or approved equal of Parry ware	For all buildings except Technical building and Control room Floor. Division plate white marble 550x1000x20 mm thick.
18.	Urinal	Parry ware touch free with electronic flushing system	Ivory colour.
19.	Wash Basins	Parry ware 0487 or approved equal of Hindware	For all buildings except Technical building and Control room area
20.	Wash basins oval counter type.	Hindware counter top 10045 or approved equal of Parry ware	Ivory colour.
21.	CP Pillar tap	Centralhole basin mixer of Jaquar no. 5167 florentine quality	
22.	CP Angular stop cock	Jaquar no. 5053 florentine quality	
23.	CP Waste coupling for wash basin	32 mm dia. CP waste of Jaquar no. 709 (Allied Quality)	
24.	Bottle trap	CP bottle trap of Jaquar no. 769 (Allied Quality)	
25.	WC hand shower (Health faucet)	CP hand shower of Jaquar no. 573 (Allied Quality)	
26.	CP shower rose with arm and CP wall mixture with provision of shower	CP shower (Continental Quality) Jaquar no. 477&491 and wall mixture no. 5273 (Continental quality)	
27.	CP wall mounted soap tray	Jaquar no.1131 Continental quality	
28.	CP Towel rail	Jaquar no. 1111 Continental quality	
29.	CP Toilet Paper Holder	Jaquar no. 1151 Continental quality	
30.	Stainless steel Kitchen sink	Hindware no. S/135/240 or approved Equal	
31.	Wall mounted Sink Mixture	CP wall mounted Sink mixture of Jaquar no. 5309	
32.	Glass shelf	Jaquar no. 1171	Not required where counter top basin provided
33.	Robe Hook	Three prong robe hook of approved quality	
34.	Mirror	600x450 mirror of 6mm thick float glass of approved quality with backing	For all buildings.
35.	Mirror from basin counter top to bottom of false ceiling and full length of counter	6 mm thick mirror of float quality with backing.	For Technical Building and Control room floor.

Sl. No.	Name of the Product	Name of the manufacturer	Remarks
	Paintings		
36.	Acrylic Emulsion paint	Asian/ICI/Berger	Approved type and shade
37.	Acrylic washable distemper	Asian/ICI/Berger	Approved type and shade
38.	Acrylic exterior grade emulsion paint	Asian/ICI/Berger	Approved type and shade

12.00.00 **LIST OF FURNITURE TO BE PROVIDED IN SERVICE & TECHNICAL BUILDING AND CANTEEN BUILDING**

Following furniture of M/s Godrej interio make shall be provided in Service & Technical Building and Canteen Building

Name of the building	Description	Quantity	Manufacturer
Service and Technical Building	**Furniture**	**Each**	**Godrej**
Technical Staff	Workstation (Stallion) Rectangular Type. 69mm thick partition with dimension W 1200mm X D1 600mm X D2 750mm. Hight of workstation 1200mm.	56 nos.	Godrej
	Metal KBPT	56 nos.	
	CPU Trolley	56 nos.	
	3 DR NOVA Pedestal (646 x 390 x 435)	56 nos.	
	Chair - Spyder – PCH-9602A	56 nos.	Godrej
Supervisor's Room/Incharge Maintenance/ Engineers	Finesse Table 5630	14 nos.	Godrej
	Finesse ERU 3619	14 nos.	
	3 DR NOVA Pedestal (646 x 390 x 435)	14 nos.	
	Chair - Leoma – 9M02AX	14 nos.	Godrej
	Visitors' Chair - Leoma – 9M12AX	28 nos.	
Senior Manager	Meastro - Desk	4 nos.	Godrej
	Meastro - Mobile Pedestal	4 nos.	
	Meastro - ERU	4 nos.	
	Chair - Leoma – 9M02AX	4 nos.	Godrej
	Visitors' Chair - Leoma – 9M12AX	8 nos.	
Assistant GM Operation	Meastro - Desk	1 no.	Godrej
	Meastro - Mobile	1 no.	

Name of the building	Description	Quantity	Manufacturer
	Pedestal		
	Meastro - ERU	1 no.	
	Chair - Leoma – 9M02AX	1 no.	Godrej
	Visitors' Chair - Leoma – 9M12AX	2 nos.	
	Midas Sofa-L-52	1 no.	
	Corner Table Centre piece-530-1E	1 no.	
PA to AGM Operation	Finesse Table 4020	1 no.	
	Chair - Spyder – PCH-9602A	1 no.	
GM Operation	Jeferson Desk	1 no.	Godrej
	Jeferson ERU	1 no.	
	Jeferson Back Unit	1 no.	
	Chair - Eden HB Sim Leather & PU Arms + Bin	1 no.	Godrej
	Visitors' Chair - Eden Visitor Sim Leather & Silver metallic colour frame	2 nos.	
	Midas Sofa-L-53	2 nos.	
	Corner Table Centre piece-530-1E	2 nos.	
PA to GM Operation	Finesse Table 4020	1 no.	Godrej
	Chair - Spyder – PCH-9602A	1 no.	
Conference Room	Conference Table Talk Membrane 10 Seater Boat Convex	1 no.	Godrej
	Chair - Leoma – 9M01AX	10 nos.	Godrej
Seminar Room	Chair - 1512 DC	40 nos.	Godrej
	Finesse Table 4020	1 no.	
	Chair - Spyder – PCH-9602A	1 no.	
Library	KD Bookrack	10 nos.	Godrej
	Finesse Table 4020	1 no.	Godrej
	Chair - Spyder – PCH-9602A	1 no.	Godrej
	Reading Table-Versatila (V3)	1 no.	Godrej
	Staq Chair (without arm)	4 nos.	Godrej
Canteen Building			
Dining Hall	Cafe Table-Versatila (V4)	15 nos.	Godrej
	Staq Chair (with arm)	60 nos.	

VOLUME: IIG/3

TECHNICAL SPECIFICATION
FOR
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

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TECHNICAL SPECIFICATION
FOR
I) LAND SURVEY AND ESTABLISHING REFERENCE GRIDS AND BENCH MARK PILLARS

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I) LAND SURVEY AND ESTABLISHING REFERENCE GRIDS AND BENCH MARK PILLARS

1.00.00 **SCOPE**

This specification is intended to cover topographical surveys and preparation of plans (maps) showing all permanent features including buildings, large trees, pucca & kutcha nullas, ditches, (with or without water), nearby roads/ approaches, railway track, culverts, overhead transmission & communication lines, ridges, boundary wall, fencing, demarcation line etc. of the project area as well as sectional views of the drains, ditches, creek, culverts and similar items (with all dimensions and invert levels). Carrying of the Bench Mark (existing reference BM outside the project area) to project site by levelling, establishing bench marks and grids in the field, spot level survey at specified intervals and on change points, contouring, constructing and fixing of bench mark pillars & grid pillars in the field, clearing of jungles & debris and cutting of trees (to the minimum extent as required for the work and as per instruction of the Owner) etc. shall also form a part of the scope of work. In addition, the true north, magnetic north and the angle between the grid lines (established at site) and the true north or magnetic north shall be indicated in all drawings.

It may also be necessary to interconnect the existing grid lines (with measured angles and distances) and level references as well as a few permanent buildings and permanent roads adjacent/near the specified project site area during the proposed survey work and thus incorporate the same in the survey plans/maps.

The Plot Plan drawing gives location of the project and an indication of the project area to be surveyed. These drawings are preliminary and do not cover the entire scope of work. These may be modified, survey area increased/ decreased, and any new drawing may be given before award of the Work or during execution of the work (keeping sufficient time for field survey work and plotting).

Permanent features and levels of a few existing items as given in the above drawings shall not be used as reference without verification by actual survey with precision instruments by the contractor and plotted in his maps/drawings accordingly.

The grid pillars and B.M. pillars shall be maintained and checked frequently to ensure the correctness of the value of the pillar till the completion of the job and handing them over to the Owner. It shall be responsibility of the Contractor to check the pillars jointly with Owner/ Engineer at the time of final handing over of the work to the Owner.

The tenderers should visit the project site, at his own cost, before quoting rates for this tender. No extra claim (in terms of extension of time or revision in rates, etc.) shall be entertained at a later date on the ground of insufficient knowledge about the site or for lack of clarifications on this specification.

2.00.00 **GENERAL**

2.01.00 **Work to be Provided for by the Contractor**

2.01.01 Work to be provided by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish necessary instruments and all other tools and materials including pegs, marking plates for reference grid and bench mark pillars, construction materials for pillars, labour & skilled surveyors, supervision by competent engineers, services, necessary transport, full insurance and all other incidental items as may be necessary for on-time and successful completion of the surveying and mapping work.

b) Furnish original field & level books, notes taken on special features and field drawings with readings & relevant features plotted.

c) Preparation, thorough checking & cross checking in the field and submission of completed survey plans/maps and drawings in specified scale incorporating sectional views and details as included under Section-1.0.

d) Construction and installation of reference grids and bench mark pillars at specified locations.

2.02.00 **Work to be provided for by others**

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 **Information to be Submitted by the Tenderer**

2.03.01 **With Tender**

The tenderer shall indicate in his tender the number of different surveying instruments (with make and year of manufacture), skilled & experienced surveyors, and competent engineers that will be deployed at the site for this work. His experience during last five years in similar survey work shall be detailed in the tenderer's offer which shall also include his present commitments.

2.03.02 **After Award**

The contractor shall inform and satisfy the Engineer regarding deployment of personnel engaged by him for quality work under an agreed time-frame for completion of the work under this Contract.

He shall also prepare, discuss with Owner/Engineer and submit an agreed work programme within seven (7) days of award of the Work and during which period he shall also mobilize his instruments, tools, personnel at the project site.

The survey documents shall be submitted to the Owner/Engineer by the Contractor progressively during execution of the Work in order to enable him to review the work and, if necessary, cross-check at site along with Contractor's surveyor and engineer and point out the deficiencies/ discrepancies, if any, therein. However, the Contractor shall be still responsible for the correctness of the entire work and shall resurvey and replot any portion of the Work which may be found to be defective later on. During such checking/cross-checking as well as supervision during execution of the entire work, the Contractor shall extend all facilities including proper instruments, tools, other materials, surveyors & labour, etc. to the Owner/ Engineer.

The Contractor shall engage qualified engineers, surveyors, drafting persons, etc. for executing the work under this Contract.

3.00.00 INSTRUMENTS AND CONSTRUCTION MATERIALS

3.01.00 Instruments

The entire field surveying shall be done with the combination of transit/ optic Theodolites (which can read upto 20 seconds or less), Prismatic Compass, Precision Levelling Instruments with well-graduated & accurate staff, Chain, Measuring Steel Tapes and Plane Table Survey by Clinometer with the help of Clinograph Scale, ranging rods, etc.

Theodolite should be optically centered and the levels should be tilting type. Measuring tapes shall be used with calibrated tension. The calibration charts for the instruments shall be submitted before the start of the Work.

High quality surveying instruments (particularly, theodolites & levels) of reputed manufacturers shall be deployed for accurate and dependable survey work. Electronic instruments, if available with the Contractor, will be preferred.

3.02.00 Construction Materials for Reference Grid and Bench Mark Pillars

Concrete for pillars shall be of mix 1:2:4 (one cement : two coarse sand : four 20 mm down stone aggregates). All the component materials shall be of best & acceptable quality and conforming to the provisions of the latest version of the Indian Standards.

Steel plates for engraving B.M. value and reference grids shall be of mild steel, conforming to IS : 2062.

4.00.00 EXECUTION

4.01.00 Permanent Adjustments

All permanent adjustments of the instruments shall be made before starting the work, to the satisfaction of the Owner/Engineer.

4.02.00 **Contour Intervals and Scale of Drawings**

4.02.01 **Contour Intervals**

For contouring, spot levels shall be taken at 10 m horizontal intervals or less in both directions to establish the contours at 300 mm intervals for nearly flat terrains and at 0.5 m to 1.0 m intervals for undulating hilly terrains, as per schedule of items and direction of the Owner/Engineer.

4.02.02 **Scale of Drawings**

Depending upon the area to be covered, survey maps shall be prepared in the scale of 1 : 500 or 1 : 1000, as indicated in Schedule of Items, and all permanent features (as indicated under Section - 1.0), grid pillars, bench mark pillars, reference grid and bench mark pillars, contours (as specified in 4.2.1 above) etc. shall be plotted.

Sectional views of the drains, ditches, culverts, roads, etc., however, can be prepared in a scale suitable for furnishing all pertinent dimensions, levels and information, and in a separate drawing sheet.

4.03.00 **Submission of Drawings and Documents**

The following documents shall be submitted to the Owner/Engineer :

4.03.01 Original field and level books and notes taken on special features, plus a photo-copy each of the above documents.

4.03.02 Field drawings with readings and relevant features and sectional views plotted - three (3) copies for review by Owner/Engineer. (One copy will be returned to the Contractor with comments, if any).

4.03.03 Original and one (1) copy of the above field drawings (item 4.03.2 above) after field verification of the comments and incorporating the corrected features.

4.03.04 Original tracing and four (4) prints of the final survey maps and drawings showing other details, all prepared in ink and in clear legible form. Format of and title block on the drawing/map shall be as per direction of Owner/ Engineer.

4.04.00 **Time of Completion**

Time shall be deemed to be the essence of the Contract. The entire survey work including submission of the final survey maps and drawings as well as other documents (ref. : 4.03 above) shall be completed within a period of weeks/months in the following manner :

a) Mobilisation and firming up time schedule and survey groups ….week

b) Completion of field survey work and submission of three (3) copies of the field drawings and a photo-copy of the field & level books and the field notes, etc. (Items 4.03.1 & 4.03.2 above). ... weeks

c) Submission of the final survey maps & drawings and other documents (item 4.03.1, 4.03.3 & 4.03.4 above). ... weeks

Construction and installation of grid and bench marks pillars, however, are to be subsequently completed within weeks of the clearance from Owner/ Engineer.

If the Owner/Engineer feels that the progress of the work is not satisfactory, he shall notify the Contractor to take necessary measures to complete the Work on time. If the Contractor fails to comply with the Owner's directive or fails to complete the Work on time, Owner will be at liberty to get the Work done by any other agency and forfeit the amount related to unfinished works and the Earnest Money/Security Deposit of the Contractor.

4.05.00 **Security Rules and Statutory Regulations**

The Contractor shall strictly follow at site all security rules and regulations enforced by Owner from time to time regarding movement of materials, equipment/instrument, personnel to and from site, issue of identity cards, badges, control of entry and all similar matters.

The Contractor, his employees and agents shall not disclose any information or drawings prepared by him or furnished to him by the Owner/Engineer.

He shall also follow all safety rules and regulations and shall take sufficient measures to adhere to the same.

The Contractor shall conform in all respects with the provisions of any statute, ordinance law, rules, regulations, by-laws of Central, State, Local or other duly constituted Authority. The Contractor shall give all notices and fees to be given or paid.

In respect of labour, the Contractor shall comply with all rules framed by the Government for the protection of health, wages, welfare and safety of the workers. The Contractor shall be responsible for effective insurance under the Indian Workman's Compensation Act., Third Party Liability Insurance, etc. in accordance with the Indian Law and Regulation at his own cost.

In fine, the Contractor shall keep the Owner and Engineer indemnified against all penalties and liabilities of every kind.

5.00.00 TECHNICAL SPECIFICATIONS

5.01.00 Establishing of Bench Marks

At least two permanent bench marks at each site at approved locations shall be established from the existing bench marks. While carrying the bench mark, levels shall be established on permanent objects as directed by the Engineer. Levelling survey shall be done in the forward and reverse direction and the closing error should not be more than ± 05mm.

5.02.00 Establishing of Grid Pillars

Permanent grid pillars shall be established in either direction at every 100m intervals or as directed. *One reference pillar and one reference grid direction shall be provided by the Owner. For carrying reference pillars, additional station points shall be established for traversing or triangulation as directed by the Engineer. The closing error for any closed traverse shall not exceed the specified limits as per clause 5.6. The maximum tolerance for any grid location shall be ± 1 mm. Generally for all angular measurements, transit of theodolite shall be done. Measurement shall be verified by cross-checking the diagonal angle as directed by the Engineer. For observing bearing from magnetic north, care should be taken that no magnetic substance to influence the bearing reading is there. The magnetic north should also be periodically verified.

Reference shall be taken from the existing permanent objects identifying from the Cadestal map for establishing the new grid line and shall be related to true north line where grids are not existing.

5.03.00 Reference Grid Pillars and Bench Marks

All reference grid pillars and permanent bench marks shall be 900 mm x 200 mm x 200 mm cement-concrete pillars with 150 mm projecting above ground. 150 mm square x 12 mm thick steel plates (with two L-shaped 20 cm long M.S. lugs welded to the plate) or 6 mm thick aluminium plates with bolts shall be embedded or bolted on top of the pillars. Grid points & lines shall be accurately punched on the plates as also the numerical values of grid lines and levels. Grid lines and levels as required shall be painted.

5.04.00 Topographical Surveying and Mapping

Positions, both in plan and elevation, of all natural and artificial features of the area in question (including permanent objects) are to be established and subsequently delineating them on survey maps by means of conventional symbols (preferably those of Survey of India maps). Necessary levelling work of the project area shall be combined with methods of establishing horizontal location so that location and sketching of contours for the area can be done at specified intervals and in specified scales on maps. Rock outcrops, springs/falls (if any) and other unusual ground formations/conditions shall be noted and locations plotted on the maps.

The field work shall be done in the following steps :-

a) Establishing horizontal and vertical controls and locating reference grids and bench marks in the area.
b) Levelling and plotting contours.
c) Surveying and locating the natural, artificial and permanent features in details as described earlier.
d) Taking of longitudinal and cross-sections of the corridors for pipe line and road/rail and drains, ditches, waterbodies, culverts, etc.

All survey work shall be related with true north and true north shall be established at site beforehand.

5.05.00 **Traversing and Ground Controls**

Triangulation or Traversing or a combination of the two methods shall be adopted for the purpose of establishing horizontal controls, in order to determine the exact relationships between various existing points/ features on ground, so that surveys required under the present scope of work and in future may be correlated and tied together.

Before commencement of work, the plan showing base lines and the grid lines and their spacings shall be got approved by the Owner/ Engineer at site. First, a traverse covering the entire survey area shall be established with reference to a permanent object/reference grid pillar already existing at Site (as instructed by the Owner/Engineer).

The closing error in traverse (primary/secondary) shall not exceed one in three thousand in terms of length or, L $\sqrt{N}$ second (total) in angular measurement, whichever is less. (Where, L = the least count of the instrument and N = the number of stations).

5.06.00 **Contouring**

Spot level surveying at specified intervals shall be adopted for contouring the area, so that accurate contouring can be done. At places of sharp curvature or abrupt changes in direction and elevation, points selected shall be close to represent the actual ground configuration.

Levelling operation shall always start on a control station / nearby bench mark and end on the same.

5.07.00 **Route Survey**

Route Survey shall be conducted along a narrow strip/belt of the terrain selected after field reconnaissance or as directed by Owner/Engineer at Site. Topographical survey for existing storm drainage lines as well as for routing pipe lines, transportation and communication lines, etc. shall be conducted. Longitudinal profiles as well as cross-sections shall be taken at 50 m intervals or less in nearly flat/undulating terrains and at 20 m intervals in hilly terrains, as per direction of the Owner/Engineer. All cross-sections shall be with reference to centre line of corridor showing levels at every 2 - 5 metre intervals and all breaks in the profile. The width of strip/corridor shall be as specified in the drawing or as directed by Owner/Engineer.

TECHNICAL SPECIFICATION
FOR
II) GEO TECHNICAL INVESTIGATION

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II) GEOTECHNICAL INVESTIGATION

1.00.00 SCOPE

This specification covers the complete soil exploration work including carrying out field tests and laboratory tests to evaluate static as well as dynamic parameters of soil/rock and preparation of detailed report including the recommendations regarding founding level, type of foundation for different kinds of structures/machines and methods of deep excavation.

2.00.00 GENERAL

The contractor shall perform all work under the purview of this specification along with all incidental and related work including setting out, staging, approach to test locations, contractor's office, stores and protection of adjacent buildings, structures or services/facilities. No separate payments shall be made on such accounts. The tenderer should therefore take into account all such relevant items while quoting his unit rates against the schedule of items.

2.01.00 Work to be provided for the Contractor

The work to be provided by the contractor, unless specified otherwise shall include but not be limited to the following.

a) Furnish necessary plant and equipment, tools and tackles, instruments, necessary power, fuel, water, labour, supervision by qualified and experienced engineers and supervisors specialised in the type of investigation, transport of materials, men and equipment etc., services, full insurance and all other incidental items as may be necessary for entire and successful completion of the work as per tender terms, drawings, specifications and instruction of the Owner/Engineer.

b) Locate in the field and in layout drawing all boreholes and other field investigation items.

c) Furnish progressively and periodically field bore logs, investigation observations, test results with relevant data and features in triplicate.

d) Prepare and submit draft (in duplicate) and final (after incorporating comments, if any) sub soil investigation report as per specification, schedule of items and instructions of the Owner/his Engineer.

2.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.03.00 **Location and Levels**

Location of all boreholes and field test points and levels of the existing ground at such locations shall be established by the contractor at his own cost from two reference grids and one bench mark given by the Owner/his Engineer and these shall be subsequently plotted in the layout plan, bore logs and other relevant field test data sheets/tables to be incorporated in the report by the contractor.

Making bench mark pillar (s) and reference line pillars (whatever are required for the work) and maintaining them upto the completion of the work shall be the responsibility of the contractor at no extra cost by the Owner.

2.04.00 **Codes and Standards**

The following is the general list of IS Codes to be used for the soil investigation work and preparation of report. In all cases latest revision along with amendments, if any, shall be referred to.

IS:1498	-	Classification and identification of soils for General Engineering purposes.
IS:1888	-	Method of load tests on soils
IS:1892	-	Subsurface investigation for foundation
IS:1904	-	Structural safety of buildings : shallow foundations
IS:2131	-	Method for standard penetration test for soils
IS:2132	-	Code of Practice for thin walled tube sampling of soils
IS:2720	-	Methods of tests for soils
IS:2809	-	Glossary of terms and symbols relating to Soil Engineering.
IS:2810	-	Glossary of terms relating to soil dynamics
IS:3025	-	Methods of sampling and testing for water used in industry
IS:3043	-	Code of Practice for earthing
IS:4078	-	Indexing and storage of drill cores
IS:4434	-	Code of Practice for in-situ vane shear test for soils
IS:4453	-	Code of Practice for exploration by pits, trenches, drifts and shafts
IS:4464	-	Presentation of drilling information and core description in foundation investigation

IS:4968 (Part-II)	-	Dynamic Cone Penetration Test.
(Part-III)	-	Static Cone Penetration Test.
IS:5249	-	Method of test for determination of dynamic properties of soil.
IS:5313	-	Guide for core drilling observations
IS:5529 (Part I)	-	In situ permeability tests - tests in over-burden
(Part II)	-	In situ permeability tests - tests in bed rock
IS:6403	-	Determination of allowable bearing pressure on shallow foundations.
IS:6926	-	Diamond core drilling for site investigation for river valley projects.
IS:6935	-	Method of determination of water level in boreholes
IS:7746	-	In situ shear test on rock
IS:8009 (Part-I)	-	Calculation of settlement of foundations - shallow foundations subjected to symmetrical static vertical loads
(Part-II)		deep foundations subjected to symmetrical static vertical loading.
IS:8763	-	Guide for undisturbed sampling of sands
IS:8764	-	Method for determination of point load strength index of rocks
IS:9143	-	Method for the determination of unconfined compressive strength of rock materials
IS:9179	-	Method for preparation of rock specimen for laboratory testing
IS:9214	-	Method of determination of modulus of subgrade reaction (k-value) of soils in field
IS:9221	-	Method for determination of modulus of elasticity and poisson's ratio of rock materials in uniaxial compression.
IS:9259	-	Liquid limit apparatus for soils

IS:9640	-	Specification for split spoon sampler
IS:10108	-	Sampling of soils by thin wall samples with stationary piston
IS:10589	-	Equipment for subsurface sounding of soils
IS:10837	-	Specification of moulds for determination of relative density and its accessories
IS:11229	-	Specification for shear box testing of soils
IS:11315 (Part II)	-	Description of discontinuities in rock mass - core recovery and rock quality

3.00.00 SOIL EXPLORATION

3.01.00 Test Boring

Test Boring through different layers of soil shall be carried out by the contractor at the locations marked in the Geotechnical Test location plan prepared by the contractor and approved by the Owner / Engineer and/or at such other locations as directed by the Engineer in a manner described below.

Various methods of boring as described in IS:1892 may be adopted. The tenderer shall furnish in his tender the complete details of the equipment and the method he proposes to follow. Minimum diameter of boring shall be 150 mm.

During the boring operations if rock strata is not encountered, the boring shall be continued upto 30 m depth for two bore holes and upto 20m depth for the remaining boreholes unless stated otherwise. Incase rock strata is encountered within the above depths, boring operations shall be discontinued and drilling operation as enumerated in clause 4.0 below shall be resorted to. If the present formation level is above the natural ground with filled-up soil, the depth of boring mentioned above shall exclude such filled-up soil.

The contractor shall describe in detail the equipment and method of boring he proposes to use. In the absence of dry boring equipment, wash boring at the discretion of the Engineer may be allowed, but the particular way of cleaning the casing by washing has to be approved by the Engineer. However, if the Engineer, at any time, feels that the washing process is disturbing the samples to be taken, he may stop the work and the contractor shall have no claim whatsoever on this score. If the contractor can, however, improve the method to the satisfaction of the Engineer, he may be allowed to resume the wash boring work.

When boring cannot be advanced due to presence of hard material, it should be checked whether there is continuous strata of hard material below before resorting to drilling methods. If only a local boulder is present it should be chopped using suitable chopping bits and the debris removed and normal boring continued.

Ground water level for each bore hole shall be checked during boring operation and shall be recorded in bore log. Sub-soil water samples shall also be collected from each borehole and recorded.

Where possible, completed boreholes shall be capped and a G.I. pipe inserted in order to preserve them for future ground water level observation. The contractor shall use his own materials for this and the unit rate quoted shall be inclusive of the same. These bore holes after completion of observation shall be handed over to the Owner in such condition as to enable future observation of ground water possible. The other boreholes not used for observation shall be backfilled by the contractor using sand fill as and when directed by the Engineer.

3.01.00 **Stabilization of Boreholes**

Boreholes shall is stabilized, whenever required, against caving of the sides of the drill hole and heaving of the bottom of the hole. especially in cases where the hole is carried below the ground water level, by use of drive pipe or casing or by means of drilling fluids (water or mixtures of water and colloidal, gel forming thixotropic clays such as bentonite), grouting (in rack) or other suitable methods.

3.02.00 **Open Trial Pits**

The location of open trial pits shall be as shown in Geotechnical Test location plan and/or at such other locations as directed by the Engineer. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall be upto a depth of 3.5m below natural ground level or not below the ground water table or as directed by the Engineer. In no case, the depth shall be extended over 5m. The size of pits shall be 3.0m x 3.0m or as directed by the Engineer. Samples of undisturbed soil shall be obtained preferably at every 1.5m or where a change in strata is noticed.

The contractor shall provide a suitable access to the bottom of the pits. Sampling in trial pits shall be done as directed by the Engineer.

The contractor shall be paid at contract unit price for each trial pit which will include all costs for earthwork in excavation with necessary side slope and backfilling and shoring/sheeting for side protection, if required. If the pits exceed over 3.5m in depth, the contractor shall be paid at unit price for the extra depths of excavation.

After completion of the test, sampling and visual examination, the pit shall be suitably backfilled as directed by the Engineer. Unless otherwise specified, excavated soil shall be used for this purpose.

3.03.00 **Boring in River Bed**

For carrying out boring in river bed, the barge / boat should be properly anchored so that there is no movement of the platform due to waves which can cause damage to the drill rods and casing.

3.04.00 **Rock Drilling**

During boring operation, once rock strata is encountered, the normal method of boring operation as described under clause 3.01.00 earlier shall have to be stopped and drilling operation will be resorted to for determining depth and nature of rock strata, in a manner as described below.

Rotary core drilling technique with continuous core recovery should be adopted for drilling through rock. The tenderer shall indicate in his tender the type of coring bit he proposes to use. The behaviour of rock mass is governed more significantly by the nature of fractures in the rock then by the type and hardness of the material composing the rock itself. Hence, good drilling technique should be adopted to obtain an intact sample truly representative of the in-situ material and for achieving highest percentage of recovery possible. Variations in the speed of rotation, the downward pressure on the core barrel, the pressure at which the drilling fluid is introduced into the hole and the length of hole drilled (run length) prior to removal of the core are major items which must be controlled by the driller. In general, coring should be initiated with short runs both because the upper portions of rock masses are commonly highly fractured and also because the elevations at which core losses occur can be more accurately determined. If conditions indicate that it is possible, the length of the runs may be determined by the length of the core barrel.

In zones which are highly fractured or where the barrel continuously becomes blocked it is essential that short runs be used even though this means removal of the entire string of drilling tools every 300 mm or less. Reduced bit pressure should be resorted to when rod vibration or chatter occurs. The pressure under which the drilling fluid should be introduced into the hole will be the minimum to be consistent with adequate removal of cuttings from the hole and proper cooling of the bit. To minimise the erosive action of the drilling fluid on the core and thereby to improve core recovery, double tube core barrels should be used. The casing and core barrel to be used shall be of designation BX or NX.

During the drilling operation for each bore-hole the contractor shall record the rate of sinking of drill rods, ground water table elevations, if any, nature, type and sequence of rock drilled. From the recovered cores the contractor shall determine nature of fractures and degree of weathering of rock for each bore hole. The contractor shall also note and record any appreciable loss of drilling fluid throughout the entire drilling operations for each bore hole. The contractor shall also determine the percentage recovery ratio and rock quality designation from the recovered cores for each stages of core advance and for all the bore-holes. Rock quality designation is defined as the ratio of cumulative lengths of intact pieces of core greater than 10 cm to the length of core advance.

The contractor shall furnish all the information mentioned above fully verified and signed by the Engineer at site and submit them in triplicate to the Engineer.

The drilling operation shall be terminated when more than 75% of the core recovery is possible. If core recovery is lower and the nature of rock is

weathered, drilling must be continued upto 30m for two bore holes and 20m for the remaining boreholes below the natural ground level.

In addition to the above mentioned points the contractor shall also take into consideration the provisions of the latest revisions of the following Codes of Practice :

a) IS:6926 - Code of practice for diamond core drilling for site investigation for river valley projects (optional).

b) IS:4078 - Code of Practice for indexing and storage of drill cores.

c) IS:4464 - Code of Practice for presentation of drilling information and core description in foundation investigation.

3.05.00 **Adits and Test Shafts**

An exploratory adit is a horizontal or near horizontal excavation made by mining methods in rock. The term "test shaft" is used to refer to a vertical excavation, generally in rock and to very deep test pits. These are used for in-situ examination of the nature of the rock and its structural features such as joints, fractures, faults and shear zones. Adits may also be used for in-situ tests to determine the modulus of deformation of rock.

3.06.00 **Sampling**

Bored spoil shall be collected continuously during boring to note any change of strata. Samples of undisturbed soil shall be obtained preferably at every 1.5 m where a change in strata is indicated by the slurry flowing out. In no case shall the depth between successive sampling be more than 3.0 m and a sample shall be obtained on the average for every 2.0 m depth of boring, since it is intended to ascertain the characteristics of the soil at various depths. If, however, there is fair uniformity in the characteristics of the soil for certain depths the Engineer may limit the number of samples stipulated above.

3.06.01 **Tube Sampling**

For obtaining undisturbed samples in its simplest from, an open drive thin wall tube sampler shall be attached to a rod and shall be lowered to the bottom after completely cleaning the borehole bottom by washing. The samplers to be used should have area ratio less than 13 percent and preferably less than 10 percent. The head should have check valve and ports to permit easy escape of drilling fluid or air from the sample tube as the sample enters it.

Sampling will be accomplished by jacking or driving the tube depending on the type of soil to be sampled. Upon completion of the sampling operation the sampler shall be withdrawn from the borehole and the sample of soil carefully taken out. Approximately on inch length of soil is to be removed from each end for identification. If there is any surface water on the sample, this shall be wiped off with soaking paper, all sludge of cuttings from advancement of borehole removed and the sample immediately packed in an airtight, close fitting container marked with respective test bore numbers, elevation at which

the sample was taken and other relevant information as per IS:1892. The size of soil test samples shall preferably be 65 mm dia x 200 mm high, but not less than 50 mm dia. x 150 mm high.

Representative/disturbed samples shall also be taken in different strata for visual classification, water content, grain size analysis, Atterberg limits, determination of specific gravity and compaction tests.

3.06.02 **Chunk Samples**

In cohesive soils, undisturbed samples of regular shapes shall be collected. The samples shall be cut and trimmed to a suitable size (0.3 x 0.3 x 0.3 m). A square area (0.35 x 0.35 m) shall be marked at the centre of the levelled surface at the bottom of the pit. Without disturbing the soil inside the marked area, the soil around this marking shall be carefully removed upto a depth of 0.35 m. The four vertical faces of the soil block protruding at the centre shall be trimmed slowly so that its size reduced to 0.3 x 0.3 m. Wax paper cut to suitable size shall be wrapped uniformly and covered with two layers of thin cloth over all the 5 exposed surfaces of the soil block and sealed properly using molten wax. A firmly constructed wooden box of size 0.35m x 0.35m (internal dimensions) with the top and bottom open shall be placed around the soil block and held in such a manner that its top edge protrudes just above the surface of the block. The space between the soil block and the box shall be filled uniformly and tightly with moist saw dust. The top surface shall also be covered with saw dust before nailing the wooden lid to cover the box firmly taking care that the soil block is not disturbed. The area of contact between the bottom portion of the block and the ground shall be reduced slowly by removing soil in small quantities using small rods, so that the block can be separated from the ground slowly without disturbance. After inverting the wooden box along with the soil block, the bottom portion shall be trimmed and covered with wax paper, cloth and sealed with molten wax. A wooden lid shall be nailed to the box after providing proper saw dust cushion below it. An arrow mark shall be made on the vertical face of the wooden box to indicate the top surface along with the coordinates and depth of sampling.

3.06.03 **Sampling in rock**

Sampling in rock shall be accomplished during the drilling process by employing double tube core barrels for continuous core recovery. The drilling procedure to be followed should be the one which brings about the highest percent recovery and the exact procedure must be determined in the field.

3.07.00 **Record of Boring**

Detailed chronological record of drilling and sampling operations shall be maintained in the field log and should be submitted to the Owner after completion of boring work at site. The final log showing pertinent subsurface information and results of field and laboratory testing should be submitted with the soil report.

The field log should contain at least the following information :

a) Reference information like project number, title and location, exploration number and location by coordinates, inclination of the boring and if inclined the bearing or azimuth of the dip of the hole, reference level and datum.

b) Personnel information - name of drilling contractor, driller and inspecting Engineer.

c) Equipment data - manufacturer's name and model designation.

d) Sampling and coring information

   i) General : Sample type and number, sampler dimension, depth at start and completion of sampling, length of sample, recovery ratio and complete visual description of each sample in "as retrieved" state.

   ii) Drive samplers : weight and height of drop of hammer and number of blows for each 150 mm penetration.

   iii) Push samplers : hydraulic pressure and rate of penetration.

   iv) Soil or rock coring : average rotational speed, downward hydraulic pressure and rate of penetration.

   v) Rock coring : Rock quality designation (R Q D)

e) Description of material penetrated but not sampled.

f) Casing information - size, depth at which required, length and depth of bottom of casing; weight and height of drop of hammer and number of blows for each 300 mm of penetration for driven casing, and average rotational speed and downward pressure on casing and average rate of penetration for drilled casing.

g) Seepage pressure test information-depth and duration of test.

h) Groundwater information - depth to water surface recorded daily and continued till water level has stabilized.

i) Artesian pressure information - depth at which encountered, measured head and lime at which each measurement is made.

j) Elevation of top and bottom of hole and top of rock

k) Date and time of all operations and delays with reasons.

l) Miscellaneous information to aid interpretation of subsurface conditions.

m) Additional pertinent information.

The final log shall be a condensation of the field log refined on the basis of field and laboratory tests. The final log should present a clear, concise and accurate picture of subsurface conditions to be utilized by the Engineer.

4.00.00 PENETRATION TESTS

Penetration tests using various types of equipment as specified shall be conducted to measure the resistance of soil to penetration.

4.01.00 Standard Penetration Test

Standard penetration test (SPT) shall be carried out in accordance with IS:2131 at every change in strata or at 1.5 m intervals or as directed by the Engineer. The contractor shall record the number of blows for each 150 mm penetration of the standard split spoon sampler over a depth of 450 mm. The number of blows for the first 150 mm of penetration shall not be considered in evaluating the penetration resistance. Rammer used for driving the sampler rod shall be 65 kg and drops of 750 mm shall be maintained. Records of the test including depth at which driving is initiated and the number of blows for each 150 mm penetration shall be shown in the field log, the final log shall indicate the actual SPT value (sum of number of blows for last 300 mm of penetration) at appropriate depths.

4.02.00 Static Cone Penetration Test

The test shall be carried out at locations as shown on the drawing and/or at such other locations as directed by the Engineer. A steel cone with an apex angle of 60 deg. and overall base diameter of 35.7 mm giving a cross-sectional area of 10 Sq.cm shall be pushed through soil strata through a distance in accordance with the design of the equipment and cone resistance is noted. Thereafter the cone and the friction jacket with 36 mm OD are pushed together for a distance depending upon the design of the cone and the friction jacket assembly and combined values of cone and friction resistance noted. The procedure shall be repeated upto the desired depth. Rate of penetration shall be 1 cm/sec. unless otherwise instructed by the Engineer. The test shall be carried out upto a depth of ... m or upto the top of rock layer whichever is earlier.

The driving mechanism shall have a capacity of not less than 10 tonne for the mechanically operated equipment. If approved by the Engineer, manually operated equipment may be used for shallow depths (Not greater than 10 m) in case of soft clay layer.

The contractor shall get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the actual test and produce the test certificates to the Engineer.

The test shall be carried out in accordance with IS:4968 (Part-III), latest edition. Cone resistance and frictional resistance shall be separately provided in the report together with a borehole log.

4.03.00 **Dynamic Cone Penetration Test**

Dynamic cone penetration test shall be conducted to predict stratification, density, bearing capacity etc. of soils. The test shall be conducted by driving a standard size cone attached to the bottom of a string of drill rods. The test shall be conducted upto the specified depth or terminated earlier if the number of blows exceeds 35 for 100 mm penetration when the cone is driven dry and 20 for 100 mm penetration when the cone is penetrated by circulating bentonite, in order to avoid damage to the equipment.

The specification for the equipment and accessories for performing this test, test procedure, field observations and reporting or results shall conform to IS:4968 Part - II. the driving system shall comprise of a 65 kg. drive mass having a free fall of 0.75m. The cone shall be of 62.5mm diameter provided with vents for continuous flow of bentonite slurry through the cane and rods in order to avoid friction between the rods and soil. The use of bentonite slurry may not be necessary when the investigation required is upto a depth of 6m only. On completion of the test, the results shall be presented as a continuous record of the number of blows required for every 300 mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot of blow count for 300 mm penetration vs depth.

5.00.00 **GROUNDWATER INVESTIGATION**

Groundwater investigation shall comprise determination of groundwater levels and pressures and permeability of subsurface materials. The effect of tidal variations (if applicable for the site) on ground water level shall also be observed by noting the water level in boreholes during high and low tide periods.

5.01.00 **Ground Water Level Observation**

The contractor shall make necessary arrangements to prepare the boreholes for ground water observation. Completed boreholes should be capped and a G.I. pipe inserted in order to preserve them for future ground water observation. These observations will be taken by the contractor during the period of investigation. At the end of the site investigation work, these boreholes shall be handed over to the Owner in such a condition that further observations can be taken by the Owner for a period of at least a year.

Piezometers will have to be installed in boreholes as directed by the Owner. A piezometer consisting of either a simple standpipe of PVC tubing with a slotted end and surrounded by granular filter of plastic fabrics shall be used for granular soils or permeable rocks. In impermeable soils, hydraulic piezometer consisting of a porous element connected by twin small-bore plastic tubing to a remote reading station will be used.

5.02.00 **In-Situ Permeability Test**

In-situ permeability test shall be performed in the boreholes specified in Geotechnical Test location plan and/or at such other locations at specified

depths as directed by the Engineer for determination of the permeability co-efficient of the soil. The type of test shall be either pump-in or pump-out test depending on the sub-soil and ground water conditions. Pump-in test shall be conducted whether ground water in the borehole exists or not. Pump-out test with piezometer installations shall be conducted to obtain data for dewatering purposes when ground water is met in the borehole.

The specification for the equipment required for the test and the procedure of testing shall be in accordance with IS:5529, Part-I. The contractor shall provide all necessary equipment (diesel operated). When it is required to carry out the permeability test for a particular section of the soil strata above the ground water table, bentonite slurry shall not be used while boring.

5.02.01 **Pump-in Test**

Pump-in test shall be conducted in the borehole/trial pit by allowing water to percolate into the soil. Choice of the method of testing shall depend on the soil permeability and prevailing ground water level. Only clear water shall be used for conducting the test. Before conducting the test, the bore hole shall be cleaned. Water shall be allowed to percolate through the test section for sufficient period of time to saturate the soil before starting the observation.

a) **Constant Head Method (in borehole)**

This test shall be conducted in boreholes where soils have a high permeability. Water shall be allowed into the bore hole through a metering system ensuring gravity flow at constant head so as to maintain a steady water level in the bore hole. A reference mark shall be made at a convenient level which can be easily seen in the casing pipe to note down the fluctuations of water level. The fluctuations shall be counteracted by varying the quantity of water flowing into the bore hole. The elevation of water shall be observed at every 5 minute interval. When three consecutive readings show constant level of water surface above test depth, diameter of casing pipe, etc. shall be noted and recorded as per the proforma recommended in IS : 5529, Part-I, Appendix-A.

b) **Falling Head Method (in borehole)**

This method shall be adopted for soils of low permeability and which can stand without casing. The test section shall be sealed by the bottom of the boreholes and a packer at the top of test section. If the test has to be conducted at an intermediate section of prebored hole then, double packers shall be used. Access to the test section through the packer shall be by means of a pipe which shall extend to above the ground level. Water shall be filled into the pipe upto the level marked just below the top of the pipe and water allowed to drain into the test section. The water level in the pipe shall be recorded at regular intervals as mentioned in IS : 5529, Part-I, Appendix-B. The test shall be repeated till constant records of water level are achieved.

c) **Percolation test (in trial pit)**

Percolation test shall be conducted in the trial pit in areas where effluent is stored/discharged in ground level tanks. The loss of water due to percolation into the soil shall be estimated by the soil absorption capacity. This test shall be conducted in trial pits as per the procedure given in IS : 2470-Part-I, Appendix-A.

5.02.02 **Pump-Out Test**

This test shall be adopted to determine accurate values of permeability of soil below water table. Observation pipes of 50 mm dia shall be installed at regular intervals along three radial lines extending from the borehole at 120 degrees to each other. Length of these pipes shall depend on the ground level and estimated lowering of the ground water table. The test shall be carried out by pumping out the water to a known depth and recording the water levels in the observation pipes at regular intervals of time till the water level is stabilized. The observations shall be recorded as specified in IS : 5529, Part-I, Appendix-D.

6.00.00 **FIELD TESTS**

In situ tests shall be performed as desired by the Engineer to measure properties of soil during the field investigation work.

6.01.00 **Menard Pressure meter Test**

This test shall be carried out as per clause 3.7 of IS:1892 in the..... bore holes specified in drg. no. ..... and/or at such other locations as directed by the Engineer to the full depth of bore holes, to assess the co-efficient of earth pressure at rest and the stress-strain modulus of soil. The tests shall be carried out at every 3.0 m intervals.

The tenderer shall furnish in his tender the complete details of the equipment and method he proposes to follow.

The contractor will submit, for approval of the Engineer detailed arrangement drawings for the tests including the detail of the equipment he proposes to use and satisfy the Engineer about its adequacy. The contractor shall also check and confirm whether the equipment he proposes to use will be suitable for carrying out this test in bore holes of size specified under clause 3.01.00 of this section. If not, separate bore holes of suitable diameter shall be made at locations approved by Engineer for conducting this test.

6.02.00 **Direct Load Tests on Soils**

The direct load tests on soil shall be carried out in the trial pits specified in Geotechnical test location plan and/or at such other locations as directed by the Engineer. This test is to be carried out at 2.5m/3.5m below the natural ground level as indicated in the above drawing/as directed by the Engineer. The plate sizes to be used shall depend on the nature of the soil, a 45 cm

square plate will be used in clayey soil and in sandy soils, three plates of size varying between 30 cm to 75 cm will be used. The test shall be carried out in a manner as to give dependable assessment of bearing capacities of the soils at particular level. The results of the test shall also be used for arriving at the modulus of subgrade reaction and deformation modulus of soil.

The tenderer shall furnish in his tender the complete detail of the equipment and method he proposes to follow.

The excavation and side protection during the test and back- filling after the test shall be carried out by the contractor. If ground water table is at a depth higher than the specified test depth, the ground water table shall be lowered and maintained at the test depth for the entire duration of the test. The cost of dewatering shall be borne by the contractor.

The contractor will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of its being capable of giving accurate data. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The contractor must get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the direct load tests at the site and produce the certificates of the tests to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The contractor shall bring not less than two dial gauges and one pressure gauge as standby.

In no case settlement observations by means of level & staff shall be accepted.

The tests shall be carried out as described in IS:1888 unless otherwise specifically directed. The application of load may be by gravity or by reaction as detailed out in the above standard.

The test plate shall be preloaded with a load of 700 Kg/ sq.m. retained for a reasonable period and then replaced to take out all slacks of the arrangement. All settlement observations shall start thereafter. Unless the ultimate bearing capacity can be calculated from the available soil data, the contractor shall assess ultimate bearing capacity of the soil under test. Increments of the load shall be of about one fifth of the ultimate bearing capacity. The increments shall continue to an extent that allows locating the 'Yield Value of the Soil' as defined in IS:1888 or upto practicable limit of testing.

While releasing the loads, the rebounds are to be observed in a similar manner as the settlement observations.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to start of releasing the load so that the total settlement can be checked by him.

In addition to carrying out plate load tests, undisturbed/disturbed soil samples shall also be collected at regular intervals during excavation.

The payment shall be lumpsum for each test & shall include all costs inclusive of earthwork in excavation upto 3.5m depth below natural ground level, shoring for side protection, if necessary, and back filling after the test. For the depths over 3.5m extra payments shall be made only for earthwork and shoring, if any. If water table is required to be lowered during the test, necessary diesel operated pumping arrangement will have to be provided by the contractor himself. All expenses in this connection shall be included in his quoted rates.

6.03.00 **Vane shear Tests**

Vane shear test shall be conducted for measuring the strength of soft clay in-situ at all depths from the surface to at least 30m and at locations as specified. The test shall be conducted by pushing into the clay a small four-bladed vane of suitable size (75mm or 100 mm diameter depending upon the soil condition), attached to the end of a rod and then measuring the maximum torque necessary to cause rotation. This torque is a measure of the moment developed by the shear strength of the clay acting over the surface of the cylinder.

The test can be performed at desired depths either inside boreholes or by direct penetration from ground surface. If cuttings at the test depth in the bore hole show any presence of gravel, sand, shells, decomposed wood etc., which are likely to influence the test results, the test at that particular depth may be omitted with the permission of the Engineer.

The specification for the equipment and accessories required for performing this test procedure, field observations and reporting of results shall conform to IS:4434.

6.04.00 **Determination of Dry-Density of Soils**

In place dry density of soil is required for assessment of bearing capacity of soils, analysis for stability of natural slopes and in settlement calculations for estimating overburden pressure at different depths. The following methods depending on the scope of application in different types of soils shall be adopted as directed by the Engineer for determination of in-place dry density of soils.

6.04.01 **Sand Replacement Method**

This method is suitable for fine, medium and coarse grained soils. Small sand pouring cylinder should be used when the soil consists of fine to medium size grains while for soils containing stones where difficulties would be encountered with this method, a large sand pouring cylinder should be used. The sand used for filling shall be clean, uniformly graded natural sand, passing 1.00 mm IS sieve and retained on 600 micron IS sieve. It shall be free from organic matter, oven dried and stored for suitable period to allow its water content to reach equilibrium with atmospheric humidity.

Equipment and accessories, test procedure, observations and reporting of results shall conform to IS:2720 (Part XXVIII)

6.04.02 **Core-cutter Method**

The specification for this test shall be as per IS:2720 (Part XXIX) . The method should be applied for fine grained soil, free from aggregates . Fine grained soils for the purpose of application of this method are defined as soil with not less than 90 percent passing 4.75 mm IS sieve.

6.04.03 **Ring and Water Replacement Method**

The specification for equipment, test procedure, observation and reporting of results for this test shall conform to IS:2720 (Part XXXIII). The test equipment shall consist of a circular ring placed at the surface of the ground and plastic film inserted in the hole to retain the water. The method should be applied in coarse grained soils including gravels, cobbles, boulders and rock. Density can be determined for either the total material or material smaller than specified or given size.

6.04.04 **Rubber balloon Method**

The equipment, testing method, observations and reporting of results shall be as per IS:2720 (Part XXXIV) . This method should be applied for firmly bonded soils, it is unsuitable for very soft soils which will deform under slight pressure or in which the volume of the hole cannot be maintained at a constant value.

6.05.00 **In-situ Block Shear/Wedge Shear Test**

The test shall be carried out in a manner as to give a dependable assessment of shear resistance of rock, when at a shallow depth, rock is encountered.

The tenderer shall furnish in his tender the complete detail of the equipment and the method he proposes to follow.

The test shall be carried out in the trial pits marked in Geotechnical test location plan. and/or at such other locations as directed by the Engineer. The interpretation of test data and report shall be as per the provisions of IS:7746. The set up without an arrangement for direct application of normal load as detailed in the above standard shall be followed.

Regarding the approval of detailed arrangement drawings for the test, adequacy of conducted test, dial gauges to be used for the test and recording of observations for the test the provisions as laid down for direct load tests on soils shall hold good.

The payment terms as indicated for clause 3.02.00 above shall hold good for this test.

6.06.00 **Test for Measurement of soil Resistivity**

For designing the earthing system for the project it is necessary to find out the electric resistivity of the soil at some representative locations of the project site.

Soil resistivity is determined in Ohmmeter by using "WENNER's FOUR ELECTRODE METHOD". The principle of the above method is generally as under :

Four electrodes are driven into the earth along a straight line at equal intervals of 'S'. This distance 'S' can be varied and different readings taken for electrode spacing S = 5, 10, 15, 20 metres etc. to detect the vertical variations of resistivity at a certain location. A current I is passed through the two outer electrodes and the earth. The voltage difference, V, between the two inner electrodes is measured. The current I flowing into the earth produces an electric field proportional to its density and to the resistivity of the soil. The voltage V measured between the inner electrodes is, therefore, proportional to this field. Consequently, the resistivity will be proportional to the ratio of voltage to current.

If the depth of burial of electrodes in the ground is negligible compared to the spacing between the electrodes, then the soil resistivity.

= 2 X 3.14 X S.V / I

Where, Resistivity of soil in Ohm-meter

S = Spacing between electrodes in metre

V = Voltage difference between two inner electrodes in volts.

I = Current flowing through two outer electrodes in amp.

Earth testers normally used for the above purpose comprise the current source and meters in a single instrument and directly read the resistance. Such an instrument is known as four terminal meggar. Using such meggar for measurement, above formula becomes

= 2 X 3.14 X S.R.

where R is meggar reading in Ohms.

Depth of burial of electrodes shall not be more than 1/20 or the spacing between the electrodes.

Correction of the test results should be done, if necessary, using the method outlined in IS:3043.

The location and number of the test points are shown in the plant layout. The number shall be increased if the test results obtained in different locations show a significant difference.

7.00.00 TESTS FOR DYNAMIC PROPERTIES

For evaluation of in-situ dynamic and damping properties of soils, Block Vibration Test, Cyclic Plate Load Test and Wave Propagation Test shall be conducted. The triaxial test method using repeated static loading should also be carried out for arriving at the value of the Young's Modulus.

The Tenderer shall furnish in his tender the complete details of the equipment and method of testing he proposes to follow.

The locations at which such tests are to be carried out are indicated in Geotechnical test location plan and/or at such locations as directed by the Engineer. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall exclude such filled-up soil.
The tests shall be carried out as described in IS:5249 or IS:1888 as applicable. The contractor will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of it being capable of giving accurate data. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to the start of releasing the load so that the total settlement can be checked by him.

The payment shall be lumpsum for each test and shall include all costs inclusive of earthwork in excavation, shoring for side protection (if necessary) construction/curing of plain concrete test block, supply and embedment of foundation bolts etc. and backfilling after the test.

7.01.00 Block Vibration Test

Test pits of size 4.5m x 2.75m at the bottom shall have to be made. Then at the bottom of the pit a Plain Cement Concrete block of grade M15 and of size 1.5m x 0.75m x 0.70m shall be constructed. Suitable foundation bolts shall be embedded in the concrete block during casting for fixing the oscillator assembly. The concrete block shall be cured for a minimum of fifteen days and then the following Block Forced/Free vibration Test shall be carried out as per the recommendations of IS:5249 :

a) Vertical Vibration Test

b) Longitudinal Horizontal Vibration Test

c) Free Vertical Vibration Test

d) Horizontal Free Vibration Test.

7.02.00 **Wave Propagation Test**

The wave propagation test for determination of shear modulus shall be conducted both by exciting the block to steady state vibrations in the vertical direction and by making seismic waves to pass through the ground by impact of hammer and determining the time of travel of these waves between two points at a known distance apart.

7.03.00 **Cyclic Plate Load Test**

The test shall be carried out in a manner as to give a dependable assessment of load-deformation characteristics within the soil mass.

The provisions of IS:1888 shall be followed for conducting the test. The application of load may be by gravity or by reaction as detailed out in the above Standard.

The contractor must get the dial gauges and pressure gauges calibrated by an approved testing laboratory before commencing the test at site and produce the certificates of the test to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The contractor shall bring not less than two dial gauges and one pressure gauge as standby.

The contractor shall provide a layer of cement-sand mortar (1:1 mix) below the bearing plate to level-off any uneven parts and interstices on the rock surface. Also to achieve a uniform distribution of pressure over the loaded surface, the contractor shall provide a flexible layer in the form of rubber pad over the loaded surface.

For conducting the load test the contractor shall apply cyclic loading and unloading, with four or five cycles, increasing in successive of 20% to 25% of full load. While releasing the loads the rebounds to be observed in a similar manner as the settlement observations. The range of cyclic loading shall be decided only after the static net bearing capacity is established by conventional plate load tests.

8.00.00 **FIELD DETERMINATION OF CALIFORNIA BEARING RATIO**

The test shall be carried out at locations as shown on the drawing or at locations as directed by the Engineer. The test shall be carried out at a depth of 500 mm below the finished ground level.

The contractor shall submit, for approval of the Engineer complete detail of the equipment and the method he proposes to use. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The surface area to be tested shall be exposed, cleaned of all loose and dried material, levelled and then soaked till saturation with a surcharge weight of 15 kg. After soaking is complete, the test surface shall be drained of all free

water and allowed to stand for at least 15 minutes before starting further operations.

The test shall be carried out strictly in accordance with the provisions as laid down is IS:2720 (Part XXXI) latest edition. Surcharge weights of 15 kg including that of the annular weight of 5 kg shall be applied before application of load on the penetration piston. Load shall be applied on the penetration piston such that the penetration is approximately 1.25 mm/min. The load readings shall be recorded at penetrations of 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 and 12.5 mm. The maximum load and penetration shall be recorded if it occurs for a penetration of less than 12.5 mm.

After completion of the test, a sample of soil shall be taken from the point of penetration for moisture content determination. In place density shall also be determined.

From the plot of load penetration curve, after necessary correction, the bearing ratios shall be calculated for penetrations of 2.5 mm and 5 mm. If the bearing ratio at 2.5 mm penetration is greater than that at 5 mm penetration the former shall be taken as the bearing ratio. If bearing ratio at 2.5 mm penetration is less than that at 5 mm penetration, the test shall be repeated and if the ratio at 5 mm penetration is consistently greater than that at 2.5 mm penetration, the ratio at 5 mm penetration shall be taken.

9.00.00 LABORATORY TESTS ON SOIL SAMPLES/ROCK CORES

The contractor shall carry out the tests as listed out in the Schedule of Items, and/or as decided by the Engineer, in laboratory. He shall furnish the name/s of laboratories where he proposes to have the tests carried out and have them approved by the Engineer.

The Owner shall have the right of access to contractor's laboratory and/or any other laboratory where tests have been arranged to be carried out during the progress of this investigation.

Adequate volume of test samples of soil/rock cores shall have to be collected from site and stored, labeled and transported carefully to the approved laboratory for carrying out the tests. The method and procedure of testing to be followed shall be as per the relevant Indian Standard Codes of Practice. The results of the tests shall be submitted to the Engineer in sextuplicate duly signed by the laboratory- in-charge. In tests for rock cores L/D = 1.0 of samples must be maintained.

10.00.00 REPORT ON SUB-SOIL INVESTIGATION

10.01.00 General

a) On completion of all the field and laboratory work, the contractor shall submit a formal report containing geological information of the region, procedure adopted for investigation, field observations, summarised test data, conclusion and recommendations. The report shall include

detailed borelogs, subsoil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, the supporting calculation for the conclusions drawn etc. Initially, the contractor shall submit ----- copies of the report in draft form for the Owner's review.

b) The contractor's qualified geotechnical Engineer shall visit the Owner's corporate office for a detailed discussion on the Owner's comments on his draft report. During the discussions, it shall be decided as to the modifications that need to be done in the draft report. Thereafter the contractor shall incorporate in his report the agreed modifications and after getting the amended draft report approved, ----- copies of the detailed final report shall be submitted along with one set of reproducible of the graphs, tables, etc.

c) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundations for different type of structures envisaged in the area under investigations. The contractor shall acquaint himself about the type of structures, foundations loads and other information required from the Engineer.

10.02.00 **Data to be furnished**

The report shall include the enlisted items but not be limited to them.

a) Purpose and scope of investigation

b) Authorization enabling the contractor to carry out the work at the site.

c) Project description including proposed facilities and construction materials required for the works.

d) Description of the site which shall include

i) Location of the site and existing facilities.

ii) Topography of the site

iii) Drainage Characteristics

e) A plot plan showing the locations and reduced levels of all field tests e.g., boreholes, trial pits, static cone penetration tests, dynamic cone penetration tests, plate load tests etc., properly drawn to scale and dimensioned with reference to the established grid lines.

f) A true cross section of all individual bore holes and trial pits with reduced levels and coordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted and samples collected at different depths and the rock stratum, if met with.

g) A set of longitudinal and transverse profiles connecting various boreholes shall be presented in order to give a clear picture of the site, how soil/rock strata is varying vertically and horizontally.

h) **Geological information**

i) Regional geology - geologic province, topographic position of site, processes of formation of subsurface materials at site.

ii) Description of overburden and bedrock at the site (if applicable for the site)

iii) Comments on texture & structure of rock, joints, bedding planes, fissures, weathering condition etc. (of applicable for the site)

iv) Effect of geologic features on design.

i) Past observations and historical data, if available, for the area or for other areas with similar profile or for similar structures in the nearby area.

j) Bore hole & trial pit logs on standard proforma showing the depths, extent of various soil strata etc.

k) Plot of SPT (N) value (both uncorrected and corrected) with depth.

l) Procedure of investigations employed - field tests and laboratory investigation.

m) Results of all laboratory test summarised (i) for each sample as well as (ii) for each layer along with all the relevant charts, tables, graphs, figures, supporting calculations, conclusions and photographs of representative rock cores.

n) For all triaxial shear tests stress vs strain diagrams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the magnitude of the same shall be indicated. The value of modulus of elasticity E shall be furnished for all tests along with relevant calculations.

o) For all consolidation tests, the following curves shall be furnished:

e vs log p

e vs p and

compression vs log t or

Compression vs square root of t (depending upon the shape of the plot for proper determination of co-efficient of consolidation).

The point showing the initial conditions (e, P) of the soil shall be marked on the curves.

p) The procedure adopted for calculating the compression index from the field curve and settlement of soil strata shall be clearly specified. The time required for 50% and 90% primary consolidation along with secondary settlements, if significant, shall also be calculated.

q) For pressure meter tests, the following curves shall be furnished:

Field pressure meter, creep and air calibration curves indicating Po, Pf and P1.

Corrected pressure meter and creep curves indicating P'o, P'f & P'1.

r) From the pressure meter test results the value of cohesion, angle of internal friction, pressure meter modulus, shear modulus and coefficient of subgrade reaction shall be furnished along with sample calculation. Calculation for allowable bearing pressures and corresponding total settlements, for shallow foundations mentioned below and capacity calculation of piles in various modes shall also be included.

10.03.00 **Recommendations**

Recommendations shall be given area wise duly considering the type of soil, structure and foundation in the area. The recommendations shall include but not be limited to the following :

a) Type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total settlements permissible for structures and equipment. Minimum depth and width of foundation shall also be recommended. The provision in relevant IS codes indicated in clause 2.04.00 shall be considered.

b) For shallow foundations, the following shall be indicated with comprehensive supporting calculations :

i) Net safe allowable bearing pressure for isolated square and continuous strip footings of different sizes at different founding depths below ground level considering both shear failure and settlement criteria, giving reasons for type of shear failure adopted in the calculation.

ii) Net safe allowable bearing pressure for mat foundations at different founding depths below ground level considering both shear failure and settlement criteria.

iii) Rate and magnitude of settlement expected of the structure.

iv) Modulus of subgrade reaction, modulus of elasticity, deformation modulus from plate load test results alongwith

time-settlement and load-settlement curves for the various footing sizes at different founding levels indicated above. The recommended values shall include the effect of size, shape and depth of foundation.

c) If piling is envisaged, the following shall be indicated with comprehensive supporting calculations.

i) Type of pile and reasons for recommending the same considering soil characteristics.

ii) Suitable founding strata for pile.

iii) Estimated length and diameter of pile for various values of pile capacities. End bearing and frictional resistance shall be indicated separately.

iv) Magnitude of negative skin friction, if any, to be considered in pile design.

d) Recommendations on foundations for special structures like tanks, transformers, sub-station structures, conveyor trestles, silo/stack like structures, etc.

e) Recommendations regarding bases of roads and pavements.

10.04.00 **Additional Recommendations**

a) Coefficient of permeability of various sub soil and rock strata based on in-situ permeability tests.

b) Cone resistance, frictional resistance, total resistance, relation between cone resistance and SPT(N) value and settlement analysis for different footing sizes based on CPT/SPT.

c) Electricity resistivity of sub-soil based on electrical resistivity tests including electrode spacing vs cumulative resistivity curve.

d) Evaluation of design parameters for design and analysis based on dynamic parameters of soil like Amplitude vs. Frequency curves, co-efficient of elastic uniform compression and elastic uniform shear of soil, co-efficient of elastic non-uniform compression, co-efficient of elastic non-uniform shear, value of damping co-efficient, elastic and shear modulus of soil and Poisson's ratio of soils.

e) Coefficient of earth pressure at rest and stress strain modulus of soil from Menard pressure meter test.

f) Recommendations regarding earth pressure as a function of depth below grade as applied to side walls of underground structures. Values of co-efficient of permeability shall be included in the report.

g) Recommendations regarding method and slope of deep excavations.

h) Recommendations regarding stability of slopes, during excavations, etc.

i) Potential of rock slides and methods of stabilisation of slides for very steep cut.

j) If expansive soil is met with recommendation on removal or retainment of the same under the structures/roads etc. shall be given. In the latter case detailed specification of any special treatment required including specification for materials to be used, construction method, equipment to be deployed etc. shall be furnished.

k) Susceptibility of sub soil strata to liquefaction in the event of earthquake and recommendation on remedial measures, if necessary.

l) Information of special significance like dewatering schemes etc. which may have a bearing on design and construction.

m) Aggressiveness of percolating water through sub-soil/ rock fissures to reinforced concrete foundation/sub-structures and also recommended protective measures, if required.

n) Recommendation for the type of cement to be used and any treatment to the underground concrete structures based on the chemical composition of soil and sub-soil water.

o) Recommendation on suitability of the overburden soil as material of construction of earthen embankments and in back filling of excavated pits/trenches.

p) Recommendation on the use of rock available as construction material.

q) Recommendation on the availability of material for use as aggregates at the site.

r) Recommendation for additional investigation beyond the scope of the present work if the contractor considers it necessary.

s) **Plates**

i) General plan showing location of site, and area geology.
ii) Plan showing existing features, proposed facilities, contours and locations of boring and other investigations.
iii) Geologic sections and soil profiles.

t) **Appendices**

i) Logs of subsurface explorations
ii) Field test results
iii) Laboratory test results.

TECHNICAL SPECIFICATION
FOR
III) AREA GRADING AND SLOPE PROTECTION

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PART-A

TECHNICAL SPECIFICATION - GENERAL

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PART-A

TECHNICAL SPECIFICATION - GENERAL

1.00.00 SCOPE OF WORK

The work to be performed under the scope of this specification consists of design, supply and construction of the following work.

This scope of work is to be considered in addition to the scope of work outlined in clause 2.00.00 of K9213-EPC-SPC-001 Volume IIG/1.

a) Clearing and grubbing areas for Area Grading and land filling, cutting trees, bushes etc. including taking out roots.

b) Area grading work including excavation, dressing and leveling as per grades shown in tender drawing annexed hereto.

c) Land filling with selected earth from excavation and from areas designated by owner and or from borrow pits arranged by the Contractor. The present grade level shall be raised upto RL 72 M (above MSL) filling with selected earth and or suitable granular fill material.

d) Earth work for embankment and temporary roads for construction.

e) Slope protection for embankment and sides of filled-up area within the plot designated for Unit 8 Expansion. This work shall also include design of slope protection work using geo-synthetic lining system and lining the sloped surface for protection against erosion.

The major area of work will be primarily within the plant boundary including areas for Unit 8 Expansion. Nature and extent of the work has been given on the Tender drawing annexed hereto but those are preliminary only and are by no means complete and are subject to change. Design drawing showing complete nature of work will be furnished to the Contractor progressively during execution of the work. Contractor shall develop detail drawings for construction and submit the same for approval.

The supply, design and construction of Geo-synthetic/Geo-textile lining system with protective earth cover and turfing (or precast concrete blocks/Brick tiles) shall be under the scope of Contractor. The design of Geo-synthetic lining system shall be done by approved manufacturer or specialized agencies and to be submitted to owner for approval. Laying of Geo-textile grid and covering the same with soil shall be done by the agencies specialized for this type of work.

All items of work shall be executed in accordance with the relevant specifications annexed hereto and the provisions of the contract.

The work to be performed under this tender specification consists of providing all labour, supervision, materials, scaffoldings, construction equipment, tools

& plants, supplies, transportation, all incidental items not shown or specified, but reasonably implied or necessary for successful completion of the work including Contractor's supervision and in strict accordance with the drawings, specifications.

Tenderers are not generally expected to stipulate any conditions of their own or deviate from the General & Supplementary Conditions of the Contract and Specifications. However, should it become necessary, all such deviations shall be indicated clause wise in a separate schedule. Deviations mentioned or brought out elsewhere in the tender other than in the above schedule, will not be entertained and such offers which do not conform to the above requirements are liable to be summarily rejected.

The requirements and the Conditions of Contract as stated in General and Special Conditions of Contract by GSECL are also applicable.

2.00.00 DESCRIPTION AND FEATURES OF THE SITE

2.01.00 The work specified herein shall be carried out at Wanakbori Power Plant, Gujarat, within the area designated for 1x800 MW Super Critical Thermal Power Plant Extension Unit.

2.02.00 The Power Plant is located at Wanakbori, Kheda District in the State of Gujarat.

2.03.00 **Location of Power Plant**

i) At Wanakbori TPS, Kheda District, Gujarat.

ii)	Nearest Town	:	Balasinor (13 Km from Site), Sevalia (10 Km from Site)
iii)	Nearest Highway	:	NH-08 (10 Km from Site)
iv)	Nearest Railway Station	:	Sevalia (8 Km from Site)
v)	Nearest Airports	:	Ahmedabad (110 Km from Site)
			Vadodara (85 Km from Site)

2.04.00 **Meteorological Data**

Weather data for the site :

a)	Dry bulb temperature (max. & min.)	:	40.8^{o}C & 10.8^{o}C
b)	Humidity (min. & max.)	:	42.5% to 81.5%
c)	Average Annual Rainfall	:	750 mm
d)	Wind speed	:	Basic wind speed of 39 m/sec as per IS-875 (Part-3).
e)	Seismic zone	:	Zone-III as per IS-1893

3.00.00 SOIL CHARACTERISTICS

Boring and subsurface data regarding nature of soil, subsoil water etc. are not available now. The tenderer shall satisfy himself of the character and volume of work under the items and expected surface and/or subsoil water to be encountered. He must satisfy himself about general conditions of the site and ascertain the existing and future obstructions likely to come up during the execution of the contract to carry out work under this scope.

[Geo-technical investigation work for preparatory work is being done by other agencies. The report will be available with GSECL after completion of work]

4.00.00 SPECIFICATIONS

The following Technical Specifications are to be referred for various items of work:

A) Technical Specification for Area Grading and Slope Protection

B) Technical Specification for Geo-textile Fabric.

The above specifications are intended for the General description of quality, workmanship etc. desired for various items of work under the Contract. The Specifications are not, however, intended to cover minutest details and all work shall be executed according to the spirit of the specifications and in absence thereof, according to the relevant latest Indian Standard Specification. In absence of the latter, the work shall be executed according to the best prevailing local Public Works Department Practice or to the recommendations of the American or British Standard Specifications at the discretion of the Engineer.

5.00.00 DRAWINGS

The following tender drawings are to be referred in relation to Area grading and Slope Protection work.

Sl. No.	Drawing No.	Description
1.	K9213R-DWG-S-0002 REV 8	Area Grading Plan & Sections
2.	K9213R-DWG-S-0008 REV 0	Paving Pattern For Slope Protection
3.	-	Contour Plan dtd MAY 2010.
4.	K9213R-DWG-M-002, Rev 4	Plot Plan – Unit # 8

Aforesaid drawings are preliminary for Tender purposes only and are by no means complete and final and do not show the full range of the work under the scope of the Contract. Work shall be carried out only on the basis of

design drawings marked "Released for Construction" with additions, alterations and modifications made to aforesaid drawings from time to time and also according to detail construction drawings that will be prepared by the Contractor progressively during the execution of the work.

The Contractor shall refer to the Engineer any discrepancy which may exist between the drawings and the specification for clarification. Engineer's decision as to the clarification of the point raised shall be final and binding to the Contractor.

6.00.00 LAYOUT

The layout and levels of all the work shall be made by the Contractor at his own cost from the general grid of the plot and bench marks given by the Engineer. He shall give all help with instruments, materials and men to the Engineer for checking the detailed layout and correctness of the layout and levels. The approval of the Engineer shall not be deemed to imply any warranty and shall not relieve the Contractor of his sole responsibility in connection with carrying out the work correctly.

Making bench mark pillars and reference line pillars etc. and maintaining them upto the completion of the work shall be responsibility of the Contractor. No extra payment shall be made on this account.

7.00.00 WORKMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. In addition to the requirement specified above, if the bye-laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

8.00.00 TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such temporary work shall have the prior approval of the Engineer, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and

re-erection, if required, shall be carried out by the Contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor.

Owner is not bound to supply materials (cement, reinforcing steel & structural steel) for such temporary work. However, depending on merit of the situation and also discretion of the Engineer, the material may be issued to the Contractor, subject to the availability of the same. The materials issued for this purpose shall be treated as bonafide consumption and will be recovered at issue price as stipulated in Special Condition of Contract.

9.00.00 **TENDER DRAWINGS (Refer Volume IIL of Specification)**

PART-B

TECHNICAL SPECIFICATION
FOR
III) AREA GRADING AND SLOPE PROTECTION

CONTENTS

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SECTION-II

TECHNICAL SPECIFICATION FOR A) AREA GRADING AND SLOPE PROTECTION

1.00.00 SCOPE

This specification shall govern all clearing, grubbing, excavating, area filling, grading and compacting soils for areas designated on the drawings. The work shall include clearing and grubbing, stripping and storage of top soil, excavation, blasting (if required), hauling, dumping and spreading of soil, undercutting to remove unstable soil areas, compacting existing soil surfaces and bottom of excavated areas to receive fills, compacting excavated areas for subgrade, placing and compacting soils in fills, dealing with surface water, pumping to keep excavated areas and areas to be filled dry, final grading of designated areas, disposing of unsuitable and excess excavated materials and incidentals thereof. For hauling of earth from approved borrow areas to site, agency shall get timely approval from all statutory authorities for right of way. GSECL will give recommendation letter to obtain the permission from appropriate authority for excavation from borrow area.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, earth-moving machineries and equipment, compaction plant and equipment, tools and plants, survey instruments, transportation etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, sumps for dewatering, space for temporary stacking of spoils, disposal area, borrow pits, fencing, slope protection work etc. and all other details as may be required by the Engineer.

c) To carry out and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

d) If blasting is resorted to, necessary licenses to be procured from the proper authorities.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

However, the Owner reserves the right to award the whole work to one Contractor or to split up the work for awarding to two or more Contractors.

2.03.00 **Codes and Standards**

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed :

IS : 1200	:	Method of Measurement of Building and Civil Engineering work, Part-I Earthwork
IS : 2720 (Part-II)	:	Determination of Moisture Content
IS : 2720 (Part-IV)	:	Grain Size Analysis
IS : 2720 (Part-VII)	:	Determination of Moisture Content/Dry Relation using Light compaction
IS : 2720 (Part-VIII)	:	Determination of Moisture Content/Dry Relation using Heavy Compaction
IS : 2720 (Part-XIV)	:	Determination of Density Index (Relative Density) of cohesion less soils
IS : 2720 (Part-XXIV)	:	Determination of Dry Density, in place, by core cutter method
IS : 2720 (Part-XXVIII)	:	Determination of Dry Density of Soils, in place, by sand replacement methods
IS : 3764	:	Safety Code for Excavation Work
IS : 4081	:	Blasting and related drilling operations
IRC : SP-11	:	Hand book of quality control for construction of roads and runways
IRC : 36	:	Construction of Earth Embankments for Road Work.

2.04.00 **Conformity with Designs**

The Contractor shall carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be used**

2.05.01 General

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.05.02 Borrow Material

Borrow material required for area filling shall be excavated from approved locations and levels and shall consist of selected material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material.

When specific borrow area can not be designated by the Engineer, necessary arrangement shall be done by the Contractor at his own cost for locating and using the borrow areas as the source of supply of filling material.

The depth of borrow pits should be so regulated that the borrow pits do not cut an imaginary line having a slope of 1 vertical in 4 horizontal projected from the edge of final section of the adjacent embankment of stack of excavated soil.

2.06.00 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

a) Lines, Levels and Grades :

i) Periodic Surveys

ii) Establishment of markers, Boards etc.

iii) Checking levels and slopes of the graded surface.

b) Area filling :

i) Checking the quality of fill material

ii) Checking moisture content of the fill

iii) Checking the degree of compaction.

2.06.01 Any work which fails to conform to the specifications will be subject to the issue of a Non-conformance Report in line with the Quality Control Procedure to be implemented at site. Corrective or remedial action, design modifications or product rejection will be reviewed in accordance with the site Quality Plan.

2.07.00 **Information regarding Site Conditions**

Boring and sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawings or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the Contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and/or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the Contract so that he may evolve a realistic programme of execution.

3.00.00 **EXECUTION**

3.01.00 **General**

The work shall be undertaken in accordance with the lines, levels, grades and details shown on the drawings, specification and the approved method of work.

The works shall be carried out in a workman like manner without endangering the safety of nearby structures, roads, railway tracks, cable, pipelines, etc. and without causing hindrance to construction activities.

Suitable approaches, fencing, area lighting and temporary works required for the works shall be provided by the contractor. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where damping from a high bench is in progress, if directed by the Engineer. Adequate area lighting shall be provided by the contractor, if night work is undertaken.

The Contractor shall submit a proposal covering the proposed excavation and placement of fill material for approval of the Engineer. The proposal shall include but not be limited to the following:

a) Mobilisation and demobilisation of plant

b) Proposed plant and equipment, labour resources & supervision.

c) Details of proposed method of clearing and grubbing for each area of cut and fill.

d) Drawings showing the areas for placement of material.

e) Management of excavation and filling works i.e., control of setting out, testing procedures, handling, temporary stockpiles, etc.

f) Temporary works proposals

g) Excavation, filling and compaction by mechanical plant

h) Dealing with surface water

i) Dewatering

j) Disposal of materials

k) Safety precautions, fencing and lighting

l) Calculations as appropriate to support work proposal.

3.02.00 **Setting Out**

Within 15 days of award of Contract, the Contractor will prepare and submit to the Engineer, detailed drawings of the excavation and filling work necessary, as proposed to be executed by him, showing the dimensions as per drawings and specification, adding his proposals for slopes, approaches, dewatering sumps, berms etc. On receiving the approval from the Engineer with modifications and corrections if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instruments for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if any. In case any errors are noticed in the Contractor's work at any stage, the same shall be remedied by the Contractor at his own cost.

3.03.00 **Initial Levels**

Initial levels either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. These initial levels and cross-sections shall be jointly signed by the Contractor and the Engineer before commencement of work and they shall form the basis of all payment in future.

3.04.00 **Clearing and Grubbing etc.**

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and leveled up. Trees upto 300 mm girth shall be uprooted. Trees of all sizes are required to be cut and transported to owner’s store. Also all serviceable materials to be credited at owner’s store. Trees above 300mm girth which are required to be cut, shall be got identified by the Engineer and then marked.

Felling of trees shall include taking out roots upto 600 mm below ground level. After the tree is cut and roots taken out, the pot-holes formed shall be filled with good earth in 250 mm layers and compacted to acceptable degree unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer and then shall be transported to the Owner's store or any other space as directed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed as directed by the Engineer. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.05.00 **Classification**

Materials involved in earthwork shall be classified under the following categories. No distinction will be made whether the material is dry or wet. The Engineer's decision in regard to such classification shall be final and binding on the Contractor :

a) Ordinary and hard soil

This shall include clay, silt, sand, moorum, shingle, kankar, gravel, loam, peat, ash and other similar materials in soft, hard or dense state which can generally be excavated with ordinary spade, pick axe, shovel etc. and does not require the use of wedges, pneumatic breaking equipment and/or blasting for removal. It shall also include loose rock boulders present in the soil, with dimensions not exceeding 500 mm in any direction. Breaking of consolidated brick ballast and mud concrete shall be considered equivalent to excavation work under this type of soil.

b) Soft and Decomposed Rock

This shall include rocks like chalk, slate, mica schist, laterite and other similar materials which in the opinion of the Engineer is rock, but does not require blasting for removal and could be removed with picks, hammers, crow bars, wedges, pneumatic breaking equipment etc. It shall also include boulders with dimensions greater than 500 mm but not exceeding 1000 mm in any direction.

The mere fact that the contractor resorts to blasting for his own convenience shall not mean that the rock will be classified as hard rock. Excavation in macadam and tarred roads and pathways, brick work etc. shall be considered at the same rate as excavation of this type of soil.

c) Hard Rock

This shall include rocks occurring in large masses which cannot be removed except by blasting. Harder varieties of rock such as trap, with or without veins and secondary mineral which in the opinion of the Engineer require blasting for removal shall also be considered as hard rock. It shall also include boulders bigger than 1000 mm in any direction. Construction in concrete, both reinforced and unreinforced, which is required to be dismantled during earthwork, shall be measured under this item, unless a separate provision is made in the schedule of Quantities for the same.

3.06.00 Earthwork in Excavation

3.06.01 General

Before commencement of excavation the existing ground surface shall be cleared in accordance with Clause no. 3.04.00.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavation including dimension, side slopes, dewatering, disposal, etc.

This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer and the Contractor shall be paid for the extra excavation and the filling at the appropriate item rates.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost with selected earth and compacted in accordance with the specification as specified in Clause No. 3.07.01.

3.06.02 Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock

The excavation in ordinary soil, hard soil and soft and decomposed rock shall be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures or roads, railway tracks, cables, pipelines etc. if any, and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly & the balance work will be carried out carefully to avoid any over-excavation.

On completion, the work will be finally checked and approved by the Engineer. In case where excavation in soil, soft and decomposed rock and/or hard rock are involved, the soil or soft and decomposed rock layers, shall be removed by turn and levels of the underlying rock surfaces observed to enable measurements. Further work shall be resumed after getting clearance from the Engineer.

3.06.03 Excavation in Hard Rock

Overburden, if any, consisting of top soil, ordinary and hard soil, soft and decomposed rock as per classification of soil, which do not require blasting shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurement. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiseling, wedging or any other approved method. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rate for excavation in hard rock shall include the cost of all these operations.

3.06.04 Blasting

3.06.04.01 General

Excavation shall be continued in hard rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines for the excavation, in the soundest possible condition. The quantity and strength of explosive used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Engineer at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Unless otherwise stated herein, I.S. Specification IS:4081 "Safety Code for Blasting & Related Drilling Operation" shall be followed.

Specific permission of Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting license from the authorities concerned.

Contractor shall obtain necessary license for storage of explosives, fuses and detonators issued to him from owner's stores or from supplier arranged by him, from the authorities dealing with explosives.

The fees, if any, required for obtaining such license, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Govt. authorities and statutory bodies / regulations.

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

Contractor shall employ a competent experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Contractor shall intimate Engineer and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

The blasting of rock near any existing buildings, equipments or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges and where directed by Engineer, a trench shall have to be cut by chiseling prior to the blasting operation separating the area under blasting from the existing structures.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an over break limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M 10. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stepping in rock excavation shall be done by hand trimming.

Contractor shall be responsible for any accident to workmen, public or Owner's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other authority duly constituted under the State and/or Union Government.

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.06.04.02 Material

All materials such as explosives, detonators, fuses tamping materials etc. are proposed to be used in the blasting operations shall have the prior approval of the Engineer.

Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used.

The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for thirty minutes. The rate of burning of the fuse shall be uniform and not less than 4 seconds or inch of length with 10% tolerance on either side.

Before use, the fuse shall be inspected and moist damaged or broken ones discarded. The rate of burning of fuses or when they have been in stock for long shall be tested before use.

The detonators used shall be capable of giving an effective blasting of the explosives, moist; and damaged detonators shall be discarded.

3.06.04.03 Storage of Explosive

Storage of explosives shall be governed by the current Explosive Rules. Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Persons entering the magazine, must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful :

- Not to put their feet on the clean floor unless they have the magazine shoes on.

- Not to allow the magazine shoes to touch the ground outside the clean floor.

- Not to allow any dirty or grit to fall on the clean floor.

Persons with bare feet, shall before entering the magazine dip their feet in water and then step direct from the tub over the barrier (if there be one) on to the clean floor.

A brush broom shall be kept in the lobby of the magazine for cleaning out the magazine, on each occasion if it is opened for the receipt, delivery or inspection of explosives.

No matches or inflammable materials shall be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100 m of a magazine.

No person having article of steel or iron on him shall be allowed to enter the magazine.

Oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Workmen shall be examined before they enter the magazine to see that they have none of the prohibited articles on their person.

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dust storm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.06.04.04 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.06.04.05 Use of Explosives

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shotholes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shot holes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shot firer himself. The shot firing cable shall not be dragged along the ground to avoid possible damage to the insulation. The shot firing cable shall be tested for continuity and possible short circuiting before it is used each time.

The shot firer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shot firer shall return to the blast area and inspect carefully and shall compare the number of blasts planted/fired to the actual number of shorts heard and satisfy himself that all blast have exploded. Withdrawal unexploded charges shall not be permitted. The unexploded charges shall be flooded with water and the hole shall be marked in a distinguishable manner. Another hole shall be made by drilling a parallel fresh hole not less than 450 mm from misfired hole and fired in the usual way. The process shall be continued till the original blast is exploded. The engineer shall also be informed by the Contractor of all the cases of misfired/unexploded charges, their causes and steps taken. The authorised shot firer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until atleast half an hour after firing.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.06.05 Disposal

The excavated spoils will be disposed off within the specified lead in any or a combination of some of the following manners, as directed by the Engineer :

a) By stacking separately the materials suitable for area filling and materials not suitable.

b) By stacking it temporarily for use in backfilling at a later date.

c) i) By either spreading

or

ii) Spreading and compacting at designated filling areas and/or disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in back-filling or other purposes by some other agency.

e) Disposal of debris, earth, mill rejects, (if not useful) excavated spoils will be disposed off outside plant area by bidder. Disposal area shall be identified by the bidders.

The rate for excavation in soil should include the cost of filling and compaction in case (c) (ii). The rate for excavation in rock should include the cost of disposal as per (d).

3.06.06 Dewatering

All areas shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer, any water inclusive of rain water and subsoil water accumulated in the area without any extra cost. Method of dewatering shall be got approved by the Engineer.

3.06.07 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

Working surfaces shall be formed to such falls to shed water and prevent ponding.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems at his own cost to drain surface water from working areas.

3.07.00 **Treatment of Slips**

The Contractor will take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and backfilled later by him at his own expenses.

3.08.00 **Earthwork in Filling**

3.08.01 Area Filling for Grading

The material to be used for area filling shall be selected material capable of being compacted to the requirements stated herein below and approved by the Engineer, obtained directly from excavation for area grading, from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits in selected areas designated/approved by the Engineer. The quality of the material shall conform to that mentioned in clause 2.5.2 of this specification.

Where excavated material is mostly rock, the boulders shall be broken into pieces not longer than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill up the voids and the mixtures used for filling.

If any material is rejected by the Engineer, Contractor shall remove the same forthwith from the site at no extra cost of the owner. Surplus fill material shall be deposited/disposed of as directed by the Engineer after the fill work is completed.

No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

Before commencement of area filling the existing top soil shall be removed upto a minimum depth of 200 mm, or more, as directed by the Engineer in order to clear the surface of undesirable materials. After this the filling operation shall be performed with earth in layers not exceeding 250 mm, loose thickness. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as given below and got approved by the Engineer.

a) Each layer of earth of cohesive nature shall be compacted to 90% of proctors dry density unless otherwise permitted/directed by the Engineer.

b) Each layer of earth of non-cohesive nature shall be compacted to minimum 75% relative density unless otherwise permitted/directed by the Engineer.

Each shall be compacted with approved machine (mechanical plant) and usually manual compaction shall not be allowed unless specifically permitted by the Engineer. The original ground formation and each fill layer shall be compacted by rollers as described below with a maximum of six passes of 8/10 tonne roller.

i) When the optimum moisture content of soil is relatively high, a pneumatic tyred roller (type pressure 3.0 - 3.5 kg/sq.cm) shall be considered to give better performance for mechanical compaction.

ii) When the optimum moisture content of soil is relatively low, a vibrating roller shall be considered to give better performance for mechanical compaction.

Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on this aspect and corrections done to optimise the moisture content. The adequacy of the compaction and moisture content of the soil shall be determined by performing field density tests and other tests as and when directed by the Engineer and shall conform to the stipulations laid down in IS:4701.

The cohesionless soil to be used for area filling, should be placed in fully saturated condition to obtain the maximum possible density. The saturation

moisture content shall be determined by laboratory tests prior to commencement of work.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed.

When density measurements reveal soft areas in the construction, further compaction shall be undertaken at the contractor's cost as directed by the Engineer. If the required compaction is then not achieved the material in the soft area shall be removed and replaced by approved material and compacted in accordance with this specification all to the contractor's account.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than 12 passes of the roller shall be accepted before subsequent similar operations are taken up.

3.08.02 Filling in Disposal Areas

Excavated materials if not used in area filling, will be disposed of in designated disposal areas as directed or as indicated in the drawings. The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 500 mm in thickness and nominal compaction done to the satisfaction of the Engineer. All clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers and trucks shall be allowed to ply over the fill to permit compaction to take place.

In wide areas rollers may be employed and nominal compaction done to the satisfaction of the Engineer. No payment for compaction shall be made for such nominal compaction.

3.09.00 **Compaction Control**

The density of each layer of compacted soil shall be ascertained by testing a number of samples. For this purpose the necessary arrangements for soil testing at the site shall be made by the Contractor in accordance with these specifications at the Contractor's expense and as directed by the Engineer.

The Contractor shall arrange the provision of the field laboratory including the testing equipment and a suitable motor vehicle. He shall also supply all

consumable materials such as kerosene, spirit, gas and sample bags as required.

All soil testing is to be carried out by a competent and suitable qualified engineering testing firm. The Contractor is to obtain the Engineer's approval for the firm to be used. The Contractor may undertake this work with the Engineer's approval.

All density testing shall be carried out on a lot by lot basis. A lot shall be considered to be a portion of work which is essentially homogeneous with respect to material type general appearance response during compaction, moisture condition during compaction, compaction process and state of underlying material.

All fill testing shall be carried out in accordance with the recent editions of relevant Indian Standards. The chainage and the off-set from the centre line of the fill of each test sample shall be recorded and presented along with the test results.

Each test lot shall be classified as cohesionless or cohesive. The classification shall be determined by the Engineer based upon particle size distribution. Cohesionless fill shall have 10% or less by mass of particles finer than 0.075 mm. Otherwise fill shall be treated cohesive.

For cohesionless fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum and minimum dry density. These reference values of dry density shall be used to compute the density index (relative density) of each of the field density test samples taken from the test lot.

For cohesive fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum dry density and optimum moisture content (OMC). These reference values of dry density and moisture content shall be used to compute the dry density ratio of each of the field density test samples taken from that test lot.

The degree of compaction shall be determined by considering the mean density of the samples in each test lot. The mean dry density shall be equal to or exceed the minimum specified density. In no individual case shall density be less than the minimum value specified by more than 2 percent, otherwise further rolling shall be done at the appropriate locations.

The contractor shall lay a further layer or fill only after compaction or a particular layer has been found and approved by the Engineer.

3.10.00 Protection of Side Slopes

The side slopes of the embankment shall be protected against slippage caused by rain cuts, erosion by wind etc. The surface treatment to be adopted will be by turfing, by lining, or by other means as shown in the drawings and also as directed by the Engineer.

3.10.01 Turfing

3.10.01.01 General

The provision of turfing involves the plantation of grass on the top and/or side slopes of the embankment as shown on the drawing or as directed by the Engineer. The work of turfing shall be taken up immediately after the construction of embankment, provided the season is favourable for the establishment of sod, preferably well before monsoon, but not during the monsoon.

The sod shall consist of dense, well-rooted growth of permanent and desirable grasses, indigenous to the locality. Thickness of sod shall be between 5cm & 8cm, so that all the dense root system is retained in the sod strip. The sods shall be of rectangular strips of uniform width, not less than about 25cm x 30cm in size but not so large that it is inconvenient to handle. During wet weather, the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather shall be watered before lifting to ensure its vitality.

3.10.01.02 Preparation of Bed

After the embankment has been constructed to shape and well compacted, the surface earth shall be loosened to a depth of 75 mm for receiving the sod. If the soil is not suitable for grass growth, suitable top soil shall be spread over the slopes and worked into the already loosened soil. Where required, fertilizer shall be spread and incorporated in the soil.

3.10.01.03 Placing of Sod

The prepared sod bed shall be moistened to the loosened depth and the sod shall be placed within 24 hours after the same has been cut. Each sod strip shall be placed edge to edge and such that the joints caused by abutting ends are staggered. The sod shall be lightly tamped with wooden or metal tampers to press it into the underlying soil. The strips are to be placed on the prepared embankment surfaces starting at the bottom. When the top is reached, the edge of the sod shall be turned into the surface and a thin layer of earth placed over the edge and compacted so as to divert water above the edge onto the top of the sod.

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2 metres, the sod shall be staked with pegs or nails spaced approximately 50 to 100 cm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods to be almost flush with them.

The sods shall be watered until the seeds or roots have sprouted. The preferable system of watering is by spraying rather than by flowing.

3.10.02 Geo-textile Membrane

Refer Volume IIG/3 Section XXXII for Technical Specification.

3.10.03 Earth/Soil

The excavated soil, selectively taken from the stacks of the same Contractor and/or stacks left by other agencies shall be used for covering geo-textile membrane and shall be free from pebbles, stones, vegetation and sieved to segregate stones, etc. present in it, if directed by the Engineer. The minimum clay-content of this soil shall be 25%. No fine sand layer excavated shall be used as cover over films.

3.10.04 Pre-cast Concrete

Ingredients used in pre-cast concrete blocks (to be used for covering geo-synthetic/geo-textile membrane) shall conform to the relevant provisions in IS:456, latest revision.

All precast work shall be carried out in a yard made for the purpose. This yard shall be dry properly levelled and having a hard and even surface. If the ground is to be used as a soffit form of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:3 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after installation.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials and men to the Engineer for checking the proper installation of the precast units. All minor defects shall be touched up with a paste of 1 part cement and 3 parts sand.

3.10.05 Bricks and Brick Tiles

Bricks and brick tiles shall be of first class (class A) quality, well burnt, of uniform size, shape and colour, free from cracks, flaws or nodules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, holes etc. compressive strengths shall be 50 Kg/sq.cm minimum for common bricks. Water absorption after 24 hours immersion shall not exceed 15% by weight for common bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for common bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

If the Tenderer can not arrange for such quality bricks during execution, he should clearly indicate it in his offer. Samples of bricks/brick tiles have to be got approved by the Engineer. Any brick or consignment of bricks not found upto the specification shall be outright rejected and shall be removed immediately from site at the Contractor's own cost.

3.10.06 Execution of Slope Protection

The Work shall be strictly executed according to the provisions of this specification, final drawings to be issued, instructions of the Engineer at site, and/or catalogues of the approved manufacturer of Geo-textile membrane films.

3.10.06.01 Preparation of Sub-grade

The side slope shall be well compacted and free from undulations. All sharp objects such as rock pieces, boulders, stones, pebbles, roots and weeds shall be cleared to prevent puncturing of the membrane, and holes are to be filled up with proper material and compacted as directed by the Engineer. If the sides of excavation is a rock-cut terrain, sharp protrusions shall be levelled off. It is important that the sloping sides are well compacted to the satisfaction of the Engineer.

3.10.06.02 Treatment of Weed- Infested Areas

For safe guarding Geo-textile membrane against the growth of weeds, weedicides (such as Biodex-C, Grammaxene, Fernoxene or equivalent products) should be mixed with water in accordance with the manufacturer's instructions (3 litres of weedicide mixed with 200 litres of water is a standard practice) and this solution should be spread over the earth with a chemical spraying pump on side slopes.

The anti-weed treatment should be given only after moisture content of the soil is brought below 29%. After completion of the spraying of anti-weed chemicals and before taking up the next activity, a period of 24 hours should be allowed for penetration of the chemical into the soil.

3.10.06.03 Anti-Termite Treatment

The danger of termites at the side slope is rather remote. However in the case of infested areas, suitable insecticide slurries with insecticides such as BHC may be used over the side slope and before laying the film to prevent termite attack.

The tenderer, in his offer, shall quote separately for spraying suitable insecticide slurries in each square metre of treated area, and shall clearly indicate the type of insecticide, he proposes to use, manufacturer's name, proportion of ingredients in the slurry, and method of application, etc.

3.10.06.04 Not used.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Soil Testing

The following tests shall be undertaken by the Contractor and results and reports shall be submitted to the Engineer for approval. Test failures are to be immediately notified to the Engineer, otherwise results to be submitted within 24 hours of testing. Each layer of material shall be tested for compaction. Each layer is to be tested in a manner that is representative of its full depth. The Engineer may at his discretion instruct the Contractor to increase or decrease the frequency of testing.

a) Minimum one test per 500 cu.m of soil coming out of the borrow pits for determination of natural moisture contents in order to evaluate how far the natural moisture content tallies with the optimum value and whether further addition or reduction of water content would be necessary. Test to be done in accordance with IS : 2720 (Part-II).

b) Minimum two sets of laboratory tests per 8000 cu.m of soil coming out of the borrow pits for determination of dry density at optimum moisture content. Test to be done in accordance with IS : 2720 (Part-VII, XIV, XXVIII, XXIV) as applicable.

c) Minimum two sets of test per 500 cu.m of loose fill for determination of moisture content just prior to compaction of area filling. Test to be done in accordance with IS : 2720 (Part-II).

d) For each compacted layer, minimum one test per 2000 sq.m of compacted area for determination of moisture content and dry density.

e) Minimum two tests per 8000 cu.m of soil for determination of soil classification. Test to be done in accordance with IS : 2720 (Part-IV).

f) Minimum 10 (ten) density measurements shall be plotted to establish moisture content-dry density relationship.

4.02.00 Acceptance Criteria

4.02.01 Excavation

On completion of excavation, the dimensions of the area will be checked as per the drawings after the area is completely dewatered.

The work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by compacted earth, at the Contractor's cost.

Over excavation of the sides will be made good free of cost by the Contractor. The excavation work will be accepted after the above requirements are fulfilled & all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.02 Area-filling

The degree of compaction required will be as per the stipulations laid down in appropriate sections of this specification. The actual method for measuring the compaction achieved will be as decided by the Engineer. The work of area filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

Following details of Machineries, transport vehicles, equipment proposed to be used for excavation, area-filling and compaction have to be submitted along with the tender :

i) Equipment, machinery & earthmoving vehicles, available with the Contractor and proposed to be used for excavation and haulage giving details regarding make, model, capacity, year of manufacture, numbers available for this contract and general condition.

ii) Equipment proposed to be used for area filling and compaction giving similar details as in item 5.01.00 (i) above.

iii) Method of transportation.

5.02.00 After Award

After award of contract the successful tenderer shall submit the following for approval and adoption :

a) Within 15 days of Award of the contract, the Contractor shall submit a detailed programme of work as proposed to be executed giving completion dates of excavation of the various areas and the time required for area-filling and compaction. The programme should also show how the excavation and area- filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with overall construction schedule without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, approaches, sump pits, dewatering lines, borrow pits, if any, fencing etc. for approval of the Engineer for adoption.

TECHNICAL SPECIFICATION
FOR
IV) EARTHWORK IN EXCAVATION AND BACKFILLING

CONTENTS

CLAUSE NO.	DESCRIPTION
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IV) EARTHWORK IN EXCAVATION AND BACKFILLING

1.00.00 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing, etc. and all other details as may be required by the Engineer.

c) To carry out sampling and testing and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

d) Construction, maintenance and removal after completion of Magazine of proper capacity as well as design for storing of explosives required for blasting work to be carried out under the scope of this tender including procurement of necessary licenses from proper authorities.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All works under this specification, unless specified otherwise, shall conform to the latest revision and/or replacement of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed:

IS:1200 : Method of Measurement of Building and Civil (Part-I) Engineering work; Part-I Earthwork.

IS:2720	:	Determination of Moisture Content (Part-II).
IS:2720	:	Determination of Moisture content/Dry Relation (Part-VII) using Light Compaction.
IS:2720	:	Determination of Density Index (Relative Density) (Part-xiv) of cohesionless soils.
IS:2720	:	Determination of Dry Density, in place, by core (Part-xxix) cutter method.
IS:2720 (xxviii)	:	Determination of Dry Density of soils, in place, (Part-by sand replacement methods.
IS:3764	:	Safety code for Excavation work.
IS:4081	:	Blasting and Related Drilling Operations
IS:4701	:	Earthwork on canals

2.04.00 **Conformity with Designs**

The Contractor is to carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and approved by the Engineer.

2.05.02 **Borrow Material**

Borrow material required for back-filling shall be excavated from approved locations & levels and shall consist of material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries shall be used as fill material.

2.06.00 **Quality Control**

The Contractor shall submit the Quality Assurance Plan (QAP) for total work to the Owner/Engineer for approval and follow the approved plan during work execution.

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

a) Lines, Levels and Grades :

i) Periodic surveys

ii) Establishment of markers, boards etc.

b) Back-filling :

i) Checking the quality of fill material

ii) Checking moisture content of the backfill

iii) Checking the degree of compaction.

2.07.00 **Information regarding site conditions**

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation there from shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, Sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.00.00 **EXECUTION**

3.01.00 **Setting Out**

Within 7 days of releasing of construction drawing, the Contractor will prepare and submit to the Engineer, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his proposals of slopes, shorings, approaches, dewatering sumps, berms, etc. On receiving the approval from the Engineer with modifications and corrections, if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be fixed at intervals prescribed by the Engineer and checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instructions for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, free of cost to the Owner in case any errors are noticed in the Contractor's work at any stage.

3.02.00 **Initial Levels**

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements.

All records of levels, measurements etc. and also any drawing, cross section etc. made there from, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.03.00 **Clearing and Grubbing, etc.**

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and leveled up. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600mm below ground level or 150mm below formation level whichever is lower. After the tree is cut and roots taken out the pot-holes formed shall be filled with good earth in 250mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burned or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.04.00 **Classification**

All earthwork shall be classified under the following categories :
No distinction will be made whether the material is dry or wet.

a) **Ordinary Soil**

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) **Hard Soil**

This shall include :

i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;

ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;

iii) soling of roads, paths, etc., and hard core ;

iv) macadam surfaces such as water bound, and bitumen/tar bound;

v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;

vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and

vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) **Soft and Decomposed Rock**

This shall include :

i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;

ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;

iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin; and

iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (requiring blasting)**

This shall include :

i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;

ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and

iii) boulders requiring blasting.

iv) Rock cutting and blasting, if required.

e) **Hard Rock (blasting prohibited)**

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.05.00 **Excavation for Foundations and Trenches**

3.05.01 **General**

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal, etc. This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Engineer they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Engineer and the Contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works.

The Contractor shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Contractor shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment of the work, etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which, in the opinion of the Engineer, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even

below the final level. The extra excavation shall be filled up as instructed by the Engineer and the Contractor shall be paid for the extra excavation and the filling at the appropriate item rates.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost (with cement concrete not leaner than 1:4:8 ordinary concrete or richer) as directed by the Engineer in each individual case.

In formation of rock requiring blasting, those over cuts which are unavoidable will be made up by ordinary cement concrete 1:2:4 which will be paid for under appropriate rate, provided this over cut is not due to negligence of the Contractor. The decision of the Engineer as to the admissibility of such over cut for payment will be final. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked separately as directed by the Engineer and shall be the property of the Owner.

3.05.02 **Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock**

The excavation in ordinary soil, hard soil, soft and decomposed rock will be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work will be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation. On completion, the work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Engineer may order to suspend the work at any stage and instruct the Contractor to carry out the balance work just before the foundation work of the structure can be started. No extra will be paid to the Contractor for such unavoidable temporary suspension of work.

3.05.03 **Excavation in Hard Rock**

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc. which can be excavated without blasting, shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurements. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 meters, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiseling, wedging or any other approved method and payment appropriate to blasting shall be made, unless otherwise mentioned in the Schedule.

3.05.04 **Blasting**

3.05.04.1 **General**

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.05.04.2 **Storage of Explosive**

Storage of explosives shall be governed by the current Explosive Rules, Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in- charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 m of a magazine.

Magazine shoes without nails shall be used while entering the magazine.

The mallets, levers, wedge etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dust storm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.05.04.3 **Carriage of Explosives**

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.05.04.4 **Use of Explosives**

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shot holes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shot holes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shot firer himself. The shot firing cable shall not be dragged along the ground to avoid possible damage to the insulation. The shot firing cable shall be tested for continuity and possible short circuiting before it is used each time.

The shot firer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the Engineer.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole not less than 600 mm from the misfired hole and by exploding a new charge. The authorised shot firer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until atleast half an hour after firing.

When blasting is conducted in the neighborhood of roads, structures, buildings etc. controlled blasting has to be carried out by drilling shallow shot holes and filling the same with light charge of explosives.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.05.05 **Disposal**

The excavated spoils will be disposed of in any or all the following manners :

a) By using it for backfilling straightway.

b) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.

c) i) By either spreading, Or
ii) spreading and compacting at designated filling areas and / or disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in backfilling by some other agency.

The rate for excavation in soil should include the cost of filling and compaction in case (c) (ii). The rate for excavation in rock should include the cost of disposal as per (d).

3.05.06 **Disposal of Surplus**

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner and if the Contractor wants to use it, he shall have to obtain it from the Engineer at a mutually agreed rate for the same.

All sound rock and other assorted materials like excavated bricks, etc. shall be stacked separately and shall be measured in stacks deducting 30% volumetric measure for voids.

3.05.07 **Protection**

The Engineer shall be notified by the Contractor as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Engineer, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval and measurement by the Engineer. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Engineer.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.

The Contractor shall protect all under-ground services exposed by excavation. The Contractor shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean.

All the above works shall be carried out by the Contractor without any commercial implication to the Owner.

3.05.08 **Dealing with Surface Water**

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems at his own cost to drain surface water from working areas.

3.05.09 **Dewatering**

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rain water & subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. (except where such de-watering would need installation of well points or deep wells for which separate payment will be made) Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

If necessary, the Engineer may direct the Contractor to continue dewatering beyond his original or extended contract period in which case he will be paid separately for dewatering as per terms mentioned elsewhere under payment & measurement, provided the Contractor has completed all the work satisfactorily.

3.05.10 **Timber Shoring**

Timber Shoring made out of approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Engineer. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.05.10.1 **Close Timbering**

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 250x40 mm sections as directed by the Engineer. The boards shall generally be placed in position vertically in pairs, one board on each side of cutting, and shall be kept apart by horizontal

walers of strong wood at maximum 1.2 metres spacings, cross strutted with bellies or as directed by the Engineer. The length of the bally struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and preceded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.05.10.2 **Open Timbering**

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Engineer. In all other respects, specification for close timbering shall apply to open timbering.

3.06.00 **Treatment of Slips**

The Contractor will take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and back-filled later by him at his own expenses.

3.07.00 **Back-filling**

3.07.01 **General**

The material used for backfilling shall consist of material, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, the Engineer may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete.

3.07.02 **Filling and Compaction in Pits and Trenches around Structures**

As soon as the work in foundations has been accepted and measured, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to achieve a dry density of not less that 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) where backfilling with cohesive soil and sandy silt containing high percentage of Silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS-2720 part XIV. Earth shall be rammed with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and leveled to proper profile as shown in the drawing and as desired by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimise the moisture content.

3.07.03 **Plinth Filling**

The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted as stated under clause no. 3.7.2 with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.07.04 **Filling in Trenches for Water Pipes and Drains**

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. The types of bedding & pipe surround material shall be as specified in the drawings.

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of excavation of trenches in rock, the filling upto a depth of 300 mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel

shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and compacted.

3.07.05 **Filling in Disposal Area**

Surplus material from excavation which is not required for backfilling will be disposed of in designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas rollers will be employed and compaction done to the satisfaction of the Engineer at the optimum moisture content which shall be checked and controlled by the Contractor.

In certain cases the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

3.08.00 **Approaches and Fencing**

The Contractor should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.09.00 **Lighting**

Full scale area lighting is to be provided if night work is permitted or directed by the Engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.00.00 **TESTING AND ACCEPTANCE CRITERIA**

4.01.00 **Excavation**

On completion of excavation, the dimensions of the pits will be checked as per the drawings after the pits are completely dewatered the work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of 1:4:8 proportion and/or richer and/or by compacted earth, as directed by the Engineer, at the Contractor's cost. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer. Over excavation of the sides will be made good free of cost by the Contractor while carrying out the back-filling. The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.00 **Back-filling**

The degree of compaction shall be sufficient to achieve a dry density of not less than 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part-vii) or a relative density of 75% as per IS-2720 (Part-xiv) as applicable depending on the nature of back filling material as stated in clause no. 3.7.2 of this specification. The work of back-filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted along with the tender.

5.02.00 **After Award**

After award of the Contract the successful tenderer shall submit the following for approval and adoption :

a) Within 30 days of Award of the Contract, the Contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures. In case the Earthwork Contractor is also the agency for the foundation work, the Earthwork programme is to be connected with the foundation programme. The programme should also show how the excavation and back-filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Engineer for adoption.

TECHNICAL SPECIFICATION
FOR
V) CEMENT CONCRETE – PLAIN AND REINFORCED

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V) CEMENT CONCRETE - PLAIN AND REINFORCED

1.00.00 **SCOPE**

1.01.00 **General**

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

1.02.00 This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in SCOPE of IS:456.

1.03.00 IS:456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate IS Code, specifications and/or replacement by any International Code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference.

2.00.00 **GENERAL**

2.01.00 **Work to be provided for by the Contractor**

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following :

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Except where it is excluded from the Scope of Contract, Contractor shall prepare progressively and submit for approval detailed drawings and Bar Bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval.

d) Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Submit for approval detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

f) Submit for approval detailed schemes of all operations required for executing the work, e.g. Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and submit for approval concrete mix designs required to be adopted on the job.

h) Furnish samples and submit for approval results of tests of various properties of the following :

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

I) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings, specifications and Schedule of Items.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 **Work by Others**

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 **Information to be submitted by the Tenderer**

2.03.01 **With Tender**

The following technical information are required with the tender :

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms, if any, with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 **After Award**

The following information and data including samples where necessary, shall be submitted by the Contractor progressively during the execution of the contract.

a) Programme of Execution and Requirement of Materials

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work giving monthwise requirements of materials, particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms and conditions of the Contract. In case the Contractor proposes to take on hire any machineries or tools and plants from the Owner, the detailed phased out programme of such hire is also to be submitted.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Approval of such programme shall bind the Contractor to adherence and assurance of their duties and responsibilities according to agreed schedule.

Detailed day to day programme of every month is to be submitted by the Contractor before the end of the previous month.

Contractor shall furnish daily/weekly progress of work and details as may be required by Owner so as to enable him to monitor the progress of work. The Contractor shall submit the progress photograph in three (3) copies every month relating to the progress of work in sequence for major activities.

b) Samples

Samples of the following materials and any other materials proposed to be used, shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities :

i) Coarse and fine aggregates.
ii) Admixtures.
iii) Plywood for Formwork.
iv) Embedded and anchorage materials as may be desired by the Engineer.
v) Joint sealing strips and other waterproofing materials.
vi) Joint filling compounds.
vii) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per Clauses 2.1 (g) & 3.4 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works. Before submission to the Engineer, the design mix needs to be approved from recognized institution.

d) Detail Drawings and Bar Bending Schedules

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.01(b) and 3.16.1 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01 (c).

f) Detailed Drawings for Templates & Temporary Supports for Embedments

As per Clause 2.01 (e).

g) Mill Test Reports for Cement & Reinforcing Steel

Mill Test Reports for Cement and Reinforcing Steel in case these materials are supplied by the Contractor.

h) Inspection Reports

Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Engineer in accordance with Clause 2.04 of this specification.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0 : SAMPLING & TESTING of this specification.

j) Any other data which may be required as per this specification.

2.04.00 **Conformity with Design**

The Contractor will prepare check lists in approved proforma which will be called 'Pour Cards'. These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the Engineer will give written permission on the same 'Pour Card' allowing the Contractor to commence placement of concrete. Details of

all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', will be prepared by the Contractor on approved proforma. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 **Materials to be used**

2.05.01 **General Requirement**

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

2.05.02 **Cement**

Generally cement shall be 43 grade / 53 grade ordinary Portland Cement conforming to IS-8112 / IS 12269. In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Engineer :

a) 33 Grade ordinary Portland Cement conforming to IS-269

b) Rapid hardening Portland Cement conforming to IS-8041

c) Portland slag cement conforming to IS-455

d) Portland Pozzolona Cement (fly ash based) Conforming to IS-1489 (Part-1)

e) Portland pozzolona Cement (calcined clay based) conforming to IS-1489 (Part-2)

f) Hydrophobic Cement conforming to IS-8043

g) Low heat Portland Cement conforming to IS : 12600

h) Sulphate Resisting Portland Cement conforming to IS-12330

2.05.03 **Aggregates**

Aggregates shall be natural or crushed gravel or crushed rock and free from deleterious material. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Engineer.

a) Coarse Aggregate

Aggregate of sizes ranging between 4.75mm & 150mm will be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS:383 will be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary.

The grading of coarse aggregates by sieve analysis shall be as per IS:383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Engineer may ask the contractor to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

b) Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS:383 is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used on works.

In certain cases there may be two types of sand, one very fine and the other very coarse. In such cases, the two types shall be combined to meet the requirements of a particular zone of IS:383. In all cases, the preferred zone is Zone-II.

In certain cases crushed stone sand may be added to natural sand in order to achieve the required grading.

Crushed stone sand alone may be used only with the approval of the Engineer.

2.05.04 **Water**

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS:3550 will be followed for routine tests. Acceptance test for water shall be as per IS:3025, and Table-I of IS:456.

In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time tests as per method of tests in accordance with the requirements of IS-516 & IS-4031 respectively. The PH value of water shall generally be not less than 6.

2.05.05 **Admixture**

Only admixture of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards :

IS : 2645 - Integral cement water proofing compound

IS : 9103 - Indian standard specification for Admixtures for Concrete

or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075, Part 1 to 3) and may be one of the following :

a) Accelerating admixtures :

Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10" or approved equivalent.

b) Retarding admixtures :

Modified ligno sulphonate based set retarding concrete admixture like, "Plastiment R" or approved equivalent.

c) Water reducing admixtures :

Modified sulphonated melamine formaldehyde based water reducing concrete admixture like, "Sikament" or approved equivalent.

d) Air entraining admixtures :

Modified ligno sulphonate based air entraining concrete admixture like "FLOMO AEP" or surface - active agents like "Sika AER" or approved equivalent.

e) Water proofing admixtures :

Modified lingo-sulphonate based waterproofing admixture like "Plastocrete Super" or approved equivalent.

However, the Contractor shall furnish following technical information about the admixtures (alongwith the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Engineer :

i) Type of admixture

ii) Mix proportion & mode of application in concrete/mortar

iii) Manufacturer's specification & necessary quality assurance certificates (mainly on chloride & sulphate content, PH value, infra red analysis & solid content).

2.05.06 **Reinforcement**

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stackwise) of all materials. Storage of materials shall conform to IS:4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated ware-houses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

Different types of cement shall be clearly marked with the type & different types of cement shall not be intermixed.

2.06.03 Aggregates

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

Grading of aggregate shall be checked by the Engineer in conformity with respective IS Code and the design requirement and if the same is found not meeting the above requirement the material will be replaced by the Contractor at his own cost.

2.06.04 **Reinforcement**

Reinforcing steel shall be stored consignment-wise and sizewise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease and distortions. If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 **Quality Control**

The Contractor shall submit the Quality Assurance Plan (QAP) for total work to the Owner/Engineer for approval and follow the approved plan during work execution. Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work :

a)	Admixture	:	Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits
b)	Aggregate	:	Physical, chemical & mineralogical qualities, Grading, moisture content and impurities.
c)	Water	:	Impurities tests.
d)	Cement	:	Tests to satisfy relevant IS Specifications (only association with Owner's tests, if the supply is made by Owner).
e)	Formwork	:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f)	Reinforcement	:	Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices. Material tests or certificates to satisfy relevant IS Spec. (If Contractor's supply).
g)	Grades of concrete	:	Usage & mix design, testing of all properties.
h)	Batching & Mixing	:	Types and capacity of plant, concrete mixers and transportation equipment.

i)	Joints	:	Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.
j)	Embedded and Anchorage Items	:	Material, shape, location, setting.
k)	Placing	:	Preparation, rate of pouring, the limitations, time intervals between mixing & placing and between two successive lifts, covering over dry or wet surfaces, cleaning & preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
l)	Compaction	:	Number of vibrators, their prime mover, frequency & amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
m)	Setting of base & Beaming plates	:	Lines, elevations and bedding mortar.
n)	Concrete Finishes	:	Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
o)	Curing	:	Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirts or other deleterious materials.

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.

However, all washing & screening of aggregates shall be carried out by approved means to ensure compliance with the aggregate specification.

3.02.00 **Admixture**

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures may be permitted to be used in accordance with IS:456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 **Grades of Concrete**

Concrete shall be in any of the grades designated in IS:456. Grade of concrete to be used in different parts of work shall be as shown on the drawing or as per the Engineer's instructions. In case of liquid retaining structures, IS:3370 will be followed.

3.04.00 **Proportioning and Works Control**

3.04.01 **General**

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Engineer.

a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.

b) Without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS:456, may be used if shown on drawings or approved by the Engineer. In all cases the proportioning of ingredients and works control shall be in accordance with IS:456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 **Mix Design Criteria**

Concrete mixes will be designed by the Contractor to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations :

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) Chemical admixtures may be used to modify the rate of hardening, to improve workability (maintaining low water - cement ratio) or as an aid to control concrete quality.

e) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Engineer. The Contractor will strictly abide by the same in his design of concrete mix installation.

Notwithstanding anything mentioned in various tables given in IS:456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, the following tables in the specification are included. For identical condition if values given in the tables shown herein below are different from those mentioned in IS:456, the values as indicated in the table shown herein below shall prevail.

Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

TABLE-I

STRENGTH REQUIREMENT OF CONCRETE

	Specified Characteristic Compressive Grade of concrete strength of 15 cm Cubes at 28 days conducted in accordance with IS:516 (All values in N/Sq.mm)
M-10	10
M-15	15
M-20	20
M-25	25
M-30	30
M-35	35
M-40	40

Note-1 : Nominal mix concrete of proportions 1:4:8 or 1:3:6 may be used as lean concrete for simple foundations for masonry walls, below the reinforced concrete foundations and mass filling. These mixes need not be designed.

Note-2 : Grades of concrete lower than M-20 shall not be used in reinforced concrete.

TABLE-II

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO

(FOR GUIDANCE)
CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/ CEMENT RATIO	RATIO BY WEIGHT OF CEMENT TO GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT TO CRUSHED STONE AGGREGATE	
		20 mm size	**38 mm size**	**20 mm size**	**38 mm size**
Very low Slump 0-25 mm	0.4	1:4.8	1:5.3	1:4.5	1:5.0
	0.5	1:7.2	1:7.7	1:6.5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low Slump 25-50 mm	0.4	1:3.9	1:4.5	1:3.5	1:4.0
	0.5	1:5.5	1:6.7	1:5.0	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7.0
	0.7	1:8.0	1:8.5	1:7.4	1:8.0
Medium Slump 50-100 mm	0.4	1:3.5	1:3.8	1:3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5.0
	0.6	1:6.0	1:7.3	1:5.2	1:6.2
High Slump 100-175 mm	0.4	1:3.2	1:3.5	1:2.9	1:3.3
	0.5	1:4.4	1:5.2	1:3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

NOTE-1 : Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

NOTE-2 : It should be noted that such high aggregate cement ratios will be required or concretes of very low slump and high water-cement ratios which may be required to be used in mass concrete work only.

NOTE-3 : The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.05.00 **Strength Requirements**

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland slag cement is used, shall be as per Table-2 of IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 **Minimum Cement Content**

The minimum cement content for each grade of concrete shall be as per strength and durability requirement conforming to IS 456 : 2000 and design mix criteria.

3.07.00 **Water-Cement Ratio**

The choice of water-cement ratio in designing a concrete mix will depend on

a) The requirement of strength.

b) The requirement of durability.

3.07.01 **Strength Requirement**

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give acceptable test results as per IS:456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS:456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS:456.

3.07.02 **Durability Requirement**

Tables 3,4 & 5 of IS:456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

However, water-cement ratio, from the point of view of durability as well as from strength consideration, should meet the requirement given in Table No. IV.

In general the water cement ratio between 0.4 & 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer.

However the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It will be preferable to use Melamine based plasticizer.

TABLE-IV

MAXIMUM PERMISSIBLE WATER/CEMENT RATIOS FROM DURABILITY CONSIDERATIONS FOR DIFFERENT TYPES OF STRUCTURES AND DEGREES OF EXPOSURE USING ORDINARY PORTLAND CEMENT

	Exposure Conditions			
Type of Structure	Severe wide range of temperature. Frequent alterations of freezing & thawing (use Airor arid Entrained concrete only)		Mild Temperature rarely below freezing or rainy	
	At the water line or within the range of fluctuating water level or spray		At the water line or within the range of fluctuating water level or spray.	
	In Air		**In Air**	
	In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)	In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)
Thin sections such as railings kerbs, sills ledges, ornamental or Architectural concrete reinforced concrete piles, pipes and all sections with less than 25mm concrete cover to reinforcement.	0.49 0.44	0.40	0.53 0.49	0.40
Moderate sections such as Retaining Walls, abutments, piers, girders, beams	0.53 0.49	0.40	* 0.53	0.44
Exterior portions of heavy mass sections.	0.58 0.49	0.44	* 0.53	0.44
Concrete deposited by Tremie under water	- 0.44	0.44	- 0.44	0.44

	Exposure Conditions			
	Severe wide range of temperature. Frequent alterations of freezing & thawing (use Airor arid Entrained concrete only)		Mild Temperature rarely below freezing or rainy	
Type of Structure	At the water line or within the range of fluctuating water level or spray		At the water line or within the range of fluctuating water level or spray.	
	In Air		**In Air**	
	In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)	In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)
Concrete slabs laid on ground	0.53 -	-	* -	-
Concrete which will later be protected by enclosure or backfill but which may be exposed to freezing & thawing for several years before such protection is offered.	0.53 -	-	*	
Concrete protected from the water, interiors of buildings, concrete below ground which is free from sulphate attacks.	*		*	

Note: * Water/Cement ratios should be selected on basis of strength & workability requirements.

3.08.00 **Workability**

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below :

TABLE-V

LIMITS OF CONSISTENCY

Degree of Workability	Slump in mm with Standard Cone as per IS:1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads and like
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion or reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note : Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS:1199 and Clause 7 of IS 456:2000 shall be carried out.

3.09.00 **Size of Coarse Aggregates**

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer :

Very narrow space	-	12 mm
Reinforced concrete except foundation	-	20/12 mm
Ordinary Plain concrete and Reinforced concrete foundations	-	40/20 mm
Mass concrete	-	80/40 mm
Mass concrete in very large structure	-	150/80 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles :

150 mm to 80 mm, 80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10.00 **Mixing of Concrete**

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Engineer for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS:4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS:1791 will be allowed to be employed.

Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Batchers conforming to IS:2722 may be used.

Batching plant conforming to IS:4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within ± 2% of the quantity of Cement, water or total aggregates being measured and within ± 5% of the quantity of any admixture being used. The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical/electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Engineer. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Engineer, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the Owner.

3.11.00 **Conveying Concrete**

Concrete shall be handled and conveyed from the place of mixing to the place of laying with required consistency and plasticity without loss of slump and as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, inspite of all precautions, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 **Placing and Compacting Concrete**

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces :

a) Earth foundation

b) Rock foundation

c) Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. All excavated areas for foundations, ring beams, plinths, pile caps etc. shall be rammed & consolidated properly before blinding with nominal mix plain concrete, as per drawing and / or direction of the Engineer and shall be allowed to cure prior to setting out steel fixing, shuttering and concrete pouring for the main structural element.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry will be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar will be deemed to be included in the unit rate of concrete.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS:4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS:2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The size of the concrete pours must be carefully considered prior to commencement to ensure the structural elements are poured in on continuous shift to avoid cold joints.

Slabs, beams and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Moulding, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation therefrom shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods & equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction. Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12. For water retaining structures and leak-proof buildings suitable approved water bars will be installed at the construction joints.

Where the location of the joints are not specified, it will be in accordance with the following :

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span.

c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it :

a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, the joint will be left to harden for at least 12-24 hrs. It will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under Cl. 3.12.

3.14.00 **Repairs, Finishes and Treatment of Concrete surfaces**

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner. All concrete work shall be inspected by the Contractor immediately after the forms are removed and he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations :

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth and shape.

c) Cleaning of reinforcement and embedments. It may be necessary to provide an anti-corrosive coating on the enforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out defective concrete.

i) Grouting with a cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortar.

k) Polymer modified patching and adhesive repair mortar for beams & columns.

3.14.02 **Finishing Unformed Surface**

The Contractor is to include in his quoted rate for concrete, the provision of normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc., as and where required by the Engineer without any extra cost to the Owner. A few typical and common cases of treatment of concrete surface are cited below :

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No overtrowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked without any extra cost to the Owner to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling by hand or by rotary power float is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the

approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 **Protection and Curing of Concrete**

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet , hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor.

If permitted by the Engineer, curing compound like "ANTISOLE (WP)" or approved equivalent may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost to the owner.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case any lapse on the part of the Contractor is noticed by the Engineer, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or pay for the part where adequate curing was noticed at a reduced rate, entirely at the discretion of the Engineer.

3.16.00 **Reinforcement**

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc., will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS:9077 , as shown on the drawing or as directed by the Engineer.

3.16.01 **Bar Bending Schedules**

The Contractor shall submit to the Engineer for approval Bar Bending Schedules with working drawings in triplicate, showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Contractor shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

3.16.02 **Cleaning**

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 **Cutting & Bending of Reinforcement**

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS:2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845 Deg.C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Engineer at exceptional cases.

3.16.04 **Placing in Position**

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire. Tack welding of bars should not be done unless permitted by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 **Welding**

Normal bond laps in reinforcement may be placed by lap or butt welding reinforcement bars, if asked by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS:2751 and IS:456. Welded mesh fabrics conforming to IS:1566 may also be used if specified in the Schedule of Items and Drawings.

3.16.06 **Control**

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS:456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 **Cold Weather Concreting**

When conditions are such that any operation of concreting may be expected to be done at 5 Deg.C atmospheric temperature or below the work shall conform to the requirement of Clause 14 of IS:456 and IS:7861. (Part. II).

3.18.00 **Hot Weather Concreting**

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS:7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40 Deg.C while placing. Positive temperature control by pre-cooling, post-cooling or any other method, if required, will be specified and paid for separately.

3.19.00 **Concreting under Water**

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14 of IS:456.

3.20.00 **Form Work**

3.20.01 **General**

Formwork shall conform to the shape, grade, lines, levels and dimension as shown on the drawings. The contractor shall prepare design & working drawings for formwork & temporary support system for important structures and get them approved by the Engineer prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load, in case the Contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits will be filled with expanding mortar to seal the void. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified free of charge as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, beveled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges without any extra charge. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 **Cleaning and Treatment of Forms**

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil based shutter release agent like "Separol/Sika form oil/ Separol Concentrate" or approved equivalent before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 **Design**

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

The design of formwork shall take into account all vertical and lateral loads that the forms will carry or be subjected to during the construction process. Besides weight and pressures of reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete; impact from dumping of concrete; movement of men and construction equipment; wind action and any other imposed load during construction. The contractor shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pourer of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sq.m excluding weight of concrete.

30.20.04 **Inspection of Forms**

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 **Removal of Forms**

Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if he so desires.

The Contractor shall record on the drawing or in any other approved Banner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed therefrom and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner. The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

Forms for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Engineer in each case.

TABLE-VI

SCHEDULE OF REMOVAL OF FORM

Part of Structure	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement Concrete			
	Temperature Deg.C				Temperature Deg.C			
	Above 40 Deg.	40 Deg.- 20 Deg.	20 Deg.-Below 5 Deg.		Above 40 Deg.	40 Deg.- 20 Deg.	20 Deg.- Below 5 Deg.	
	Days	Days	Days	Days	Days	Days	Days	Days
a) Columns & Walls	2	1	1	Do not remove	1	1	1	Do not remove
b) Beam sides	3	2	3	forms until site cured	2	1	1	forms until
c) Slabs, 125 mm	10	7	8	test speci-	7	4	5	site
d) Slabs over 125mm thick and sof-				men develop at least 50% of the speci-				cured test specimen develop
fit of minor beams	18	14	16	fied 28 days strength	12	8	9	at least 50% of the speci-
e) Soffit of main beams	24	21	22		14	10	12	fied 28 days strength

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40 Deg.C can be reduced to those of the temperature range of 20 Deg.C to 40 Deg.C subject to approval of the Engineer.

Construction joints in beams, if required to be provided, will be located within the middle third of span according to clause 3.13.1(b) of this specification. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Engineer.

If any type of cement other than ordinary Portland cement and Rapid hardening Portland cement is used the time of removal or forms shall be revised as approved by the Engineer such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form as mentioned above. This has to be supported by regular tests.

3.20.06 **Tolerance**

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Engineer :

For :	a)	Sectional dimension	-	$\pm$ 5 mm
	b)	Plumb	-	1 in 1000 of height
	c)	Levels	-	$\pm$ 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 **Re-use of Forms**

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified herein before. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 **Classification**

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Engineer :

a) Ordinary

These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) Plywood

These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-se may only be permitted after special inspection and approval by the Engineer. He may also permit utilisation of used plywood for the 'ordinary' class, if it is still in good condition.

c) Ornamental

These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 **Opening, Chases, Grooves, Rebates, Blockouts etc.**

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 **Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and Other misc. Embedded Fixtures**

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to be painted with one coat of approved anti-corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer, free of cost to the Owner.

Items to be embedded

a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be left embedded for future extension, special connection etc.

d) Lugs or plugs for door and window frames occurring in concrete work.

e) Flashing and jointing in concrete work.

f) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibre board of approved manufacturer as per IS:1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint Sealing Strips

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

Non-metallic sealing strips will be normally in Rubber or PVC Rubber or PVC joint seals can be of shape having any combination of the following features :

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer :

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75 Deg.C
Ultimate Elongation	:	Not less than 350%

b) P.V.C. Sealing Strips

The minimum thickness of P.V.C sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly :

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to 80A
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 **Joint Sealing Compound**

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS:1834.

Alternatively, when directed, the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

3.23.05 **Isolation Joints**

Strong and tough alkathene or PVC sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 **Rubber Pad**

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 **Grouting under Machinery or Structural Steel Bases**

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stonechips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If desired by the Engineer, admixtures like Aluminium powder, 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Engineer. Admixture, if directed to be added, will be measured and paid separately.

Alternatively non-shink, free flow, cementitious grout like "Sikagrout 214 / Ankor NSG" or approved equivalent specifically selected for the type of equipment to be located (vibrating, static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Engineer.

3.25.00 **Precast Concrete**

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly leveled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting & curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapour or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

All members shall be indelibly marked with a unique identification mark on a surface which will not be permanently exposed to show on which production line they were manufactured, their type, the class of concrete, the data of casting and if they are of a symmetrical section the face which will be uppermost when the member is in its correct position after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Engineer. If centerings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement : sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Waterproofing of concrete structures shall be done by either suitable extraneous treatments like applying waterproofing paints like "Sikatop Seal" or approved equivalent, fixing bitumen felts etc. or internally by suitable design of the concrete mix, addition of suitable admixtures conforming to IS:2645 and equivalent American or British codes in the concrete or mortar at the time of mixing and/or installing water bars at the joints.

The design, material and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be rubber or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint should be provided as per clause 3.13.1 with or without water bar / Seal as shown on the drawing. In case of water bars being used at the construction Joint, fixing of the same has to be done carefully so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods :

Method 1 : A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent will be mixed with water which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days :

Compressive strength	-	55 to 60 N/Sq. mm
Flexural Strength	-	25 to 30 N/Sq. mm.
Tensile strength	-	15 N/Sq. mm (approx.)
Bonding strength to concrete	-	3 N/Sq. mm (approx.)
Bonding strength to steel	-	20 N/Sq. mm (approx.)

The whole operation shall be done as per manufacturer's specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

Method 2 : One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 Kg/Sq cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%.

The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement but a lower dosage will always be preferred.

The product shall be stored in strong moisture proof packings.

However, in case of important structures where M25 or higher grade concrete is specified, a melamine based super plasiticizer will be preferable.

a) In concrete : The admixture shall be procured from reliable and reputed manufacturers and approved by the engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to the Owner to supervise the work, if desired by the Engineer.

b) In Plaster : The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost to the Owner. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Bituminous or Tar Coating on External Surface

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS:216 (not heated above 375 Deg.F) using not less than 2 Kg. per Sq.M or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400 Deg.F) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Engineer, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely. In place of hot application by coal tar / asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous emulsion/rubber protective coating of approved manufacturer.

3.26.05 Protective Coating on Inside Surface

Two coats or cement based to components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt : Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS:1322, and the workmanship to IS:1609. The bitumen felt shall be Hessian base and/or fibre base as specified in Drawing/Schedule of Items. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well known specialised firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. shall be included in the rate for this item. If any protective brickwork on/against concrete sub-bases or walls are required, these will be paid extra under suitable items in the contract. A 20 (twenty) years' guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this item of work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 **Polyethylene Films : Application in Walls or base of Structures**

Waterproof treatment shall be applied as outlined and as per sequence given hereunder :

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.

ii) apply hot bitumen 80/100 grade (IS:73-1961) at the rate of 1.0 Kg/Sq.m minimum.

iii) lay black polyethylene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.

v) Lay hot bitumen 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250 micron polyethylene film as second layer similar to (iii) above.

vii) Lay second layer of 100 gm brown craft paper laminated similar to (iv) above.

viii) Apply hot bitumen (straight run grade) to IS:73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

ix) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 **Protective coating on Concrete Surface**

3.27.01 **On Foundation**

The outside faces of foundation of important structures will be protected from adverse effect of soil/ underground water, if shown on drawing or instructed by the Engineer, by using rubber/bitumen emulsion protective coating of approved manufacturer.

3.28.00 **Waterproofing by Pressure / Chemical Grouting**

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non-shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. The pressure during injection shall not be less than 2.5 kg/Sq.cum and the thickness of epoxy resinous emulsion waterproof paint (to be applied on the external surface of walls/slabs) shall not be less than 700 microns.

4.00.00 **SAMPLING AND TESTING**

4.01.00 **General**

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 **Cement**

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Engineer. The tests shall be carried out free of charge by the Owner if cement is supplied by him. In case the Contractor is directed to arrange for the supply of cement as per the terms and conditions of the Contract the tests shall be carried out by him without any expense to the owner. In case due to any circumstances, the

agency of supply is changed in the middle of the Contract, the party who bore the original contractual obligation will carry on with the test, free of charge to the other, till the end of the job. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Owner, Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the Owner or the Contractor. These tests are of great importance as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 **Aggregates**

The Contractor shall carry out any or all the tests aggregates as may be required by the Engineer in accordance with IS:2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 **Water**

Sampling and Testing of water being used for concrete works as per IS:3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt will be as per IS:3025 & IS:456.

4.05.00 **Admixture**

4.05.01 **Air Entraining Agents (A.E.A)**

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor free of charge by carrying out sufficiently large number of tests. After than, at regular intervals and whenever directed by the Engineer, the Contractor will check up free of charge, the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 **Other Admixtures**

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Contractor free of charge to the Owner.

4.06.00 **Concrete**

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS:516 and IS:1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS:516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 15 of IS:456.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS:1199 and as mentioned in Clause 3.6 of this Specification shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 16 of IS:456.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to Clause 9.2.4 of IS:456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to Clause 16 of IS:456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 17 of IS:456.

5.04.00 Load Test

Load tests of structural members may be required by the Engineer, when the strength of test specimen results fall below the required strength, as per 'Load Test on Parts of Structures', Clause 17.6 of IS:456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Contractor free of cost to the Owner. Alternatively, if permitted under Statutory Regulations and at the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS:456.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 LIST OF IS : CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed :

IS : 73 - Indian Standard Specification for Paving Bitumen.

IS : 216 - Indian Standard Specification for Coal Tar Pitch.

IS : 269 - Indian Standard Specification for 33 grade Ordinary Portland Cement.

IS : 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.

IS : 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement - Part-1 & 2.

IS : 455 - Indian Standard Specification for Portland Slag Cement

IS : 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.

IS : 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures.

IS : 516 - Indian Standard Specification for Methods of Test for Strength of Concrete.

IS : 737 - Indian standard specification for wrought Aluminium and Aluminium Alloy sheet and strip for general Engineering purpose.

IS : 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete

IS : 1200 - Indian Standard Specification for Method of (Part-II) Measurement Cement Concrete Works.

IS : 1200 - Indian Standard Specification for Method of (Part-V) Measurement of Formwork.

IS : 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing.

IS : 1489 - Indian Standard Specification for Portland - Pozzolona Cement - Part 1 & 2.

IS : 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.

IS : 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts.

IS : 1786 - Indian Standard Specification for high strength deformed Bars & wires for Concrete Reinforcement.

IS : 1791 - Indian Standard Specification for Batch Type Concrete Mixers.

IS :1834 - Indian standard specification for hot applied sealing compound for joint in concrete.

IS : 2062 - Steel for general structural purpose.

IS : 2185 - Indian Standard Specification for Hollow and solid/ solid light wt. Cement Concrete Blocks - Part-1 & 2.

IS : 2210 - Indian Standard Specification for Design of Reinforced Concrete Shell Structures and Folded Plates.

IS : 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII.

IS : 2430 - Indian standard specification for method of sampling of Aggregate for concrete.

IS : 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement.

IS : 2505 - Indian Standard Specification for Concrete Vibrators Immersion Type.

IS : 2506 - Indian Standard Specification for Screed Board Concrete Vibrators.

IS : 2514	-	Indian Standard Specification for Concrete Vibrating tables.
IS : 2645	-	Integral Cement water proofing compound.
IS : 2722	-	Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type).
IS :2751	-	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.
IS : 2770	-	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete. Part-1 : Pull out Test.
IS : 3025	-	Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water & Waste Water - part-1 to 37.
IS : 3201	-	Indian Standard Specification for Design and Construction of Precast Concrete Trusses and purlins.
IS : 3370	-	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4.
IS : 3384	-	Indian standard specification for / Bitumen primer for use in waterproofing and Damp proofing.
IS : 3414	-	Code of practice for Design and Installation of joints in Buildings.
IS : 3550	-	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry.
IS : 3558	-	Code of Practice for use of Immersion Vibrators for Consolidating Concrete.
IS : 3696	-	Safety Code for Part-1 : Scaffolding and Part 2: Ladders.
IS : 3812	-	Indian Standard Specification for Fly Ash for Use as Pozzolone & Admixture.
IS : 4031	-	Indian Standard Specification for Method of Tests for Hydraulic Cement - Part-1 to 14.
IS : 4082	-	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site.
IS : 4090	-	Indian Standard Specification for Design of Reinforced Concrete Arches.
IS : 4634	-	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers.

IS : 4656	-	Indian Standard Specification for Form Vibrators for Concrete.
IS : 4925	-	Indian Standard Specification for Concrete Batching and Mixing Plant.
IS : 4926	-	Indian Standard Specification for Ready Mixed Concrete.
IS : 4990	-	Indian Standard Specification for Plywood for Concrete Shuttering work.
IS : 4991	-	Indian Standard Specification for Blast Resistant Design of Structure for Explosion above ground.
IS : 4995 (Part-I&II)	-	Indian Standard Specification for Design of Reinforced Concrete Bins for the Storage of Granular and Powdery Materials.
IS : 4998 (Part-I)	-	Indian Standard Specification for Design of Reinforced Concrete Chimneys.
IS : 5512	-	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials.
IS : 5513	-	Indian Standard Specification for Vicat Apparatus.
IS : 5515	-	Indian Standard Specification for Compaction Factor Apparatus.
IS : 5751	-	Indian Standard Specification for Precast Concrete Coping Blocks.
IS : 5816	-	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders.
IS : 5891	-	Indian Standard Specification for Hand Operated Concrete Mixers.
IS : 6452	-	Indian Standard Specification for High Alumina Cement for Structural Use.
IS : 6909	-	Indian Standard Specification for Supersulphated Cement.
IS : 6923	-	Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators.
IS : 6925	-	Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.
IS : 7242	-	Indian Standard Specification for Concrete Spreaders.

IS : 7246	-	Indian Standard Specification for Table Vibrators for Consolidating Concrete.
IS : 7251	-	Indian Standard Specification for Concrete Finishers.
IS : 7320	-	Indian Standard Specification for Concrete Slump Test Apparatus.
IS : 7861 (Part-I&II)	-	Indian Standard Specification for Recommended Practice for hot and cold Weather Concreting.
IS : 7969	-	Safety Code for Storage and Handling of Building Materials.
IS : 8041	-	Indian Standard Specification for Rapid Hardening Portland cement.
IS : 8043	-	Indian standard specification for hydrophobic cement.
IS : 8112	-	Indian Standard Specification for 43 grade ordinary Portland Cement.
IS : 8142	-	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance.
IS : 8989	-	Safety Code for Erection of Concrete Framed Structures.
IS:9013	-	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens.
IS : 9077	-	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction.
IS : 9103	-	Indian Standard Specification for Admixtures for Concrete.
IS: 9417	-	Recommendation for welding cold worked bars for reinforced concrete construction.
IS : 10262	-	Recommended Guideline for concrete Mix Design.
IS : 12269	-	Indian standard specification for 53 grade ordinary portland cement.
IS : 12330	-	Indian standard specification for sulphate resting portland cement.
IS : 12600	-	Indian standard specification for low heat portland cement.

TECHNICAL SPECIFICATION
FOR
VI) DRIVEN PRECAST CONCRETE PILES

CONTENTS

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VI) DRIVEN PRECAST CONCRETE PILE

1.00.00 SCOPE

This Specification deals with the requirements regarding materials, workmanship, casting, curing, handling, transportation and driving of precast concrete piles (both vertical and raker) and all related items of work like surveying, layout of piles, sand filling in holes (considering driving of precast piles into the ground using follower) after driving of the piles, lengthening of the piles, redriving of the piles, jetting, and load testing of the piles, etc.

IS:2911 (Part I/Sec.3) shall form a part of this Specification and shall be complied with unless they are at variance with the Specification where the latter will prevail.

2.00.00 GENERAL

2.01.00 Work to be Provided by the Contractor

Work to be provided for by the Contractor, unless otherwise specified, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, forms, templates, supports, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Prepare and submit for approval detailed drawings and bar bending schedules for reinforcement bars showing the positions and details of spacers, supports, etc.

c) Submit for approval detailed scheme of all operations required for executing the work e.g. Material handling, casting, curing, handling, transporting, driving, testing, services, approaches, sand filling of holes etc.

d) Design and submit for approval concrete mix designs required to be adopted for the job.

e) Furnish samples and submit for approval results of tests for various properties e.g. various ingredients of concrete, concrete cubes etc.

f) Supply and install the pile shoes made of chilled cast iron of approved design.

g) Supply and paint Bitumen coating, if required, on the outer surfaces of the piles prior to their driving, as per schedule of items.

h) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings, specifications and schedule of items.

2.02.00 **Work to be Provided by Others**

No work under this specification shall be provided by any agency other than the Contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 **Codes and Standards**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practices.

IS-269	:	I.S. Specification for ordinary, and Low Heat Portland Cement.
IS-383	:	I.S. Specification for Coarse and Fine Aggregates from Natural Source for concrete.
IS-432	:	I.S. Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for Concrete Reinforcement.
IS-456	:	I.S. Code of Practice for Plain and Reinforced Concrete.
IS-516	:	I.S. Specification for Methods of Test for Strength of Concrete.
IS-1199	:	I.S. Specification for Methods of Sampling and Analysis of Concrete
IS-1786	:	I.S. Specification for Cold-twisted Steel Bars for Concrete reinforcement.
IS-2386	:	I.S. Specification for Methods of Test for Aggregates for Concrete - Part - I to VIII.
IS-2502	:	Codes of Practice for Bending and Fixing of Bars for concrete Reinforcement.
IS-2751	:	Code of practice for welding of mild steel bars used for Reinforced concrete construction.
IS-2911 (Part-I/ Sec.3)	:	Code of practice for Design and Construction of Pile Foundations. Driven Precast Concrete Piles.
IS:2911 (Part-IV)	:	Code of Practice for Design and Construction of Pile Foundations - Load Test of Piles.
IS:3558	:	Code of Practice for use of immersion Vibrators for Consolidating Concrete.

IS-6999	:	I.S. Specifications for super-sulphated cement.
IS-8112	:	I.S. Specification for high strength Ordinary Portland Cement.
IS : 12269	:	Indian standard specification for 53 grade ordinary portland cement

2.04.00 **Conformity with Design**

The Contractor will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the Engineer, the work will be checked and approved by the Engineer for Correctness and conformity with the design, Specifications and drawings, before allowing the next phase of the work to commence. The intermediate checks and approval by the Engineer will not, however, absolve the Contractor from his total responsibility to execute the work as per the specification and drawings and remove and/or rectify all work which is defective or inaccurate.

2.05.00 **Materials**

2.05.01 **Cement**

Cement used shall conform to IS:8112 or IS 12269.

2.05.02 **Aggregates**

Aggregates both fine and coarse shall comply with requirements of IS:383. Size of coarse aggregates shall be selected considering the size of section. Generally 20 mm down coarse aggregate shall be used.

2.05.33 **Steel**

Reinforcement Steel shall conform to IS:432 (Part-I) and IS:1786.

2.05.04 **Concrete**

Controlled concrete grade M25 (minimum) shall be used for the piles, unless specified otherwise in the schedule of items. Water/cement ratio including water contained in aggregates shall not be more than 0.45. However, minimum cement content and corresponding W/c ratio shall be determined by trial mix design and as approved by the Engineer. Materials and methods of manufacture of concrete shall be in accordance with IS:456. In addition, the materials shall have special resistance against sulphate attack where subsoil conditions warrant it.

2.05.05 **Water**

Clear water, free from acids and other impurities, shall be used for the manufacture of concrete. Normally potable water is found to be suitable.

2.06.00 **Storage of Materials**

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer shall not be used, failing which, the Engineer shall be at liberty to get the materials removed and the cost increased thereof shall be realised from the Contractor's dues.

2.07.00 **Quality Control**

The Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The requirements will include but not be limited to the following :

a) Casting of piles

b) Inspections of piles

c) Location and Plumb : Control survey for accuracy in plan and check for verticality.

d) Driving : Correlation of weight of hammer, length of stroke, number of strokes per minute and rate of penetrations.

e) Load tests.

3.00.00 **INSTALLATION**

All installation requirements shall be in accordance with IS:2911 (Part-I/ Sec. 3) latest edition and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all this aspects to the full satisfaction of the Engineer.

3.01.00 **General**

The tenderer shall furnish complete information about the type of piles offered, method of driving of piles, details and availabilities of driving equipment, formula or data curve on which the tenderer bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient `founding' of individual piles and any other relevant details.

The Contractor shall acquaint himself fully about the nature of the soil encountered from bore hole logs or any other data as available with the owner. All piles will have to be driven to the required set and/or based on load tests, as decided by the Engineer. In case the Contractor is required to drive piles to greater or shallower depths than that is envisaged the rates will be adjusted as per relevant items in Schedule of Items and no other extra claims

will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bore holes if he feels it necessary to assess the type of equipment to be used and the depths to which the piles may have to be driven finally.

3.02.00 **Casting and Curing**

Precast concrete piles shall be square with chamfered edges. (25mm x 25mm) and conical bottom. The top edges of all piles shall also be chamfered (25mm x 25mm).

Before placing in moulds, the steel skeletons shall be accurately fabricated and assembled away from the moulds, complete with metal shoe if specified, accurately fitted so that the point is truly on the axis of the pile.

Care shall be taken to ensure that the binders are perfectly tight and main reinforcements straight and true. Spacer fork of approved design are to be inserted throughout and spacing shall not be more than 1.5 m apart.

Longitudinal bars shall be in one length. In cases where laps in reinforcement bars cannot be avoided, the bars shall be staggered. Welded joints in reinforcement may be used with prior approval of the Engineer. Welding of reinforcements shall be done in accordance with the recommendations of relevant IS Code of practice. The cages shall be rigidly fixed straight and parallel to the moulds and held correctly as to maintain cover by spacer blocks. Care shall be taken to ensure correct and uniform cover throughout.

Formwork to be used for casting of the piles must be strong and level so that the outer faces of the piles are smooth and free from undulations. The prefabricated steel formwork with proper fasteners shall be used. Deformed and out of alignment formwork will be rejected.

The Casting Yard shall be so located that the piles can be lifted directly from their beds and transported to the piling frame with a minimum of handling. The casting yard should have a well drained surface to prevent excessive uneven settlement due to softening of soil during manufacturing and curing. The contractor shall submit layout drawing of the casting yard to the Engineer for approval prior to its construction.

Each pile shall be cast in continuous operation from end to end. The concrete shall be thoroughly compacted against the forms and around the reinforcement by means of immersion and/or shutter vibrators. Care shall be taken to ensure that the heads of the piles are formed plane and square to the axis. Particular attention must be paid to compaction at head and toe having regard to the more closely spaced reinforcement and the need for the densest possible concrete.

Immediately on completion of the casting the top surface shall be finished level without excess trowelling. Care shall be taken to ensure that vibration from adjacent work does not affect the previously placed concrete for piles during the setting period.

Side shutters shall be stripped off only after 24 hours of concreting. The piles shall be kept continuously wet for at least 7 days and protected from rapid drying by sheltering them from the wind and direct sunlight by covering the stacks.

3.03.00 **Storing and Handling**

Storage area shall be of firm ground free from liability to unequal subsidence or settlement under weight of the stack of piles. The piles shall be placed on timber supports which are truly level and spaced so as to avoid undue bending in the piles. The supports shall be vertically one above the other. Space shall be left round the piles to enable them to be lifted without difficulty. The order of stacking shall be such that the older piles can be withdrawn for driving without disturbing the new piles.

Great care shall be taken at all stages of transporting, lifting and handling of the piles that they are not damaged and cracked. Piles shall be lifted only by means of bolts or shackles inserted through the lifting holes provided and in no other way. Any pile damaged in handling shall be replaced free of charge by the Contractor.

All lifting and toggle holes shall be formed by casting in pieces of steel pipe for the full length of the concrete section. In places where lifting holes have not been provided in the piles, the points of lifting shall be clearly marked on the surface of the pile over at least half the perimeter. If the piles are put down temporarily after being lifted, they shall be placed on trestles or blocks located at lifting points. Lifting shall be by two points i.e. at 1/5th length of pile from either end so as to keep the handling stress minimum. Single point lifting is not permitted.

Piles must not be taken for driving before 28 days have passed after casting.

3.04.00 **Driving**

The proposed arrangement for driving, the equipment and accessories shall be to the approval of the Engineer.

The equipment and accessories are to be selected considering the hardness of driving, the capacity suitable for the size and weight of the pile to be handled. Piles may be driven with any type of hammer provided they penetrate to the prescribed depth or attain the specific resistance without being damaged. A hammer may be 'single acting' or 'double acting'. The hammer, dolly, helmet and the pile should be co-axial and sit squarely one upon the other. For a single acting or drop hammer, the fall should be limited to 1.2m, preferably 1m.

The head of precast concrete piles shall be protected with packing of resilient material, evenly spread and held securely in place. A helmet should be placed over the packing and provided with dolly of hardwood or equivalent not thicker than the width of pile.

Any sudden change in rate of penetration which cannot be explained due to normal change of nature of the ground should be noted and the cause ascertained before driving is continued.

Jetting may be used in case of sand, gravel and fine grained soils provided percentage of clay is small, after approval of the Engineer, as a means of minimizing the to resistance and skin resistance along the pile shaft. Jetting shall not be used in case of clay soils. The pressure of jetting should be from 6 Kg./Sq.cm. to 10 Kg./Sq.cm. Proper arrangement shall be made for taking away water that emerge at the ground so that the stability of the piling equipment is not endangered by softening of the ground. Special care should be taken to ensure that pile penetrates vertically.

Jetting shall be stopped prior to completing the driving which should always be made by ordinary methods. Jetting shall also be stopped if there is any tendency of the pile tip to be drawn towards the piles already driven owing to disturbance of the ground.

Piles should be installed as accurately as possible as per the drawings. As a guide, for vertical piles a deviation 1.5% and for raker piles a deviation of 4% shall not be exceeded. Piles shall not deviate more than 75 mm from their designed position. Spacing of the piles shall be as per the drawings.

In case of piles deviating beyond these limits, the piles shall be replaced or, supplemented by one or more piles as instructed by the Engineer at no extra cost to the owner.

In a group the sequence of installation shall be from the centre to the periphery of the group or from one side to the other, such that the carrying capacity of previously installed pile is not reduced. The driving shall not cause appreciable upheaval of the ground or cause unusual soil resistance to rest of the pile driving. It shall be ensured that soil is not flowing out literally during driving operation.

Set criteria shall be same as those used when the sets of test piles were obtained under identical driving conditions.

3.05.00 **Stripping of Pile Heads**

If specified in the schedule of items the concrete shall be stripped to the cut-off levels shown on the drawings. Reinforcements shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap. All concrete and cement shall be removed from the bars which shall also be wire brushed to remove any loose rust, dirt and scale. Any cracked or defective concrete shall be cut away and made good with new concrete properly bonded to the old concrete.

3.06.00 **Lengthening of Piles**

Length of individual piece of precast pile is generally restricted from handling point of view. Considering the required total length of pile and the length of individual piece as mentioned above, the contractor shall develop standard

splicing detail using studs, dowels, keys etc. at the spliced end of the piles and get it approved by the Engineer. The splice shall be as strong as the pile segments.

If due to unforeseen site conditions over and above the preplanned splicing mentioned above, further lengthening of pile is required during driving the longitudinal reinforcement shall be exposed by stripping of head and jointed properly either by welding or lapping as directed by the Engineer. The exposed surface of the concrete shall be hacked to form a key, brushed to remove loose material and covered with 25 mm thick cement mortar (1:2 mix) immediately before the new concrete is placed.

3.07.00 **Risen Piles**

In places where the piles may rise due to ground heaving, levels of the tops of the piles should be measured at interval while nearby piles are being installed. Piles which have risen as a result of driving adjacent piles should be redriven to the original depth as per the direction of the Engineer.

3.08.00 **Defective Piles**

Defective piles shall be removed or left in place without affecting performance of the adjacent piles as per direction of the Engineer. Additional piles shall be provided by the Contractor free of charge.

3.09.00 **Idle Period**

The phasing of construction and movement of plant shall be done as desired by the Engineer. The phasing may involve some extra movement of the plant or some idle period, but the Contractor will not be entitled for any claim due to this reason.

During the actual testing of the piles, the Contractor's plant and personnel may remain temporarily idle. Again, during the period of redesign, if any, (based on the pile test results), the plant personnel of the contractor may remain idle for any reason whatsoever.

For such idle periods mentioned above, the Contractor will not be entitled to any claim and rates quoted by him shall include the same. However, during the testing of piles and other hold ups, pile driving operation may be allowed on other piles wherever possible, if decided by the engineer with a view to minimise idle times.

If due to change in loading, elevations or any other alteration, some amendments become necessary in the design of foundations, the Contractor shall not be entitled to any claim whatsoever for such amendments in the pile layout during the progress of work including claims for any idle labour or tools and plant on this account.

3.10.00 **Test Pile**

The Contractor may have to construct test piles, if desired by the Engineer, before he starts systematic piling operation at locations indicated. For this

purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Load test on such piles shall be as per the provisions under "Procedure for Initial Load Test" in IS:2911.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

The Contractor shall carry out all sampling and testing for the components of reinforced concrete in accordance with the relevant Indian Standards at his own cost unless otherwise specified in the Contract. Whenever directed, the Contractor shall get the specimens tested in a laboratory approved by the engineer and submit to the Engineer the test results in triplicate within three (3) days of completion of the test.

Initial tests and/or routine tests as indicated in the Schedule of Items or as directed by the Engineer shall be carried out on single pile or pile groups to ascertain the capacities of the piles and their behaviour.

Any or all of the following tests shall be carried out as indicated in the Schedule of Items and as directed by the Engineer.

a) Vertical load test on pile (Compression)

b) Lateral load test on pile

c) Pull out test on pile

All the above tests are to be performed as per requirements of IS:2911 (Part-IV) - latest revision and as supplemented herein.

4.02.00 Static Load Test on Working Piles

In order to determine the carrying capacity of piles, static load tests shall be undertaken by the Contractor on single pile or pile groups, as indicated on drawings. Before any load test is made, the proposed arrangement of the structure, dead load to be used in making the load test, and method of application of load to the pile shall have to be approved by the Engineer. All load tests shall be made under the supervision of the Engineer. All responsibilities for conducting the test safely and properly lie with the Contractor.

The test load to be applied on pile or piles shall be one and a half times the proposed load value of the pile or piles as claimed by the Contractor. The test load shall be applied in 6 increments equal to one fourth, half, three fourth, one, one and one fourth and one and one half times the proposed working load. Readings of settlements and rebounds shall be referred to a constant elevation bench mark and shall be recorded with the help of three dial gauges of 0.02 mm sensitivity each positioned at equal distance around the pile. Each stage of loading, except the final test load of one and one half times the working load, shall be maintained till the rate of movement of the pile top is not more than 0.02 mm per hour. The final test load shall be maintained for

24 hours and hourly readings of settlements are to be recorded. The total test load shall be removed in decrements not exceeding 1/5 of the total test load with intervals of not less than one hour. The rebounds shall be recorded after each decrement is effected and the final rebound shall be recorded 24 hours after the entire test load has been removed. A complete record in triplicate shall be filed with the Engineer on the loads and readings obtained duly verified and countersigned by the Engineer.

The tested piles shall be used as usual foundation piles if they satisfy the acceptance criteria and no extra payment shall be made except for load tests on the piles.

If so desired by the Engineer, special test caps may have to be cast and subsequently dismantled at no extra cost.

4.03.00 **Acceptance Criteria**

The piles shall be accepted as satisfactory only when the work has been executed in order with this Specification to the satisfaction of the engineer and satisfy the following requirements :

a) Deviations shall be within the prescribed limit of tolerance specified in this specification.

b) Results of the load tests satisfy the specification and IS Code requirements.

4.04.00 **Recording Data**

The Contractor shall maintain a separate register, signed jointly by him and the Engineer, giving the following information during installation of the piles:

a) The sequence of installation of piles in each group with dates of starting and completion

b) The dimensions of the pile including the reinforcement details of the piles

c) The depth driven

d) The final set for the last ten blows or as may be specified by the Engineer

e) Cut-off levels

f) The type and size of hammer and its stroke, or with double acting hammers, the number of blows per minute

g) The type and condition of the packing on the pile head and the dolly in the helmet; and

h) Any other important observation

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The tenderer shall submit the following information along with his tender.

5.01.01 Programme of Construction

The tenderer will submit the details of the method of construction and the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and possible delays due to modifications of design should be drawn up and submitted along with the tender, keeping in view the completion dates stipulated in the tender.

5.02.00 After Award

After award of the contract, the successful tenderer is to submit the following details.

5.02.01 Execution Plan

Within 15 days of the receiving the Letter of Intent the Contractor will submit 6 (six) copies of drawings showing the sequence of driving. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the Engineer.

5.02.02 Detailed Construction Programme

Within 30 (thirty) days of the award of contract, a detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the Engineer, incorporating the various factors which have caused or are likely to cause changes in the programme.

5.02.03 Requirement of Materials, Tools and Plants and Equipment

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the Owner is to supply or is to help in procurement as per the terms and conditions of the Contract, is to be submitted within 30 (thirty) days of the contract.

5.02.04 Test Results

The test data and result for the various ingredients of R.C.C., concrete cubes and cylinders, driving of the pile, static load test on single piles and group will be submitted regularly and as and when directed by the Engineer.

TECHNICAL SPECIFICATION
FOR
VII) DRIVEN CAST IN SITU CONCRETE PILES

CONTENTS

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VII) DRIVEN CAST-IN-SITU CONCRETE PILES

1.00.00 SCOPE

This specification covers driven reinforced cement concrete cast in situ piles including movement of pile driving equipment as per drawings as made available from time to time, and all related items of work like sand filling in the holes left after casting the piles, testing the load bearing capacity of individual piles and group of piles, etc. The relevant clauses of the "Technical Specification for Cement Concrete (Plain or Reinforced)" appearing in this document elsewhere, fall within the Scope of this Specification.

IS : 2911 (Part-I/Sec-2) shall form a part of this specification and shall be complied with unless they are at variance with the specification where the latter will prevail.

Other items of work like, excavation, casting pile caps, beams etc. which in most cases, will be required to be executed in connection with piling, will fall under the Scope of other relevant sections of the Technical Specifications which appear separately in this document.

2.00.00 GENERAL

2.01.00 Work to be provided by the Contractor

The work to be provided for by the Contractor, unless otherwise specified, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment, tools, plants, transportation etc. required for the supply and installation of piles of desired capacity.

b) Mark the proposed sequence of driving on six (6) copies of identification plan. The identification plan will be prepared by the Contractor as per the basic plan furnished by the Engineer, if so desired by him.

c) Furnish detailed drawings in six (6) copies of the pile driving equipment giving all salient dimensions and loads.

d) Submit detailed daily report of pile driving incorporating information as required by the Engineer.

e) Carry out load tests to the satisfaction of the Engineer including casting and dismantling of test caps if necessary and submit the test results in approved proforma.

f) Make necessary earthwork and approaches for movement of the pile driving rig.

g) Provide all necessary work mentioned under the "Technical Specification for Cement Concrete (Plain or Reinforced)", as may be applicable.

2.02.00 **Work to be provided by others**

No work under this Specification will be provided by any agency other than the Contractor unless specifically mentioned otherwise elsewhere in the Contract.

2.03.00 **Codes and Standard**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standards Specifications and codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other Standard Practice as may be specified by the Engineer shall be followed :

IS : 269 Indian standard Specifications for 33 Grade ordinary Portland Cement.

IS : 383 Indian Standard Specifications for Coarse and fine Aggregates from Natural sources for concrete.

IS : 432 I.S. specification for Mild Steel and Medium (Part-I) Tensile Steel Bars and Hard Drawn Steel Wire for Concrete Reinforcement : Part I Mild Steel and Medium Tensile Steel Bars.

IS : 455 Indian Standard Specification for Portland Slag Cement.

IS : 456 Code of Practice for Plain and Reinforced concrete.

IS : 516 Indian Standard Specification for Methods of test for Strength of concrete.

IS:1199 Indian Standard Specification for Method of sampling and Analysis of Concrete.

IS:1786 Indian standard Specification for Cold worked steel High strength Deformed Steel Bars and Wires for Concrete Reinforcement.

IS : 2502 Code of practice for bending & Fixing of Bars for Concrete Reinforcement.

IS: 2722 Indian Standard Specification for Portable Swing Weight Batches for Concrete (Single and Double Bucket Type).

IS : 2751 Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.

IS :2911 Code of Practice for Design and (Part-I/Construction of Pile Foundations - Driven Sec-2)Cast-in-situ Concrete Piles.

IS : 2911 Code of Practice for Design and Construction (Part-IV) of Pile Foundations - Load Test on Piles.

IS : 4926 Indian Standards Specification for Ready Mixed Concrete.

IS : 5121 Safety Code for Piling and other Deep Foundations.

IS : 8112 I.S. Specification for 43 grade Ordinary Portland Cement.

IS : 12269 I. S. Specification for 53 grade ordinary portland cement

2.04.00 **Conformity with Design**

The Contractor will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the Engineer, the work will be checked and approved by the Engineer for correctness and conformity with the design, specifications and drawings, before allowing the next phase of the work to commence. The intermediate checks and approvals by the Engineer will not, however, absolve the Contractor from his total responsibility to execute the work as per the specification and drawings and to remove and/or rectify all work which is defective or inaccurate.

2.05.00 **Materials**

2.05.01 **General**

All materials whether incorporated in the works or used temporarily as aids or for executing enabling works will be of best approved quality conforming to the latest Indian Standard Specification.

2.05.02 **Pile Shoes and Shells**

Piles shoes, where used, should be manufactured out of best quality cast Iron or Steel with proper treatment, the composition and thickness of the materials being of special importance where they are likely to be in contact with harmful chemicals and organic materials causing deterioration in service. The shell tubes which are to be left in place should also receive similar consideration in selection.

2.05.03 **Cement**

Cement used shall conform to IS : 8112 or IS : 12269 (Portland Cement.

2.05.04 **Aggregates**

Aggregates both fine and coarse shall comply with the requirements of IS : 383. Size of coarse aggregates shall be selected considering the size of the section. Generally, 20 mm down coarse aggregates shall be used.

2.05.05 **Steel**

Reinforcement steel shall conform to IS : 432 (Part - I) (Mild Steel plain bars) or IS : 1786 (High yield strength deformed bars).

2.06.00 **Storage of Materials**

2.06.01 **General**

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer shall not be used, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The relevant clauses pertaining to storage of material under "Technical Specification for Cement Concrete (Plain & Reinforced)" will apply.

2.06.02 **Cast Iron or Steel Shoes and Shells**

All cast iron or steel shoes and shells will be painted with two coats of anticorrosive paint or smeared with protective layer of grease and kept stored in weatherproof sheds, off the ground, on sturdy racks in such a manner as to enable quick and easy inspection.

2.07.00 **Quality Control**

The Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The Quality Control requirements stipulated under the "Technical Specifications for Cement Concrete (Plain and Reinforced)" will apply wherever relevant. In addition, the requirements will include but not be limited to the following :

a) Location and Plumb : Control survey for accuracy in planned check for verticality.

b) Driving : Correlation of wt. of hammer, length of stroke, number of strokes per minute and rate of penetration.

c) Casting of Piles : Check inside casing, reinforcement cage, concrete mix, placing, consolidation and curing.

d) Inspection of Pile

e) Load Tests

2.07.01 **Non-conformance**

Any work which fails to conform to the specification will be subject to the issue of a non-conformance report in line with the quality control procedures to be implemented at site. Corrective or remedial action, design modification or product rejection will be reviewed in accordance with site quality plan.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:2911 (Part I) and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all the aspects to the full satisfaction of the Engineer.

3.01.00 General

The Tenderer shall furnish complete information about the type of piles offered with sketches of pile sections showing reinforcement, method of driving the piles, details and availability of driving equipment, formula or data curve on which the Tenderer bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient 'founding' of individual piles and any other relevant details.

The Tenderer will be supplied with bore hole logs or any other data indicating the nature of the soil expected to be encountered. The information furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the Contract. All piles will have to be driven to the required set and/or based on load tests, as decided by the Engineer. In case the Contractor is required to drive piles to greater or shallower depths than that is envisaged the rates will be adjusted as per relevant items in the Schedule of Items and no other extra claims will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bore holes if he feels it necessary to assess the type of equipment to be used and the depths to which the piles may have to be driven finally.

3.02.00 Type of Pile

All piles shall be adequately reinforced cast in situ concrete piles driven as specified on the drawing/s. The reinforcement and diameters of piles should be exactly as indicated in the drawing and specification. Only cast in situ piles with complete reinforcement for the total length and casing driven to total depth required for pouring controlled concrete mixture shall be accepted.

3.03.00 Identification of Piles

A plan, in triplicate, showing clearly the designation of all piles by an identifying system shall be filed with the Engineer before installation of piles is started if so desired by the Engineer.

3.04.00 Sequence of Construction

The piles shall be installed in such a sequence that the carrying capacity of previously installed pile is not reduced. The driving shall not cause appreciable upheaval of the ground or cause unusual soil resistance to rest of the pile driving. It shall be ensured that the soil is not flowing out laterally during driving operation. The Engineer shall decide on the sequence of the groups of piles and the Contractor shall have to follow this sequence.

3.05.00 **Driving of Piles**

Piles shall be installed with due consideration to the adjacent structures and by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance. Equipment and the method of driving the pile shall be such that the pile is installed in its proper position and alignment. The pile shall not be out of plumb by more than 2% of the pile length. If any pile goes out of plumb by more than 2% of the pile length, the design of the foundation shall have to be modified in a manner approved by the Engineer to support the resulting vertical and lateral forces properly. The cost of modification, however, has to be borne by the Contractor at no extra cost to the Owner. A maximum positional deviation of 7.5 cm at the cut off level from the designed location of pile may be permitted, beyond which modification in the design shall become necessary.

Jetting shall not be done except when permitted in writing by the Engineer. The driving shall start from the existing ground level. After completion of driving, concrete shall be placed and compacted to fill up the hole left by the driving up to 300 mm above the cut of level. The balance depth between the G.L. and the top of concrete shall be filled up with sand so that the next pile does not move out of place during construction. To construct the pile cap, the ground will be excavated to expose the top portion of the piles, which will be dismantled neatly upto the cut off level removing all cracked, loose and unsound concrete. the top surface of the piles will be kept rough to ensure bond with the pile cap in which they will be ultimately embedded. The reinforcement rods of the pile should project out of the top by at least the value of bond length for the bar depending on its diameter and grade of concrete in pile cap. This length of bar will be later on bent and embedded in the pile cap concrete.

During the process of driving, should an obstruction be encountered, through which piling tube can not penetrate, the Contractor shall be compensated for the cost of removal of such obstruction at actual cost plus 20%.

Liquefaction of soil or localised compaction of soil due to driving of piles, if occurring, may create conditions when determination of load bearing capacity by the usual method of 'set' sometimes gives erroneous results. The pile, in such cases, shall be driven to the set desired or the desired strata based on the experience gained on the various load tests as desired by the Engineer.

The Contractor shall ensure that any green concrete in the nearby piles or any pile loaded in testing operation is not disturbed by driving the tube adjacent to it.

3.06.00 **Concrete in Pile**

This shall conform to the requirements of "Technical Specification for Cement Concrete (plain and reinforced)" enclosed herewith, to the extent it has been referred to or as applicable to this Specification. The concrete shall be of controlled grade and approved quality M 25 (minimum). The stipulation laid down in IS:2911 (Part I), regarding selection of mix shall be generally followed unless otherwise specified by the Engineer.

Concreting shall start as soon as possible after the hole is completed. Concrete shall be so placed as to fill the entire volume of the hole without segregate and formation of voids caused by faulty consolidation or entrapped air. The volume of concrete placed shall be observed in the initially cast piles and the average figure obtained shall be used to check whether there is undue deviation in concrete consumption for the subsequent piles.

Where the concrete is cast in place in a tube, its consistency shall be suitable to the method of compaction employed in the formation of piles. If necessary, concrete shall be as dry as possible to minimise shrinkage and to minimise the possibility of cement being washed down by flow of subsoil water while casing is withdrawn. Care shall be taken against segregation of concrete while passing the reinforcement cage, and against inflow of soil and water during withdrawal of the tube by maintaining sufficient head of concrete inside the tube. The extraction of casing shall not cause any shearing or necking of the poured concrete thereby reducing the capacity of piles.

The method of concreting shall strictly conform to the above specification and no deviation shall be allowed.

As mentioned in Section 3.5, concreting of the pile shall have to be done at least 300 mm above the cut off level of the pile. The remaining part of the hollow formed by the withdrawal of driving tube from ground down to the top of the concreted pile shall be filled up with sand.

3.06.01 Trimming of Pile Heads

Completed piles shall be trimmed to the cut-off levels shown on the drawings or until sound concrete is found. In the event of trimming being carried below the cut-off level, the pile shall be made up to the correct cut-off level, with concrete of the same quality as used in the piles at the contractor's expense. A 'non-conformance' will be raised in such circumstances. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap as per drawing. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose rust, dirt and scale.

3.06.02 Lengthening of Piles

Where it is necessary to increase the length of any pile after it has been installed, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be chiselled to form a key brushed to remove loose material and covered with 25 mm thick cement mortar (1 : 2 mix) immediately before the new concrete is placed.

3.07.00 Reinforcement in Piles

Steel Reinforcement conforming to IS:432, IS:1139 or IS:1786 grade suitable for reinforced cement concrete for general building work shall be applicable for the specification to the extent it has been referred to or applicable.

Pile has to be reinforced throughout its length. In spite of different methods of driving, concreting, etc. of different types of cast-in-situ driven piles, the minimum area of longitudinal reinforcement within the pile shaft shall be 0.4 percent of the sectional area calculated on the basis of outside diameter of the casing of the shaft when mild steel plain bars conforming to IS : 432 Grade I are used. For other grades of steel noted above, the area of reinforcement may be adjusted suitably, but in no case shall the number of vertical reinforcing bars be less than six and the bar diameter less than 16 mm. The minimum diameter of the links or spirals shall be 6 mm and their spacing shall not be less than 150mm. In addition to the binders/links, spacer bars of 8 mm diameter shall be welded at the inside face of the cage of suitable intervals.

Reinforcement used in cast in situ piles shall be made up into cages sufficiently well wired or spot welded to withstand handling without damage. The bars shall be so spaced as not to impede the placing of the concrete. Care shall be taken to preserve correct cover and alignment of reinforcement throughout the whole operation of placing the concrete by means of concrete rollers or by any other means approved by the Engineer. Any distortion or displacement of reinforcement, during the compaction of concrete or while extracting the tube, shall be avoided. The reinforcement in the pile shall be exposed for a minimum length of the anchor length in tension above cut off level to permit it to be adequately bonded into the pile cap. All reinforcement in piles including the dowels projecting above the piles, shall be measured and paid separately.

3.08.00 **Dowels**

The Contractor shall provide necessary dowels as directed by the Engineer. In case of inadequate length of dowels, the same shall be extended by welding or by mechanical devices, if necessary as per direction of the Engineer. The expenditure on this account shall be borne by the Contractor. The extra reinforcement thus required shall be taken into consideration during reconciliation if the same is supplied by the Owner.

3.09.00 **Inspection**

Before placing the reinforcement and concrete in the driven pile, the same shall be inspected by lowering a battery or flash lamp or by any other method approved by the Engineer to ensure water tightness of the tube. In case of water in any bore or damage to any cast iron shoe, the tube shall be extracted and redriven after earthfilling of the hole, with a fresh shoe at the cost of the Contractor.

3.10.00 **Record for driving of Piles**

A joint record of the entire penetration shall be maintained by the Contractor in a proforma approved by the Engineer for every pile for the behaviour of such pile during its entire process of construction. Such records shall be submitted to the Engineer regularly as the job progresses. Any sudden change in the rate of penetration which can not be ascribed to the nature of the ground or any deviation from the designed location, alignment or load

carrying capacity of any pile or any upheaval or subsidence noticed on any pile driven under this Contract shall be promptly reported to the Engineer and adequate corrective measures shall be taken free of any charge as decided by the Engineer.

Upon completion of the pile driving, all records together with the records of such additional borings or other subsurface information that were obtained during the process of driving shall also be filled with the Engineer in triplicate.

3.11.00 **Defective Piles**

Piles that are defective or piles with deviation in alignment of the tube or position of the base more than that permissible under this specification shall be pulled out or left in place as per the direction of the engineer. Additional piles shall be driven to replace them and/or the pile cap shall be redesigned in consultation with the engineer. All the additional costs associated with the corrective action shall be borne by the Contractor. However, the extra reinforcement and cement that will be required for such work shall be taken into consideration during reconciliation of Owner's material, if the same are supplied by the Owner.

3.12.00 **Idle Period**

The phasing of construction and movement of plant shall be done as desired by the Engineer. The phasing may involve some extra movement of the plant or some idle period, but the Contractor will not be entitled for any claim due to this reason.

During the actual testing of the piles, the contractor's plant and personnel may remain temporarily idle. Again, during the period of redesign, if any, (based on the pile test results), the plant personnel of the contractor may remain idle for any reason whatsoever.

For such idle periods mentioned above, the Contractor will not be entitled to any claim and rates quoted by him shall include the same. However, during the testing of piles and other hold ups, pile driving operation may be allowed on other piles wherever possible, if decided by the engineer with a view to minimise idle times.

If due to change in loading, elevations or any other alteration, some amendments become necessary in the design of foundations, the Contractor shall not be entitled to any claim whatsoever for such amendments in the pile layout during the progress of work including claims for any idle labour or tools and plant on this account.

In case of extra rolling of rig arising out of a decision taken by the Engineer due to non-availability of drawings or site, or priority consideration, the same shall be paid under the relevant item in the schedule of items.

3.13.00 **Test Pile**

The Contractor may have to construct test piles, if desired by the Engineer, before he starts systematic piling operation at locations indicated. For this

purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Initial test shall be carried out on such piles as per the relevant provision in IS : 2911 (Part-IV).

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in the Contract. Whenever directed, the Contractor shall get the specimens tested in a laboratory approved by the engineer and submit to the Engineer the test results in triplicate within three (3) days of completion of the test.

4.02.00 Components of R.C.C

The testing and acceptance criteria for the components of Reinforced Cement concrete shall be as stipulated in the relevant clauses of the Technical Specification for Cement concrete (Plain and Reinforced) appearing in the document elsewhere.

4.03.00 Static Load Test on Working Piles

In order to determine the carrying capacity of piles, static load tests shall be undertaken by the Contractor on single pile or pile groups, as indicated on drawings. Piles to be tested shall be cast at least 30 days before loading unless otherwise directed by the Engineer. Before any load test is made, the proposed arrangement of the structure, dead load to be used in making the load test, and method of application of load to the pile shall have to be approved by the Engineer. All load tests shall be made under the supervision of the Engineer. All responsibilities for conducting the test safely and properly lie with the Contractor.

The test load to be applied on pile or piles shall be one and a half times the proposed load value of the pile or piles as claimed by the Contractor. The test load shall be applied in 6 increments equal to one fourth, half, three fourth, one, one and one fourth and one and one half times the proposed working load. Readings of settlements and rebounds shall be referred to a constant elevation bench mark and shall be recorded with the help of minimum two dial gauges of 0.02 mm sensitivity and resting on diametrically opposite sides. Each stage of loading, except the final test load of one and one half times the working load, shall be maintained till the rate of movement of the pile top is not more than 0.02 mm per hour. The final test load shall be maintained for 24 hours and hourly readings of settlements are to be recorded. The total test load shall be removed in decrements not exceeding 1/5 of the total test load with intervals of not less than one hour. The rebounds shall be recorded after each decrement is effected and the final rebound shall be recorded 24 hours after the entire test load has been removed. A complete record in triplicate shall be filed with the Engineer on the loads and readings obtained duly verified and countersigned by the Engineer.

The tested piles shall be used as usual foundation piles if they satisfy the acceptance criteria, and no extra payment shall be made except for load tests on the piles.

If so desired by the Engineer, special test caps may have to be cast and subsequently dismantled at no extra cost.

4.03.01 **Acceptance Criteria**

The pile or piles tested shall be accepted to carry the proposed working load provided that the total settlement of the pile top under the load does not exceed 12 mm.

4.04.00 **Lateral Load Tests/Pull out Tests**

If desired by the Engineer lateral load tests on piles will be carried out by the Contractor as per IS:2911. Pull out tests will be carried out in special cases if required by either cantilever or fulcrum loading as may be approved by the Engineer. The quantum and nature of test loading will be as approved by the Engineer.

4.05.00 **Non-destructive Dynamic Testing on Working Piles**

In addition to the above load tests, the Contractor may also have to carry out testing of piles by non-destructive dynamic testing methods before or during piling work as desired by the engineer.

4.05.01 **"Low Strain" Method for Integrity Investigation of Concrete Piles**

The method of testing shall conform to ASTM D4945. All equipment including small impact device, 16 lbs nylon tipped hand held hammer accelerometer pile integrity tester and pile driving analyser shall be arranged by the Contractor. Analysis shall be carried out by exponential amplification of the signal with line and the average velocity curve obtained by numerically integrating the acceleration record to be submitted. From analysis of the results any defect like necking, honey-combing, segregation or weakness in concrete, when detected shall be reported in detail.

4.05.02 **"High Strain" Method for Determination of Pile Capacity**

The method of testing shall conform to ASTM D 4945. All equipment including piezoelectric transducers, strain gauges, pile driving analyser, two track oscilloscope for displaying data and contractor for every hammer below the analyser shall determined the following data :

a) Pile bearing capacity

b) Transferred energy

c) Maximum compression force

d) Maximum tension force

e) Maximum impact velocity

f) Maximum acceleration

g) Maximum displacement

which are to be properly recorded and analysed and submitted in detailed report form.

4.06.00 **Lateral Dynamic Load Test on Piles**

Two types of tests, namely, free and forced vibration lateral tests shall be carried out to observe response of soil-pile system under horizontal dynamic loads and for the evaluation of soil pile stiffness, soil modulus, natural frequency, time period and damping characteristics of soil- pile system.

A minimum of three representative piles of same type in almost similar soil conditions shall be tested. Two adjacent piles shall be subjected first to free vibrations and then to forced vibrations, the third pile shall only be tested under forced vibrations.

The equipment and accessories for the test, setting up and test procedure and recording of observations shall be as described in relevant sections IS : 9716 (Guide for Lateral Dynamic Load Test on Piles).

The tests shall normally be carried out without sustained vertical load other than that of the oscillator assembly. However, sustained weight can be used to increase dynamic force to obtain resonance or nearly resonance condition.

From analysis of test data, the following parameters shall be determined:

i) Frequency of vibrations

ii) Amplitude of vibrations

iii) Imparted dynamic force

iv) Natural frequency

v) Damping coefficient

vi) Soil-pile stiffness

vii) Coefficient of horizontal soil modulus variation

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

The Tenderer should submit the following information alongwith his tender :

5.01.01 **Design Data**

The Contractor will submit full details of method of construction, design data and drawings for the type of piles he wishes to adopt.

5.01.02 **Programme of Construction**

The Contractor will also submit the details of the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and possible delays due to modifications of design should be drawn up and submitted along with the tender, keeping in view the completion dates stipulated in the tender.

5.02.00 **After Award**

After award of the contract, the successful tenderer is to submit the following details.

5.02.01 **Execution Plan**

Within 15 days of receiving the letter of Intent the Contractor will submit 6 (six) copies of drawings showing the sequence of driving. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the Engineer.

5.02.02 **Detailed Construction Programme**

Within 30 (thirty) days of the award of contract, a detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the Engineer, incorporating the various factors which have caused or are likely to cause changes in the programme.

5.02.03 **Requirement of Materials, Tools and Plants and Equipment**

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the Owner is to supply or is to help in procurement as per the terms and conditions of the Contract, is to be submitted within 30 (thirty) days of the contract.

5.02.04 **Test Results**

The test data and result for the various ingredients of R.C.C., concrete cubes and cylinders, driving of the shell, static load test on single piles and group and non-destructive dynamic test on working piles will be submitted regularly and as and when directed by the Engineer. For testing the ingredients of R.C.C. the relevant clauses of the "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply.

TECHNICAL SPECIFICATION
FOR
VIII) BORED CAST IN SITU CONCRETE PILES

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VIII) BORED CAST IN SITU CONCRETE PILE

1.00.00 SCOPE

This specification deals with the requirements regarding materials, workmanship and installation of bored cast-in-situ reinforced concrete piles and all related items of work like sand filling in the holes after casting the piles, testing the load bearing capacity of individual piles and group of piles, etc. The relevant clauses of the "Technical Specification for Concrete Work", appearing elsewhere in this document, fall within the scope of this specification.

IS:2911 (Part-I/Sec-2) shall form a part of this specification and shall be complied with unless they are at variance with the specification where the latter shall prevail.

2.00.00 GENERAL

2.01.00 Work to be provided by the Contractor

The work to be provided for by the contractor, unless otherwise specified, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment and accessories, tools, plants transportation including consumables and temporary works required for the supply and installation of piles of desired capacity.

b) Mark the proposed sequence of installation on six (6) copies of identification plan. The identification plan will be prepared by the contractor as per the basic plan furnished by the Engineer, if so desired by him.

c) Furnish full details of the proposed piling equipment, accessories, temporary works and method of pile construction for approval of the engineer.

d) Submit detailed daily report of boring and pile casting incorporating information as required by the Engineer.

e) Carryout load tests to the satisfaction of the engineer including casting and dismantling of test caps if necessary and submit the test results in approved proforma.

f) Make necessary earthwork and approaches for movement of pile installation equipment.

g) Provide all necessary work mentioned under "Technical Specification for Cement Concrete (Plain and Reinforced)", as may be applicable.

2.02.00 **Work to be provided by others**

No work under this specification will be provided by any agency other than the contractor unless specified elsewhere in the Contract.

2.03.00 **Codes and Standards**

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements/amendments of the following or any other Indian Standard Specifications and Code of Practice.

IS : 269 Indian Standard Specifications for 33 Grade Ordinary Portland Cement.

IS : 383 Indian Standard Specifications for Natural Sources for Concrete.

IS : 432 Indian Standard Specification for (Part - I)Mild Steel & Medium Tensile Steel Bars and Hard drawn Steel Wire for Concrete Reinforcement : Part I Mild Steel and Medium Tensile Steel Bars.

IS : 455 Indian Standard Specifications for Portland Slag Cement.

IS : 456 Indian Standard Code of Practice for Plain and Reinforced Concrete.

IS : 516 Indian Standard Specifications for Methods of Test for Strength of Concrete.

IS : 1199 Indian Standard Specifications for Methods of Sampling and Analysis of Concrete.

IS : 1786 Indian Standard Specifications for high strength deformed steel bars and wires for concrete reinforcement.

IS : 2062 Steel for General Structural Purposes

IS : 2386 Indian Standard Specification for Methods of Test for Aggregates for Concrete Part - I to VIII.

IS : 2502 Code of Practice for Bending & Fixing of Bars for Concrete Reinforcement.

IS : 2722 Indian Standard Specifications for Portable Swing Weight Batches for Concrete (Single and Double Bucket Type).

IS : 2751 Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.

IS : 2911 Code of Practice for Design and Construction of Pile Foundations - Bored Cast-in-situ piles.

IS : 2911	Code of Practice for Design and (Part - IV)Construction of Pile Foundations - Load Test on Piles.
IS : 4926	Indian Standard Specifications for Ready Mixed Concrete.
IS : 8112	I.S. Specification for 43 grade Ordinary Portland Cement.
IS : 9716	Guide for Lateral Dynamic Load Test on Piles.
IS : 12269	I. S. Specification for 53 grade ordinary portland cement

2.04.00 **Conformity with Design**

The contractor will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the engineer, the work will be checked and approved by the engineer for correctness and conformity with the design, specification and drawings, before allowing the next phase of work to commence. The intermediate checks and approvals by the engineer will not, however, absolve the contractor from his total responsibility to execute the work as per the specification and drawings and to remove and/or rectify all work which is defective or inaccurate.

2.05.00 **Materials**

2.05.01 **General**

All materials whether incorporated in the works or used temporarily as aids or for executing enabling works will be of best approved quality conforming to the latest Indian Standard specification.

2.05.02 **Casing**

Casing in boreholes where used, should be manufactured out of best quality mild steel with proper treatment, the composition and thickness of the materials being of special importance where they are likely to be in contact with harmful chemicals and organic materials causing deterioration in service. Casing to be left in place like in offshore piling should also receive similar consideration in selection. They shall have sufficient strength and rigidity to permit their being driven and not to be distorted by soil pressure or driving of adjacent tubes. They shall be sufficiently water-tight to exclude water during placing of concrete.

2.05.03 **Concrete**

Concrete type M-25 (minimum) grade shall be used for piles as indicated in drawings. Materials and method of manufacture for cement concrete shall in general be in accordance with IS : 456. The concrete cube strength on 15 cm. cubes at 28 days shall satisfy the acceptance criteria as per IS : 456. Concrete cubes will be cast as per instruction of the Engineer. These will be cast and cured by the Contractor at site for testing. The concrete shall be of such consistency as to give a slump of 100 to 150 mm. Cement used for the concrete shall be 43 / 53 Grade ordinary Portland cement conforming to IS:8112 & IS:12269 respectively.

2.05.04 **Reinforcement**

Reinforcement shall be mild steel bars conforming to IS: 432. If instead of mild steel, Tor steel bars are used, they shall conform to IS : 1786.

2.06.00 **Storage of Materials**

2.06.01 **General**

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the engineer shall not be used, failing which, the engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the contractor's dues. The relevant clauses pertaining to storage of material under "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply.

2.06.02 **Casing**

Mild steel casing will be painted outside with two coats of anticorrosive paint or smeared with protective layer of grease and kept stored in weather proof sheds, off the ground, on sturdy racks in such a manner as to enable quick and easy in spectrum. Epoxy painting on outside surface shall be provided if so specified in the drawing.

2.07.00 **Quality Control**

The contractor shall establish and maintain quality control for different items of work and materials as may be directed by the engineer to assure compliance with contract requirements and maintain and submit to the engineer records of the same. The quality control requirements stipulated under the "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply wherever relevant. In addition, the requirement will include but not be limited to the following.

a) Location and plumb : Control survey for accuracy in plan and check for verticality.

b) Driving of casing : Correction of weight of hammer, length of fall, number of strokes per minute and rate of penetration.

c) Boring : Boring method to suit soil profile.

d) Casting of piles : Check inside casing, reinforcement cage, concrete mix, placing, consolidation and curing.

e) Inspection of pile

f) Load tests

2.07.01 Any work which fails to conform to the specification will be subject to the issue of a `non-conformance report' in line with the quality control procedures to be implemented at site. Corrective or remedial action, design modification or product rejection will be reviewed in accordance with site quality plan.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:2911 (Part-I/ Sec.2) and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all the aspects to the full satisfaction of the engineer.

3.01.00 General

The tenderer shall furnish complete information about the type of piles offered with sketches of pile sections showing reinforcement, method of boring, details and availability of equipment and accessories formula or data curve on which the tenderer bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient founding of individual piles and any other relevant details.

The tenderer will be supplied with bore hole logs or any other data indicating the nature of the soil expected to be encountered. The information furnished to the contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. Piles should be founded on suitable continuous hard strata. In case the contractor is required to drive piles to greater or shallower depths than that is envisaged, the rates will be adjusted as per relevant items in the schedule of items and no other extra claims will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bores if he feels it necessary to assess the type of boring equipment to be used and the depth to suitable founding strata.

3.02.00 Design of Pile

The contractor shall satisfy the engineer as to the boring procedure and equipment which he proposes to use for the particular conditions of the site. If the engineer desires, sufficient test piles shall be installed to prove the adequacy of the pile, at the places indicated by the engineer and a load test shall be performed on each pile.

The Contractor shall satisfy the Engineer as to the boring procedure and equipment which he proposes to use for the particular conditions of the site. If the Engineer desires, sufficient test piles shall be driven to prove the adequacy of the pile, at the places indicated by the Engineer, and a load test shall be performed on each pile.

Piles have to be reinforced throughout their length. Main longitudinal reinforcement in the length of the piles as well as links or spirals shall be provided as shown in the drawings. Longitudinal bars shall preferably be in one length. Reinforced cage shall be handled and installed carefully without damaging its shape. All other requirements of reinforcement bars i.e., quality,

workmanship, etc. shall be as specified for reinforced concrete work in Technical Specification for Concrete work.

The average basic length of the piles shown in the drawing/schedule of items is tentative and is to be assumed from cut-off level to the tip of the pile, but the final length will be decided by the Contractor with approval of the Engineer on the basis of boring resistance actually observed at site at the particular location. It will be the responsibility of the Contractor to prove by subsequent load tests/pull-out tests that the adopted length of the pile shall carry the safe loads, in compression and tension with the resulting deflections being within permissible limits. To ensure this, the length of the pile actually installed will be subject to change if considered necessary from the above mentioned basic length and payment shall be made to the Contractor on the basis of the actual lengths of pile installed at the rates quoted by the Contractor for deviation in length above or below the stipulated basic length.

If the load test is satisfactory and the Engineer accepts the type of the pile as suitable, payment shall be made for the pile. If the piles by reasons of defective workmanship or failure of one or more load tests, are found to be unsatisfactory, the cost of the test piles shall be borne by the Contractor.

3.03.00 **Identification of Piles**

A plan in triplicate, showing clearly the designation of all piles by an identifying system shall be filed with the engineer before installation of piles is started if so desired by the engineer.

3.04.00 **Sequence of Piling**

Individual piles and pile groups shall be constructed in such a sequence that the adjacent piles already installed are not disturbed, nor their carrying capacity reduced by subsequent boring/driving operation. The Contractor shall submit the sequence order and programme chart to the Engineer and get his confirmation before starting the work.

3.05.00 **Boring**

3.05.01 **With Casing**

Boring equipment and accessories shall generally conform to IS:2911 - relevant section. Boring may be done by either rotary or percussion equipment or grabbing equipment using reversed or direct mud circulation method. In case of unstable soils the boring tools used should be such that suction effects are minimised. Stabilisation of the sides of bore hole shall be done by use of casing. The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm.

The casing should be used from the ground level and shall be kept ahead of boring in case where there is danger of caving-in due to subsoil water entering into the bore hole or where the soil is loose. While boring below subsoil water level, precaution shall be taken so that no boiling of the bottom of the hole occurs due to difference in hydrostatic head.

Boring shall proceed by alternatively driving the casing and extracting the bored material with the boring tools. While boring in soft material liable to cavitation boring tools shall not be operated at a level below the toe of the casing. Care shall be taken to ensure that the volume of water added to the bore shall be not more than the minimum necessary for the operation of the boring tools. The casing shall be driven down through the soft material to penetrate a hard stratum not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter the boring shall be continued by means of the boring tools until the approved bearing layer is reached.

Criteria for approval of the bearing layer will be agreed between the Engineer and the Contractor based on visual inspection of recognisable samples, recovered from the pile bore in the upper levels of the compact layer. The approved samples shall consist of sound material shall be consistent in quality for a depth of 300 mm in the pile bore. A sample of this material shall be supplied by the Contractor to the Engineer duly labelled for maintaining records of the founding strata.

The piles shall be installed with due consideration for safety of adjacent structures by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance.

Where the soil is such that driving of a pile causes previously installed piles to heave, load test shall be conducted at the expense of the Contractor on such proportion of the heaved piles which shall be ordered by the Engineer.

3.05.02 **With Drilling Fluid**

Alternate to the boring with casing, stabilisation of the sides of bore hole can be effected by the use of drilling fluids.

In such cases the drilling fluid must be used at least from the level of subsoil water, as the hole, should then be always kept almost full with the fluid. The density and composition of the fluid shall be such as to suit the requirements of ground conditions and to maintain the fine materials from the boring in suspension. At the last stage of boring or in intermediate hard layers chisel or a chopper may be used. The rate for piling work should be inclusive of any chiselling, chopping of hard strata, clearing of bottom of pile borehole etc. complete as per specifications and necessary penetration test as may be required to prove the soundness of the founding strata. A five per cent bentonite suspension would be generally suitable and its quality shall conform to specification given in Appendix 'A' of IS : 2911 (Part-I/Sec.2).

3.06.00 **Spacing of Piles**

In general, all piles shall have a minimum spacing on centres of 3 d (where 'd' is the diameter of the pile) unless shown otherwise in the drawings.

3.07.00 **Placing of Reinforcement**

Reinforcement as required shall be made into stiff cages sufficiently wired or welded to withstand handling without any damage or distortion. Reinforcement shall be placed immediately after cleaning and inspection of

the bottom of bore holes. The reinforcement should be supported away from the sides of the shaft by means of suitable space block to ensure concentric alignment in the shaft. Steps shall be taken to ensure correct positioning during concreting of reinforcement in the piles without any distortion.

Nominal lap between reinforcement cages shall be 60 cm and the main reinforcing steel shall project for a length sufficient to develop bond (45 times the diameter of reinforcing bar) above the level of the underside of the pile cap.

The concrete cover to main reinforcement shall not be less than 5 cm and suitable spacer blocks shall be provided at intervals not exceeding 2 metres and wired to the main reinforcement.

3.08.00 **Concreting**

Immediately before concreting the bottom of the hole shall be cleaned very carefully. The cleaning of the hole shall be ensured by careful operation by air lifting process unless otherwise allowed by the Engineer. To lift the spoil at founding level before concreting, borehole shall be agitated by jetting with fresh drilling mud with relatively higher pressure than that used during boring or air through tremie pipe. While boring by use of drilling mud, the specific gravity of the mud suspension in the vicinity of the bottom of the borehole shall be determined by suitable slurry sampler in a first few piles and at suitable interval of the piles and recorded. Consistency of the drilled mud suspension shall be controlled throughout the boring as well as concreting operation in order to keep the hole stabilised and to avoid concrete mixed up with the thicker suspension of the mud.

Concreting of boreholes shall start as soon as possible after the completion of boring. If a borehole, be left unconcreted for more than two hours, it shall be cleaned thoroughly as directed by the Engineer before concreting. Concrete shall be so placed as to fill the entire volume of the tube or bore without the formation of voids caused by faulty consolidation or entrapped air. Great care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete. Concreting under water shall be done in one operation. Concrete shall be placed by means of a tremie pipe. It shall, however, be ensured that concrete entering the tremie pipe does not get mixed up with the slurry and 1/4 kg of granulated vermiculite shall be poured in the tremie pipe before pouring concrete as directed by the Engineer.

3.08.01 **Tremie Method of Concreting**

The tremie pipes and funnel shall be filled and lifted just 15 cm above bottom before releasing the concrete column to facilitate flushing out the bottom. The concrete levels in the tremie shall be checked every few centimeters in order to note the difference, if any, between the theoretical quantity that should have been placed and actual quantity that has gone in. This is to locate the position of over cut during boring.

In addition to the normal precautions to be taken in tremie concreting as per relevant section of IS:2911 the following specifications shall be particularly applicable for the use of tremie concrete in pipes :

a) The concrete shall be coherent, rich in cement (not less than 400 kg/m3) and of slump not less than 100 mm.

b) The hopper and tremie shall be closed system embedded in the placed concrete, through which water cannot pass.

c) The tremie shall be large enough with due regard to the size of the aggregate. For 20 mm aggregate the tremie pipe shall be of diameter not less than 200 mm, aggregates more than 20 mm shall not be used.

d) The first charge of concrete shall be placed with a sliding plug pushed down the tube ahead of it or with a steel plate of adequate charge to prevent mixing to concrete and water. However, the plug shall not be left in the concrete as a lump.

e) The tremie pipe shall always penetrate well into the concrete with an adequate margin if safety against withdrawal of the pipe is required while discharging the concrete.

f) The pile shall be concreted wholly by tremie and the method of deposition shall not be changed part way up the pile, to prevent the laittance from being entrapped within the pile.

g) All tremie tubes shall be scrupulously cleaned after use.

Normally concreting of the piles shall be uninterrupted. In exceptional cases interruption of concreting may be allowed but it will be resumed within 1 or 2 hours. The tremie shall not be taken out of the concrete, instead it shall be raised and lowered slowly, from time to time to prevent the concrete around the tremie from setting. Concreting should be resumed by introducing a little richer concrete with a higher slump for taking care of the partly set concrete in the bore.

If the concreting cannot be resumed before final setting of concrete already placed, the pile so cast may be rejected.

In case of withdrawal of tremie out of the concrete, either accidentally or to remove a choke in the tremie, the tremie may be reintroduced in the following manner to prevent impregnation of laittance or scum lying on the top of the concrete already deposited in the bore.

The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug shall be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm shall be filled in the tremie which will push the plug forward and will emerge out of the tremie displacing laitance/scum. The tremie will be pushed further in steps making fresh concrete sweep away laitance/scum in its way. When tremie is buried by about 60 to 100 cm, concreting may be resumed.

3.08.02 **Concreting in Cased Holes**

In case of cased holes, after the required founding level is encountered, the bottom shall be sealed with concrete and the reinforcement cage shall be lowered. If the borehole is dry, concrete shall be deposited by direct pour from the top followed by gradual withdrawal of casings. If water is present in the borehole, it shall be bailed out by bailer.

If it is difficult to dewater by the bailer, concrete shall be placed under water by means of a placer. After the head of water has been neutralised by the head of the concrete, excess water shall be bailed out and concrete shall then be deposited by direct pouring from the top, as is done, if the borehole is dry.

Extraction of casing shall be done in such a way that no necking or shearing of the concrete in the shaft takes place.

During the extraction of casing, slumping of concrete shall be observed and when required, additional quantity of concrete shall be poured so that the pile is formed above the cut-off level as per the requirements indicated below.

3.08.03 **Cut-off Level**

The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap.

Where cut-off level is less than 1.5 m below the working level concrete shall be cast to a minimum of 500 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level additional coverage of 50 mm minimum shall be allowed. Higher allowance may be necessary depending on the length of the pile as directed by the Engineer. When concrete is placed by tremie method, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of one metre above cut-off level. In the circumstances where cut-off level is below ground water level, the need to maintain a pressure on the unset concrete equal to or greater than water pressure shall be observed and accordingly length of extra concrete above cut-off level shall be determined and allowed in Works.

3.09.00 **Steel Pipe or Casing Tube**

This item shall be fabricated with mild steel plates conforming to IS : 2062 and/or steel tubes for structural purpose conforming to IS : 1161 & IS : 1239 as shown on drawings and/or described in the schedule of items.

Fabrication work and welding of steel shall be done in accordance with IS : 800 and IS : 9595. Welding of pipes shall be done by experienced and good welder who have been qualified by tests in accordance with IS : 817.

3.10.00 **Trimming of Pile Heads**

Completed piles shall be trimmed to the cut-off levels shown on the drawings or until sound concrete is found to the satisfaction of the Engineer. In the event of trimming being carried below the cut-off level, the pile shall be made upto the correct cut-off level, with concrete of the same quality as used in the piles at the Contractor's expense. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap. The minimum distance of keying of pile into pile cap shall be 75 mm unless noted otherwise. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose, rust, dirt and scale.

Manual chipping shall be permitted after three (3) days of pile casting. Pneumatic chipping, if permitted by the Engineer, shall not be started before seven (7) days. In case Portland Pozzolana cement is used, chipping shall only be started as directed by the Engineer.

3.11.00 **Lengthening of Piles**

Where it is necessary to increase the length of any pile after it has been driven, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be hacked to form a key, brushed to remove loose material and covered with 25 mm thick cement mortar (1:2 mix) immediately before the new concrete is placed.

3.12.00 **Removal of Spoil**

The Contractor shall be responsible for the prompt removal from the site of all spoil due to the boring to places indicated by the Engineer. The cost of such disposal shall be deemed to have been included in the cost of piling.

3.13.00 **Back-Filling of Abandoned Borings**

The Contractor shall backfill all the abandoned borings between the concrete pile and the surface level after setting of concrete of the piles, by sand or by other materials as directed by the Engineer.

All permanently abandoned boreholes generally shall be backfilled with selected materials and for a depth of 5 M below cut-off level with plain concrete of mix 1:4:8 so that resistance to lateral forces on neighboring piles are developed.

3.14.00 **Record for Installation of Piles**

The Engineer and the Contractor shall maintain separate registers, signed jointly by both the parties, giving the following information for each pile or any other proforma as agreed between Engineer and Contractor. These data shall be submitted to the Engineer, in triplicate, on completion of installation of each pile.

a) Date of completion, pile number & sequence of installation of piles in a group.

b) Bored depth, concreted depth, empty boring and nature of stratum at founding level.

c) Pile diameter, details of reinforcement and details of mild steel liner where provided along with stiffener.

d) Volume of concrete poured, time taken, cement bag consumption, slump of concrete and RL of top of concrete.

e) Time taken for penetration of every 15 cm during last 2 M depth before founding level.

f) Method of cleaning bottom of hole at founding level before concreting.

g) Records of additional borings or other subsurface information obtained during the process of boring.

h) Any other relevant important information.

Any sudden change in the rate of boring which cannot be ascribed to the nature of the ground or any deviation from the designed location, alignment or load carrying capacity of any pile or any upheaval or subsidence noticed on any pile shall be promptly reported to the engineer and adequate corrective measures shall be taken free of any charge as decided by the engineer.

The data for pile load test (load, displacement, time, etc.) are to be recorded sequentially for the test under consideration in a suitable proforma as agreed between Engineer and Contractor. These data along with the load displacement curve shall be submitted to the Engineer, in triplicate, on completion of each load test.

3.15.00 **Defective Piles**

Any pile which is shown to be defective under load test shall not be accepted and the Engineer will relate such failure to the acceptance of other piles in the area.

If an individual pile should fail to meet the requirements specified in Clause 16.00.00 above such piles may be deemed to be defective and the Engineer may order such investigation to be made as he considers appropriate.

When any pile is found defective, the Contractor shall perform at his own expense one or more of the following remedial measures as directed by the Engineer.

i) Replacement of defective piles.

ii) Providing additional piles.

iii) Alteration in design of pile caps.

3.16.00 **Idle Period**

The phasing of construction and movement of plant shall be done as desired by the engineer. The phasing may involve some extra movement of the plant or some idle period, but the contractor will not be entitled to any claim due to this reason.

3.17.00 **Test Pile**

The contractor may have to construct test piles, if desired by the engineer, before he starts systematic piling operation at locations indicated. For this purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Load test on such piles shall be as per the provisions under "Procedure for Initial Load Test" in IS : 2911 (Part-IV) or as directed by the engineer.

3.18.00 **Offshore Piles**

Offshore piles, subjected to high horizontal forces and having large unsupported height above the bed level are to be installed under structures to be constructed on river/sea bed. Installation shall be done with the help of floating rig/crane from the river or by cantilever method from land using moving gantry or similar other equipment. Temporary filling of the area for movement of the piling rig will, however, be allowed to the extent that such filling does not encroach on the flow of the river and also no hindrance is caused to adjoining work. The cost of building such temporary gangway/ filling, embedment and removal of the same shall be included in the cost for relevant items related to installation of offshore Piles in the schedule of items.

The piles adopted are in general large diameter bored piles with mild steel liner retained for a height as indicated in the related drawings. The liner shall be of 6 mm mild steel plates fabricated to true shape and be provided with protective surface treatment. The concreting shall be done by tremie method as described earlier and according to the other stipulation as described in the Technical Specification.

4.00.00 **TESTING AND ACCEPTANCE CRITERIA**

4.01.00 **General**

The contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in the contract. Whenever directed, the contractor shall get the specimens tested in a laboratory approved by the engineer and submit to the engineer test results in triplicate within three (3) days of completion of the test.

4.02.00 **Components of RCC**

The testing and acceptance criteria for components of reinforced cement concrete shall be as stipulated in the relevant clauses of the Technical Specification for Cement Concrete (Plain and Reinforced).

4.03.00 **Components of Steel**

Testing and acceptance criteria for the component of steel pipe material and fabrication work shall be as stipulated in relevant clauses of IS : 800 and IS : 9595.

4.04.00 **Load Tests**

4.04.01 **General**

Initial tests and/or routine tests as indicated in the schedule of items or as directed by the engineer shall be carried out on single pile or pile groups to ascertain the capacities of the piles and their behaviour.

Minimum three (3) nos of test piles are to be provided for each test – Vertical, lateral and pull out test. Minimum load for initial test shall be 2.5 (Two and half) times of design load. Safe load shall be derived from IS code and Technical specification guideline.

Any or all of the tests described below shall be carried out as indicated in the schedule of items and as directed by the engineer. The tests shall be performed as per requirements of the relevant Indian Standards and as supplemented herein.

4.04.02 **Vertical Load Test [as per IS : 2911 (Part-IV)]**

Load tests shall be carried out on single piles to check the bearing capacity or the quality of piles in the manner specified below :

From among the completed piles the Engineer at his discretion shall select piles for the purpose of testing.

At least 1% of the piles driven shall be tested to an overload of 50% above the working load of the pile and 0.1% of the piles driven shall be tested to an over load of 100% above the working load of the pile.

Load shall be applied in increments of about one-fifth of the design load till the design load is reached and thereafter in increment of 10 tonnes till the test load is reached.

Each increment of load shall be maintained for minimum of half an hour upto design load and thereafter for one hour till the test load is reached. Test load shall be maintained for 24 hours.

For each increment of load, readings of settlement at every ten minutes shall be taken. The next increment of load shall be applied only when the difference in settlement of readings between the last two readings does not exceed 0.02 mm. On application of test load, readings shall be taken at every hour.

Unloading will be done in following decrements of load :

i) Test load to design load

ii) Design load to 50% of design load

iii) 50% of design load to 25% of design load

iv) 25% of design load to complete unloading

Each decreased load shall be kept for a minimum of half an hour and readings of rebound taken every ten minutes. The next decrement shall be applied only when the difference in readings between the last two readings is less than 0.02 mm.

The observation and recording of settlement and rebound shall be done simultaneously by the Contractor and the Engineer's representative. Three copies of all the readings for the test shall be supplied by the Contractor to the Engineer-in-charge. Actual proforma for recording the results shall be proposed by the Contractor and approved by the Engineer-in-charge before the start of the load test.

The pile shall be deemed to be acceptable if the gross settlement at the test load of one and a half times the designed load does not exceed 0.01" per tonne of test load or 1/2" (12 mm) whichever is less.

In case a pile fails under or during the load test, the Engineer shall select two additional piles in lieu of each of such piles failed and the Contractor shall carry out load tests on these piles in the same way as the load tests on the original piles at his own cost. This procedure will be repeated in the case of each failure of pile under/during load test.

The Contractor shall arrange at his own expense sufficient amount of knowledge for loading well in advance of the commencement of the load test.

Detailed proposal together with a sketch for the load test arrangement shall be furnished by the Contractor to the Engineer-in-charge for checking and approval.

The pile head shall be chipped off to natural horizontal plane till sound concrete is met. The projecting reinforcement shall be cut-off or bent suitably and the top finished smooth and level. A bearing plate with a hole at the centre shall be placed on the head of the pile for the jacks to rest.

Jacks used in any particular load test should be of the same capacity and their number shall be limited to two only. They should preferably be connected and operated by one pump. The Contractor shall submit certificates certifying the correctness of the calibrations of the pressure gauges and jacks before use. All jacks should be fitted with locking devices. Settlement and rebound shall be recorded by minimum two (2) deflectometers of 0.01 mm sensitivity and also by other independent means of direct measurement. Deflectometers shall be supported independently and in such a way as to be not affected by the settlement of the piles.

4.04.03 **Lateral Load Test**

The test shall be carried out by introducing hydraulic jack with gauge between two piles under test or the reaction shall be suitably obtained otherwise. When the test is conducted by jack located between two piles, the full load imposed by the jack shall be taken as the lateral resistance of each pile.

Load shall be applied in increments of about one-fifth of the design load. The next increment shall be applied after the rate of displacement is nearer to 0.1 mm per 30 minutes. Displacement shall be read by using at least two (2) deflectometer of 0.01 mm sensitivity spaced by 30 cm and kept horizontally one above the other or by any means as per IS-2911 (Part-4) or as approved by the Engineer. The safe lateral load on pile shall be taken as the least of the followings :

a) Fifty percent (50%) of the final load at which displacement increases to 12 mm.

b) Final load at which the total displacement corresponds to 5 mm.

4.04.04 **Pull-out Test**

The test shall be carried out to an overload of fifty percent (50%) of the estimated safe load or a displacement of 12mm total whichever is earlier.

Uplift force may preferably be applied by means of hydraulic jack(s) with gauge using a suitable pull-out set up as per IS-2911 (Part-4) or as approved by the Engineer.

The pull-out load increments and consequent displacement readings shall be same as in the case of Vertical Load Test.

The safe load shall be taken as the least of the followings :

a) Two-thirds of the total load at which the displacement is 12mm.

b) Half the load at which the load-displacement curve shows a clear break (downward trend).

4.05.00 **Non-destructive Dynamic Test on Working Piles**

4.05.01 **"Low Strain" Method for Integrity Investigation of Concrete Piles**

The method of testing shall conform to ASTM D 4945.

All equipments e.g., small impact device 16 lbs. nylon tipped hand held hammer, accelerometer, pile integrity tester & pile driving analyser shall be arranged by the Contractor. Analysis shall be carried out by exponential amplification of the signal with time and the average velocity curve obtained by numerically integrating the acceleration record to be submitted. From analysis of the results any defect like necking, honey-combing, segregation or weakness in concrete, when detected shall be reported in detail.

4.05.02 **"High Strain" Method for Determining of Pile Capacity**

The method of testing shall conform to ASTM D 4945. All equipment including piezoelectric transducers, strain gauges, pile driving analyser, two track oscilloscope for displaying data and analog tape recorders for recording data shall be arranged by the contractor. For every hammer below, the analyser shall determine the following data :

i) Pile bearing capacity

ii) Transferred energy

iii) Maximum compression force

iv) Maximum tension force

v) Maximum impact velocity

vi) Maximum acceleration

vii) Maximum displacement

which are to be properly recorded and analysed and submitted in a detailed report form.

4.06.00 **Acceptance Criteria**

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification to the satisfaction of the Engineer and the standards stated hereinafter.

a) The head of the pile shall be within 75 mm of the specified position on the drawings.

b) The pile shall not be out of plumb by more than two percent.

c) The toe of the pile shall be at the approved bearing level in each case.

d) The total volume of concrete shall not be less than 20% and not more than 50% greater than the calculated volume. The calculated volume for this purpose shall be the cross-sectional area inside the casing multiplied by the length of the shaft. The concrete shall show the specified strength as indicated by the cube test results.

e) The results of the load tests including non destructive dynamic test carried out in accordance with the contract and with the specifications shall be satisfactory.

f) In case of single pile the positional tolerance shall not be more than 50mm.

4.07.00 **Lateral Dynamic Load Test on Piles**

Two types of tests, namely, free and forced vibration lateral tests shall be carried out to observe response of soil-pile system under horizontal dynamic loads and for the evaluation of soil-pile stiffness, soil modulus, natural frequency, time period and damping characteristics of soil-pile system.

A minimum of three representative piles of same type in almost similar soil conditions shall be tested. Two adjacent piles shall be subjected first to free vibrations and then to forced vibrations, the third pile shall only be tested under forced vibrations.

The equipment and accessories for the test, setting up and test procedure and recording of observations shall be as described in relevant sections of IS : 9716 (Guide for Lateral Dynamic Load Test on Piles). The tests shall normally be carried out without sustained vertical load other than that of the oscillator assembly. However, sustained weight can be used to increase dynamic force to obtain resonance or nearly resonance condition.
From analysis of test data, the following parameters shall be determined:

i) Frequency of vibrations

ii) Amplitude of vibrations

iii) Imparted dynamic force

iv) Natural frequency

v) Damping coefficient

vi) Soil-pile stiffness

vii) Coefficient of horizontal soil modulus variation

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

The tenderer should submit the following information along with his tender.

5.01.01 **Design Data**

The contractor will submit full details of the method of construction, design data and drawings for the type of piles he wishes to adopt.

5.01.02 **Programme of Construction**

The contractor will also submit the details of the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and

possible delays due to modifications of design should be drawn up and submitted along with the tender, keeping in view the completion dates stipulated in the tender.

5.02.00 **After Award**

After award of the contract, the successful tenderer is to submit the following details :

5.02.01 **Execution Plan**

Within 15 days of receiving the letter of intent the contractor will submit six (6) copies of drawings showing the sequence of piling. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the engineer.

5.02.02 **Detailed Construction Programme**

Within thirty (30) days of award of the contract, a detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the engineer, incorporating the various factors that have caused or are likely to cause changes in the programme.

5.02.03 **Requirement of Materials, Tools and Plants and Equipment**

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the owner is to supply or is to help in procurement as per the terms and conditions of contract is to be submitted within thirty (30) days of award of the contract.

5.02.04 **Test Results**

The test data and results for the various items like welding of pipes, ingredients of RCC, concrete cubes and cylinders, driving of the shell, static load tests on single piles and pile groups and dynamic tests on working pile will be submitted regularly and as and when directed by the engineer.

TECHNICAL SPECIFICATION
FOR
IX) FABRICATION OF STRUCTURAL STEEL WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
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5.00.00	INFORMATION TO BE SUBMITTED

IX) FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable required for fabrication and supply of all bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract. However, for any special structures such as rail & road bridges, steel chimney, tanks, transmission towers, furnace structures, etc., the relevant Indian Standard or IRC specification and Codes of Practices shall be given due consideration over & above this specification.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following :

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on design drawings to be furnished by the Owner.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections. The field connection materials supplied by the contractor shall be to the extent of actual requirement plus 10% (ten percent).

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Despatch lists, Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

i) Furnish necessary test certificates of all raw steel material supplied by the Contractor.

2.02.00 **Work by others**

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 **Codes and standards**

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed:-

List of IS Codes - Relevant to Fabrication of Structural Steel Work

IS Codes	**Description**
IS:800	Code of practice for general construction in steel.
IS:801	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS:806	Code of practice for use of steel tubes in general building construction.
IS:808	Dimensions for rolled steel beams, channels and angle sections.
IS:812	Glossary of terms relating to welding & cutting of metals.
IS:813	Scheme of symbols for welding.
IS:814	Covered electrodes for metal arc welding of carbon and carbon manganese steel.
IS:815	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
IS:816	Code of practice for use of metal arc welding for general construction in mild steel.
IS:817	Code of practice for training & testing metal arc welders.
IS:818	Code of practice for safety and health requirements in electric and gas welding and cutting operations.

IS:819	Code of practice for resistance spot welding for light assemblies in mild steel.
IS:822	Code of practice for inspection of welds.
IS:919	Recommendations for limits and fits for (Part-1&2) engineering.
IS:1161	Steel Tubes for structural purposes.
IS:1182	Recommended practice for Radiographic Examination of fushion welded butt joints in steel plates.
IS:1200	Method of measurement of steel work and iron (Part-8) work
IS:1239	Mild steel tubes, tubulars and other wrought (Part-1&2) steel fittings
IS:1363	Hexagon head bolts, screws and nuts of product (Part-1 to 3) grade C.
IS:1364	Hexagon head bolts, screws and nuts of product (Part-1 to 5) grade A & B.
IS:1365	Slotted counter sunk head screws (dia. 1.6 to 20 mm)
IS:1367	Technical supply conditions for threaded steel (Part-1 to 18) fasteners.
IS:1608	Method for tensile testing of steel products.
IS:1730	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
IS:1852	Rolling and cutting tolerances for hot-rolled steel product.
IS:1977	Structural steel (Ordinary quality)
IS:2016	Plain washer
IS:2062	Steel for general structural purposes.
IS:2629	Recommended practice for hot-dip galvanizing of iron and steel.
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:3644	Code of practice for ultrasonic pulse echo testing by contact and immersion method.
IS:3757	High Strength Structural Bolt

IS:4000	High strength bolts in steel structure
IS:4759	Specifications for hot-dip zinc coatings on structural steel and other allied products.
IS:4923	Hollow steel sections for structural use.
IS:5334	Code of practice for magnetic particle flaw detection of weld.
IS:5369	General requirements for plain washers and lock washer.
IS:6005	Code of practice for phosphating of iron and steel.
IS:6649	Specification for hardened and tempered washers for high strength structural bolts and nuts.
IS:6623	Specification for high strength structural nuts.
IS:7215	Tolerances for fabrication of steel structures.
IS:7280	Bare wire electrode for submerged arc welding
IS:8500	Structural steel micro alloyed (medium & high strength quality).
IS:8629	Code of practice for protection of iron and (Part-I to III) steel structures from atmospheric corrosion.
IS:9595	Recommendation for metal arc welding of carbon manganese steels.

Painting

IS:117	Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.
IS:128	Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.
IS:1477	Code of practice for painting of ferrous metal (Part-I & II) in building.
IS:2074	Ready mixed paint, air-drying red-oxide zinc chrome priming.
IS:2339	Specification for aluminium paints for general purposes in dual container.
IS:2932	Specification for enamel, synthetic exterior type-I.
IS:2933	Specification for enamel, synthetic exterior type-II.

2.04.00 **Conformity with Designs**

Except where the standard connection details are furnished, the contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer Keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 **Materials to be used**

2.05.01 **General**

All steel materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant.

If desired by the Engineer, Test Certificates of materials supplied by the contractor in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tonnes or less of any particular section.

The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and ampereage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 **Steel**

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable :

1)	IS:801	Cold formed light gauge steel structural member.
2)	IS:806	Steel tubes in general building construction.
3)	IS:1161	Steel tubes for structural purpose.
4)	IS:1977	Structural steel (Ordinary quality) St-42-0.
5)	IS:2062	Steel for general structural purpose
6)	IS:8500	Structural steel-micro alloyed (Ordinary & high strength quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 **Electrodes**

All electrodes to be used under the Contract shall comply with any of the following Indian Standard Specifications as may be applicable :

1) IS:814 Covered electrodes for metal arc welding structural steel

2) IS:815 Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.

3) IS:7280 Base wire electrode for submerged arc welding.

2.05.04 **Bolts and Nuts**

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS:1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm2 and a minimum elongation of 23 per cent on a gauge length of $5.6\sqrt{A}$, where 'A' is the cross sectional area of the test specimen :

   1) IS:1367 Technical supply conditions for threaded fastners.

   2) IS:1608 Method for tensile testing of steel other than sheet, strip, wire and tube.

b) High Tensile Steel : The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Engineer.

2.05.05 **Washers**

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract :

1) IS:1977 Structural steel (Ordinary Quality) St-42-0

2) IS:2062 Steel for general structural purpose

3)	IS:8500	Structural steel - microalloyed (medium & high strength quality)
4)	IS:6623	High Strength Structural Nuts
5)	IS:6649	Hardened and tampered washers for high strength structural bolts & nuts.

2.05.06 **Paints**

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS:2074 - Ready mixed Paint, Air Drying, Red Oxide - Zinc Chromate Priming.

In highly corrosive environment other type of primer such as epoxy resin based zinc rich primer may be necessary.

2.06.00 **Storage of Material**

2.06.01 **General**

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.06.02 **Steel**

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground sectionwise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.06.03 **Electrodes**

The electrodes for electric are welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.06.04 **Bolts, Nuts and Washers**

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

2.06.05 **Paints**

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.07.00 **Quality Control**

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work :

1)	Steel	Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
2)	Bolts, Nuts Washers	Manufacturer's certificate, dimension checks, material testing.
3)	Electrodes	Manufacturer's certificate, thick-ness and quality of flux coating.
4)	Welders	Qualifying Tests
5)	Welding sets	Performance Tests
6)	Welds	Inspection, X-ray, Ultrasonic tests
7)	Paints	Manufacturer's certificate, physical inspection reports
8)	Galvanizing	Tests in accordance with IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-Dip Zinc

coatings on Structural Steel and other allied products.

2.08.00 **Standard dimensions, forms and weights**

The dimensions, forms, weights and tolerances of all rolled shapes bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.09.00 **Shop Drawings**

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and delivery of structural steelwork for approval. He shall within forty five (45) days after issue of design drawings start to submit progressively for approval, the shop drawings based on the Design Drawings furnished to him and, before proceeding with the fabrication work, shall get the said shop drawings approved in accordance with the contract.

The sequence of submission of shop drawings for approval shall match with the approved fabrication and delivery schedule. The approval for the shop drawings will be accorded only towards the general conformity with the design requirements as well as specification and will ensure the correctness of general arrangement for centreline dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates. The correctness of all other details like cutting lenghts, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. will be entirely the contractor's responsibility. The approval of the drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The shop drawings shall include but not be limited to the following :

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolt location etc.

c) Details of all connections with supporting calculations.

d) Comparison sheets to show that the proposed alternative section, if any, are as strong as the original sections shown on the Design Drawings.

e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked -up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS:800 - Code of Practice for use of Structural Steel in General Building Construction and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification IS:1852 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600 Deg. C.

3.01.03 Cutting

Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gauges not more than 4 mm deep will be permitted. Gouges greater than 4 mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 **Planning of edges**

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 **Clearances**

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

3.02.00 **Bolted construction**

3.02.01 **Holes**

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 as specified in IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for bolts shall not be formed by gas cutting process.

3.02.02 **Assembly**

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 **Welded Construction**

3.03.01 **General**

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS:817.

3.03.02 **Preparation of Material**

Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 **Assembling**

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 Deg.).

The work shall be positioned for flat welding whenever practicable.

3.03.04 **Welding Sequence**

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 **Welding technique**

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the Contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03.06 **Temperature**

No welding shall normally be done on parent material at a temperature below (-) 5 Deg.C. However, if welding is to be undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5 Deg. C and 0 Deg. C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is

greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20 Deg. C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03.07 **Peening**

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03.08 **Equipment**

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 **Finish**

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

3.05.00 **Slab bases and caps**

Bases and caps fabricated out of steel slabs, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.06.00 **Lacing bars**

The ends of lacing bars shall be neat and free from burrs.

3.07.00 **Separators**

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.08.00 **Bearing Plates**

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.09.00 **Architectural Clearances**

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.10.00 **Shop connections**

a) All shop connections shall be welded as specified on the Drawings.

b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Contractor will have to make the desired changes at no extra cost to the Owner.

3.11.00 **Castings**

Steel castings shall be annealed.

3.12.00 **Shop erection**

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before despatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchangeability.

3.13.00 **Shop painting**

3.13.01 **General**

Unless otherwise specified, steelwork which will be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by through sweeping with a fibre brush.

After completion of the precleaning, the metal surface shall be immediately painted with red oxide zinc chromate primer conforming to IS : 2074.

In highly corrosive environment, all steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum. The shop paint shall be epoxy rasin based zinc rich primer.

Painting on Structural Steel

All structural steel shall receive 2 coats of red oxide zinc chromate primer (conforming to IS:2074), over 2 coats of synthetic enamel paint (of approve quality) Minimum thickness of each coat shall not be less than 25 micron).

3.13.02 **Inaccessible parts**

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.13.03 **Contact surfaces**

Contact surface shall be cleaned in accordance with Sub-clause 3.13.1 before assembly.

3.13.04 **Finished surfaces**

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.13.05 **Surfaces adjacent to field welds**

Unless otherwise provided for, surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.14.00 **Galvanizing**

3.14.01 **General**

Structural steelwork for switchyard or other structures as may be specified in the Contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS : 2629 - Recommended practice for Hot-Dip Galvanising of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.14.02 **Surface Preparation**

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.14.03 **Procedure**

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

4.00.00 **INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY**

4.01.00 **Inspection**

Unless specified otherwise, inspection to all work shall be made by the Engineer or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract.

The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 **Testing and Acceptance Criteria**

4.02.01 **General**

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost, unless otherwise specified in the Contract. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 **Steel**

All steel supplied by the Contractor shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T. or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be borne by the Contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

4.02.03 **Testing Criteria for checking Lamination in raw steel plates**

All raw steel plate of thickness more than 20 mm supplied by the contractor shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Engineer.

a) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.

b) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Engineer.

c) All raw steel plate of thickness more than 40 mm shall be procured with UT tested condition.

If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop, if the Engineer requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Contractor. If the plates in the fabricated item are found to be laminated, the component will be rejected.

4.02.04 **Welding**

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Engineer may ask for at least 1 (one) test- destructive or non-destructive including X-ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor. In the event of further tests as may be desired by the Engineer, the cost of such test shall be borne by the Contractor if the results are found to be unsatisfactory; and if the test shows no defect, the cost shall be borne by the Owner. In cases of the test results showing deficiency, the Engineer shall have option to reject or instruct any remedial measures to be taken free of charge to the Owner.

4.02.05 **Bolts, nuts and washers**

All bolts, nuts and washers shall be procured from reputed manufacturer approved by the Engineer and shall conform to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor.

4.02.06 **Shop painting**

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02.07 **Galvanizing**

All galvanizing shall be uniform and of standard quality when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 **Tolerance**

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS:1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and

thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

4.04.00 **Acceptance**

Should any structure or part of a structure be found not to comply with any of the provisions of this Specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check the test results obtained at the Contractor's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory, the costs shall be borne by the contractor, and if satisfactory, the costs shall be borne by the Owner.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue an acceptance certificate, upon receipt of which, the items will be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 **Delivery of materials**

4.05.01 **General**

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. the Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 **Marking**

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 **Packing and Shipping**

All projecting plates or edges and all ends of members of joints shall be stiffened, all straight members and plates, shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers, and small loose parts shall be packed separately in order to prevent damage or distortion during shipping.

Shipping shall be strictly in accordance with the sequence stipulated in the agreed programme. Payment may be held up for items sent in advance of the sequence till they could be erected. The Contractor shall include and provide for in his rates, the freight and other charges for despatching the materials to

the worksite and also for securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All packings shall allow for easy removal and checking at site. Special precautions shall be taken against rusting, corrosion, breakage or damage otherwise of the materials. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following :

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water- proof envelope, quoting especially

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each package shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner without any extra payment.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel

belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above mentioned charges, the amount paid will be deducted from the progressive bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information are required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

1) Preparation and approval of shop drawings

2) Procurement of materials

3) Fabrication and shipping of all anchor bolts

4) Fabrication and shipping of main steelwork

5) Fabrication and shipping of steelwork for bunkers. Tanks and / or silos as applicable.

6) Fabrication and shipping of all other remaining steel work including miscellaneous steelwork

7) Final date of completion of all shipments

Time required for completion being one of the main criteria for selecting the successful bidder, it is desired that the bidder quotes the minimum time required by him for completing the work.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following :

a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings furnished to him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day of each month, giving the up to date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Results of any test as and when conducted and as required by the Engineer.

d) Manufacturer's mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.

TECHNICAL SPECIFICATION
FOR
X) ERECTION OF STRUCTURAL STEEL WORK

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X) ERECTION OF STRUCTURAL STEEL WORK

1.00.00 **SCOPE**

This specification covers the erection of structural steelwork and installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 **GENERAL**

2.01.00 **Work to be provided for by the Contractor**

The work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.

b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. any defect observed in the foundation shall be brought to the notice of the Engineer. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, leveling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures if required by the Contract.

g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:

   i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size bolt if required.

iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting will be permitted only at the discretion of the Engineer.

v) Re-fabrication of parts damaged beyond repair during transport and handling or Re-fabrication of parts which are incorrectly fabricated.

vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

viii) Carry out tests in accordance with this Specification if directed.

2.02.00 **Work by others**

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 **Codes and Standards**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS-800 : Code of Practice for general construction in steel

IS-456 : Code of Practice for plain or reinforced concrete

IS-7205 : Safety Code for erection of Structural Steel work

IS-12843 : Tolerance for erection of Steel Structures

2.04.00 **Conformity with designs**

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard Specifications and/or the instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and /or the instructions of the Engineer.

2.05.00 **Material**

2.05.01 **General**

All fabricated steel structures and connection materials shall be supplied by the Contractor for fabrication work. The Contractor may also have to take delivery directly from railway wagons or trucks at Site as per terms & condition of the contract, in which case he shall have to unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.1.0 and as specified herein before.

While taking delivery, the Contractor will check the quantity, quality and the sizes of the materials and verify the adequacy of the same in accordance with the Drawings and Specifications. In case the Contractor finds any material inadequate, he shall inform the Engineer immediately prior to taking delivery of the same. No claim whatsoever, in respect of bad quality, shortages or difference in size will be entertained once the delivery is taken and the Contractor shall make good any such deficiency, if detected later, either by repair or with fresh material as may be directed by the Engineer at the Contractor's Own cost.

Excepting all field connection materials like bolts, nuts, washers and electrodes, which will be supplied by the fabrication Contractor to the extent of 10% in excess of the estimated requirements as per Drawings, all other consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract will be supplied by the contractor for erection work and will be deemed to have been included in this rates.

2.05.02 **Materials to conform to Indian Standards**

All materials required to be supplied by the Contractor under this Contract shall conform to the relevant Indian Standard Specifications.

2.06.00 **Storage of materials**

2.06.01 **General**

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the Engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 **Yard**

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of

sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work.

The Tenderer should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 **Covered Store**

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 **Quality control**

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following items of work :

a) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

b) Grouting : Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.

c) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 **Taking Delivery**

The erection Contractor shall take delivery of fabricated structural steel and necessary connection materials supplied by the fabrication Contractor from railhead, trucks at site as may be necessary and as per terms & conditions of the contract or as directed by the Engineer. He shall check, unload, transport the materials to his stores for proper storing at his own cost. The erection Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The erection contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.

3.01.03 Temporary bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The responsibility of the Contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, leveled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work and cribbing shall be removed immediately upon completion of the steel erection and shall return to the Owner's store in good condition if the materials are supplied by the Owner otherwise permission shall be given to Contractor to take out the materials from the project site. The Owner may remove and return the materials in good condition to the Contractor without any charge if they have been left in place under other agreed arrangement.

3.01.04 Temporary floors for buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or by-laws of state, Municipal or other local authorities.

3.01.05 **Setting out**

Positioning and leveling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. Concrete foundations, where required, shall be made by other agencies. Anchor bolts and other anchor steel shall be embedded by other agencies. The Contractor shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Contractor shall set proper screed bars if desired by the Engineer, to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.

3.01.06 **Field bolting**

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following :

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 x dia. or 200 mm	Bolt length exceeding 8xdia. or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30 over or under.

Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm)	Torque to be applied (Kg.M) for bolt class 8.8 of IS:1367
20	59.94
22	81.63
24	103.73

Note :

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia., 18.2 MT for 22 mm dia.; and 21.2 MT for 24 mm dia., bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.07 **Field Welding**

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.08 **Holes, cutting and fitting**

No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done unless specifically approved and / or instructed by the Engineer.

The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 **Drifting**

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 **Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)**

Grouting shall be carried out with Ordinary Cement grout as described below :

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm downgraded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

Admixtures like aluminium powder, "ironite" or equivalent may be required to be added to the grout to enhance certain desirable properties of the grout.

Alternatively, the grouting may be done with non-shrink high strength free flow cementious grout (ready mixed) like "Sika grout - 214", or "Anchor NSG" or approved equivalent.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally leveled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

3.04.00 **Painting after erection**

Field painting, if required to be done by the erection Contractor, shall only be done after the structure is erected, leveled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. However, touch up paintings, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the erection Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in rainy or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which will be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabricated steel members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project. The number of coats and the shades to be used shall be as specified or as directed by the Engineer.

3.05.00 Stainless Steel Plate Lining in Bunker Hopper

The hopper portion of the coal bunkers shall be lined with stainless steel plates of 3 mm thickness. The stainless steel shall be of AISI-316 quality. The work includes supply, fabrication, welding and fixing of stainless steel lining plate to bunker M.S. plate as per drawing & specification.

The stainless steel liner shall be fixed to the bunker hopper MS by plug welding using special electrodes (such as, Inox-CW coding AWS-310-16, ISMBOS-311 or Inox-D2 coding AWSE-309-16, ISMB 04-311 manufactured by Advani Oerlikon Ltd. or equivalent). Such plug welding shall be done by drilling 21.5 mm dia. holes at 300 mm centre to centre both ways as per drawings. The plug welding shall be ground flush with the lining plate.

3.06.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the Contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

3.07.00 Safety Measures during Erection

The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slinging, welding, gas cutting, etc.) should be taken as per IS:7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract of either fabrication or erection of steelwork whoever is responsible for it and no payment towards the cost of the dismantled portion and any connected work shall be made to the Contractor, unless it is proved that the deficiency is due to reasons beyond the Contractor's scope. On the basis of the tests, the Engineer will decide whether the fabricator or the erector is responsible for the unacceptable member or structure and his decision will be final. In case it is established that the unacceptability of the member or

structure is due to design deficiency, the cost of replacement and/or modifications will be borne by the Owner. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor responsible, to the satisfaction of the Engineer. The cost of the tests specified hereinafter shall be borne by the Owner. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following Sub-clauses 4.1.1, 4.1.2 and 4.1.3. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 **Stiffness Test**

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 **Strength Test**

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 **Structure of same design**

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of

comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 **Repair for subsequent test and use after strength tests**

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 herein before and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.1.1. herein before.

4.02.00 **Tolerances**

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steelwork applicable to this Project and as specified below:

I. For Buildings Containing Cranes

Component	Description		Variation Allowed	
Main columns	a)	Shifting of column axis at foundation level with respect to building line		
		i) In longitudinal direction	i)	$\pm$ 3.0 mm
		ii) In lateral direction	ii)	$\pm$ 3.0 mm
	b)	Deviation of both major column axis from vertical between foundation and other member connection levels :		
		i) For a column upto and including 10M height	i)	$\pm$ 3.5 mm from true vertical

Component	Description		Variation Allowed
	ii)	For a column greater than 10M but less than 40M height any 10M	ii) ± 3.5 mm from true vertical for length measured between connection levels, but not more than ± 7.0 mm per 30 m length
	c)	For adjacent pairs of columns across the width of the building prior to placing of truss.	± 9 mm on true span.
	d)	For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e)	For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
Trusses	a)	Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord	1/1500 of the span or not greater than 10 mm whichever is the least
	b)	Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is the least
Crane Girders & Tracks	a)	Difference in levels of crane rail measured between adjacent columns.	2.0 mm
	b)	Deviation to crane rail gauge	± 3.0 mm

Component	Description		Variation Allowed
	c)	Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm
	d)	Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps		At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per Deg.C per unit length.	

II. For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10M section of height and not more than 7.0 mm per 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 **Acceptance**

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1.0, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this Contract.

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **Before Tender**

Along with the Tenders the Tenderers will be required to submit the following information :

5.01.01 **Tentative Programme**

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 **Constructional Plant & Equipment, Tools, Temporary Works & Manpower**

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 **Erection yard**

A site plan showing the layout and location of the erection yard proposed to be established by the Tenderer shall be attached with the Tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00 **After award of the Contract**

After award of the contract, the Contractor shall submit the following :

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 **Fortnightly Progress Report**

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub- clause 5.2.1 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

TECHNICAL SPECIFICATION
FOR
XI) ROADS AND DRAINAGE

PART-I : CONSTRUCTION OF ROADS & DRAINS

CONTENTS

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XI) ROADS AND DRAINAGE

PART-I : CONSTRUCTION OF ROADS & DRAINS

1.00.00 SCOPE

This specification covers all work required for the construction of road including box-cutting, edging, sub-base, water bound macadam, bituminous macadam, wearing course etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification also includes all work required for drainage including road side drain, R.C.C. culverts, pipe-culverts, drainage pipes, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 Work to be Provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.

b) Submit for approval detailed schemes of all operations required for executing the work e.g., material handling, placement, services, approaches etc.

c) To carry out and submit to the Engineer results of tests whenever required by the Engineer to assess the quality of work.

2.02.00 Work to be Provided for by Others

No work under this specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and Codes of Practice.

1. Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.

2. IRC-19 Standard specifications and Code of Practice for Water Bound Macadam.

3. IRC:SP-11 Hand Book of Quality Control for Construction of Roads and Runways.

4. IS:456 Indian Standard Code of Practice for Plain and Reinforced Concrete.

5. IS:2212 Code of Practice for Brickwork.

6. IS:783 Code of Practice for Laying of Concrete Pipes.

7. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard Specification, any other standard practice as may be specified by the Engineer shall be followed.

2.04.00 **Conformity with Designs**

The contractor shall carryout the work as per the drawings issued to him and/or contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be Used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.06.00 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used.

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for roadworks are described hereinafter.

i) Horizontal Alignments

Horizontal alignments shall be reckoned with respect to the center line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of $\pm$ 25 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be $\pm$ 40 mm.

ii) Longitudinal Profile

The levels of the sub-grade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer, beyond tolerances mentioned below:

Sub-grade	$\pm$ 25 mm
Sub-base	$\pm$ 20 mm
Base course	$\pm$ 15 mm
Wearing course	$\pm$ 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6 mm.

iii) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of completed sub-bases, base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table-I.

TABLE-I

PERMITTED TOLERANCES OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal Profile with 3 m straight edge					Cross Profile
		Max. Permissible undulation.	Max. number of undulations permitted in any 300 metres length exceeding :				Max. permissible variation from specified profile under camber template
			mm	mm	mm	mm	
			18	12	10	6	
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50mm & 40-63mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing ** (two coat) over WBM (20-50mm or 40-63mm size metal), Bituminous penetration macadam or built-up spray grout	12	-	-	20	-	8
6.	Open graded premix carpet, mixseal surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20 ***	6
8.	Semi-dense carpet	10	-	-	-	20 ***	6
9.	Asphaltic Concrete	8	-	-	-	10 ***	4

The longitudinal profile shall be checked with a 3 meter long straight edge, at the middle of each traffic lane along a line parallel to the center of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10 metres.

Notes :

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However, this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 EXECUTION

3.01.00 Shoulder Construction

3.01.01 Description

This work shall consist of constructing shoulders on either side of the pavement, in accordance with the requirements of this specification and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

3.01.02 Materials

Shoulder may be of selected earth or granular material conforming to the requirements of embankment construction or granular sub-base construction respectively.

3.01.03 Construction Operations

Except in the case of bituminous constructions, shoulders shall be constructed in advance of the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and included area cleaned of all spilled material before proceeding with the construction of the pavement layer.

In the case of bituminous courses, shouldering operations shall start only after the pavement course has been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement and the area so affected thoroughly cleaned.

During all stages of shoulder construction, the required cross-fall shall be maintained to drain off surface water.

3.02.00 **Kerb**

3.02.01 **Material**

Kerb, if required for construction of footpath, shall consist of precast concrete blocks with a concrete grade of M-20 (minimum).

3.02.02 **Laying**

The Kerb shall be laid by cutting trenches 150 mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the Kerbs shall be in plumb and the gap between the block shall not be more than 10 mm.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.03.00 **Sub-base (Granular Sub-base)**

3.03.01 **Description**

This work shall consist of laying and compacting well-graded material on prepared sub-grade in accordance with the requirements of these specifications. The material shall be laid in one or more layers as shown on the drawings and according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

3.03.02 **Materials**

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kanker etc. or combinations thereof depending upon the grading required. The mixed materials shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table-II below.

TABLE-II
GRADING FOR GRANULAR SUB-BASE MATERIALS

Sieve designation	**Percent by weight passing the sieve**		
	Grading 1	**Grading 2**	**Grading 3**
80 mm	100	100	100
63 mm	90-100	90-100	90-100
4.75 mm	35-70	40-90	50-100
75 micron	0-20	0-25	0-30
CBR Value (Minimum) : for fraction of material passing 20 mm sieve	30%	25%	20%

Note : The material passing 425 micron sieve for all the three gradings when tested according to IS:2720 (Part V) shall have liquid limit and plasticity index of not more than 25 percent and 6 percent respectively.

3.03.03 **Physical Requirements**

The fraction of material passing 20 mm sieve shall give a CBR value as specified in Table-II when tested in accordance with IS:2720 (Part XVI) after preparing the samples at maximum dry density and optimum moisture content corresponding to IS:2720 (Part VII) and soaking the same in water for 4 days.

3.03.04 **Spreading and Compacting**

Immediately prior to the laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary, and rolled with one pass of 8-10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of the layer after consolidation does not exceed 150 mm.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part II) and suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part VIII). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be started with 8 to 10 tonne smooth wheeled rollers or other approved plant. Rolling shall commence at the edges and progress towards the center longitudinally except that on super elevated portions it shall progress from the lower to the upper edge parallel to the center line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density for the material determined as per IS:2720 (Part VII). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

3.04.00 **Water Bound Macadam Sub-base/Base Course**

3.04.01 **Description**

Water bound macadam shall consist of clean, crushed aggregates mechanically interlocked by rolling, and bonded together with screenings, binding material, where necessary and water, laid on a prepared sub-grade or sub-base, as the case may be, and finished in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or otherwise directed by the

Engineer.

3.04.02 **Materials**

3.04.02.1 Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table-III.

TABLE-III

PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM

Sl. No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value*	IS:2386 (Part IV)	50 percent maximum.
		or		
		Aggregate Impact Value	IS:2386 (Part IV)	40 percent maximum.
		or IS:5640**		
2.	Base	a) Loss Angeles Abrasion Value*	IS:2386 (Part IV)	50 percent maximum.
		or		
		Aggregate Impact Value	IS:2386 (Part IV)	40 percent maxi mum.
		or IS:5640**		
		b) Flakiness Index***	IS:2386 (Part I)	15 percent maximum.

* Aggregate may satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water, shall be tested for impact value under conditions in accordance with IS:5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

3.04.02.2 Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt and other objectionable matter.

3.04.02.3 Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table-IV, provided, however, the use of Grading No. 1 shall be restricted to sub-base courses only.

TABLE-IV

GRADING REQUIREMENTS OF COARSE AGGREGATES

Grading No.	Size range	Sieve designation	Percent by weight passing the sieve
1.	90 mm to 40 mm	100 mm	100
		80 mm	65-85
		63 mm	25-60
		40 mm	0-15
		20 mm	0-5
2.	63 mm to 40 mm	80 mm	100
		63 mm	90-100
		50 mm	35-70
		40 mm	0-15
		20 mm	0-5
3.	50 mm to 20 mm	63 mm	100
		50 mm	95-100
		40 mm	35-70
		20 mm	0-10
		10 mm	0-5

3.04.02.4 Screenings

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the gradings set forth in Table-V Screenings of Type A in Table shall be used with coarse aggregates of grading 1 in Table IV. Screenings of Type A or B, shall be used with coarse aggregates of grading 2. Type B screenings shall be used with coarse aggregates of grading 3.

TABLE-V

GRADINGS FOR SCREENINGS

Grading Classifi-cation	Size of screenings	Sieve designation	Percent by weight passing the sieve
A.	12.5 mm	12.5 mm	100
		10.0 mm	90-100
		4.75 mm	10-30
		150 micron	0-8
B.	10 mm	10 mm	100
		4.75 mm	85-100
		150 micron	10-30

3.04.02.5 Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value of less than 6 as determined in accordance with IS:2720 (Part V).

Application of binding material may not be necessary, when the screenings used are of crushable type such as moorum or gravel.

3.04.03 **Construction Operations**

3.04.03.1 Preparation of Base

The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50 mm x 50 mm furrows shall be cut at an angle of 45 degrees to the center line of the road at 1 meter intervals in the latter before laying the coarse aggregate.

3.04.03.2 Inverted Choke

If the water bound macadam is to be laid directly over the sub-grade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) shall be spread on the prepared sub-grade before application of the coarse aggregates is taken up.

3.04.03.3 Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly upon the prepared surface in such quantities that the thickness of the compacted layer is 100 mm for grading 1 and 75-100 mm for gradings 2 and 3 for each layer.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted base be permitted.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall not normally be spread more than 3 days in advance of the subsequent construction operations.

3.04.03.4 Rolling

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the center. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the center line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re-rolling until the entire surface conforms to desired camber and grade. In no case shall the use of screenings be permitted to make up depressions.

3.04.03.5 Applications of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreaders, or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

3.04.03.6 Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excessive quantities of water during construction.

3.04.03.7 Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

3.04.03.8 Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.05.00 Tack Coat

3.05.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.05.02 Materials

Binder : The binder used for tack coat shall be bitumen of a suitable grade as directed by the Engineer and conforming to IS:73, 217 or 454, as applicable, or any other approved cutback.

3.05.03 Construction Operations

3.05.03.1 Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous material before the application of the binder.

3.05.03.2 Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight-run bitumen shall be 5 kg. per 10 square meter area for an existing bitumen treated surface and 10 kg per 10 square meter area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers.

The tack coat shall be applied just ahead of the on-coming bituminous construction.

3.06.00 **Bituminous Macadam Binder Course**

3.06.01 **Description**

This work shall consist of construction, in a single course, of 50 mm / 75 mm thickness of compacted crushed aggregates premixed with a bituminous binder, laid immediately after mixing, on a base prepared previously in accordance with the requirements of these Specifications, and in conformity with the lines, grades and cross sections shown on the drawings or directed by the Engineer.

3.06.02 **Materials**

3.06.02.1 Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS:73.

3.06.02.2 Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, of fairly cubical shape and free of disintegrated pieces, organic and other deleterious matter, and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table-VI.

TABLE-VI

PHYSICAL REQUIREMENTS OF AGGREGATES FOR BITUMINOUS MACADAM

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion * Value	IS:2386 (Part IV)	35% Maximum
2.	Aggregate Impact Value *	-do-	30% "
3.	Flakiness Index	IS:2386 (Part I)	35% "
4.	Stripping Value	IS:6241	25% "
5.	Water Absorption	IS:2386 (Part III)	2% "

* Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thicknesses shall conform to the grading A or B given in Tables-VII & VIII.

TABLE-VII

AGGREGATES GRADING FOR 75 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90-100	
40 mm	35-65	100
25 mm	20-40	70-100
20 mm	-	50-80
12.5 mm	5-20	-
4.75 mm	-	10-30
2.36 mm	-	5-20
75 micron	0-5	0-4

TABLE-VIII

AGGREGATE GRADING FOR 50 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90-100	
25 mm	50-80	100
20 mm	-	70-100
12.5 mm	10-30	-
10 mm	-	35-60
4.75 mm	-	15-35
2.36 mm	-	5-20
75 micron	0-5	0-4

3.06.02.3 Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate grading A and B respectively, except when otherwise directed by the Engineer.

The quantities of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

3.06.02.4 Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content of $\pm$ 0.3 percent by weight of total mix shall, however, be permissible for individual specimens taken for quality control tests.

3.06.03 **Construction Operations**

3.06.03.1 Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

3.06.03.2 Preparation of Base

The base on which bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free from dust and foreign matter.

3.06.03.3 Tack Coat

A tack coat shall be applied over the base.

3.06.03.4 Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix.

The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg.C and that of aggregates in the range 125 Deg. - 150 Deg.C, provided that the difference in temperature between the binder and aggregate at no time exceeds 25 Deg.C.

Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly.

The mixture shall be transported from the mixing plant to the point of use in suitable vehicles. The vehicles employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

3.06.03.5 Spreading

The mix shall be spread immediately after mixing by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However, in restricted locations and in narrow widths, where the available plants cannot operate in the opinion of the Engineer, he may permit manual laying of the mix.

The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg.C.

In multilayer construction, the longitudinal joint in one layer shall offset that in the layer below by about 150 mm. However, the joint in the topmost layer shall be at the center line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the center line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

3.06.03.6 Rolling

After the spreading of mix, rolling shall be done by 8 to 10 tonne power rollers or other approved plant. Rolling should start as soon as possible after the material has been spread. Rolling shall be done with care to keep from unduly roughening the pavement surface.

Rolling of the longitudinal joint shall be done immediately behind the paving operation. After this, the rolling shall commence at the edges and progress towards the center longitudinally except that on super-elevated portions it shall progress from the lower to the upper edge parallel to the center line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface or having the mix pick up on the roller wheels. The second or inter-mediate rolling shall follow the break down rolling as closely as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh material. The rolling shall then be continued till the entire surface has been rolled to compaction, there is no crushing of aggregate and all roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking to the wheels and being picked up. In no case shall fuel lubricating oil be used for this purpose.

Rolling operations shall be completed in every respect before the temperature of the mix falls below 80 Deg.C.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with final surfacing without any delay. If there is to be any delay, the course shall be covered by a seal coat before allowing any traffic over it.

3.07.00 **Open-Graded Premix Carpet**

3.07.01 **Description**

This work shall consist of laying and compacting an open-graded carpet of 2 cm thickness in a single course composed of suitable small sized aggregates premixed with a bituminous binder on a previously prepared base, to form a wearing course, in accordance with the requirements of these specifications.

3.07.02 **Materials**

3.07.02.1 Binder

The binder shall be bitumen of a suitable grade, as directed by the Engineer, and satisfying the requirements of IS:73, 217, 454 or other approved cutback as applicable.

3.07.02.2 Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, and vegetable or other deleterious matter. They shall preferably be hydrophobic type.

The aggregates shall satisfy the quality requirements set forth in Table-VI except that the Flakiness Index shall be limited to a maximum of 30.

3.07.02.3 Proportioning of Materials

The materials shall be proportioned as per quantities given in Table IX.

TABLE-IX

QUANTITIES OF MATERIALS REQUIRED FOR 10 SQ.M OF ROAD SURFACE FOR 2 CM THICK OPEN-GRADED PREMIX CARPET

Aggregates of Carpet

a)	Stone chippings - 12 mm size; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
b)	Stone chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total :	0.27 Cu.m

Binder for premixing (quantities in terms of straight run bitumen)

a)	For 0.18 Cu.m of 12 mm size stone chippings at 52 kg per Cu.m	9.5 kg
b)	For 0.09 Cu.m of 10 mm size stone chippings at 56 kg per Cu.m	5.1 kg
	Total :	14.6 kg

3.07.03 **Construction Operation**

3.07.03.1 Weather and Seasonal Limitations

Open-graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg.C or below.

3.07.03.2 Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade & cross section in accordance with Table I as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matter with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

3.07.03.3 Tack Coat

A tack coat complying with clause 3.5 shall be applied over the base preparatory to laying of the carpet. Application of tack coat shall, however, not be necessary when the laying of carpet follows soon after the provision of a bituminous course.

3.07.03.4 Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer, in boilers of suitable design avoiding local overheating and ensuring a continuous supply.

The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified.

The mixing of binder with chippings shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

3.07.03.5 Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader, without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material has been laid rolling shall commence with 6 to 8 tonne power rollers, preferably of smooth wheel tandem type, or other approved plant. Rolling shall begin at the edges and progress toward the center longitudinally, except that on the super elevated portions it shall progress from the lower to upper edge parallel to the center line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

3.07.03.6 Seal Coat

A seal coat conforming to clause 3.8 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.08.00 **Seal Coat**

3.08.01 **Description**

This work shall consist of application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and camber.

Seal coat shall be of either of the two types below, as specified:

Type A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.08.02 **Materials**

3.08.02.1 Binder

The binder shall be bitumen of a suitable grade as directed by the Engineer and conforming to the requirements of IS:73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be utilised, in terms of straight run bitumen shall be 9.8 kg and 6.8 kg per 10 square meter area for Type A and Type B seal coat respectively.

3.08.02.2 Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matter. Stone chippings shall be of 6 mm size defined as 100 percent passing through 10 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cubic meter per 10 square meter area. The chippings shall satisfy the quality requirements spelled out in Table-VI except that the upper limit for flakiness Index shall be 30.

3.08.02.3 Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky

material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic meter per 10 square meter area.

3.08.03 **Construction Operations**

3.08.03.1 Preparation of Base

The seal cost shall be applied immediately after the laying of bituminous course which is required to be sealed. Before application of seal coat materials the surface shall be cleaned free of any dust or other extraneous matter.

3.08.03.2 Construction of Type A Seal Coat

The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state, shall be spread uniformly on the surface, preferably by means of a mechanical gritter, otherwise manually so as to cover the surface completely. If necessary, the surface shall be broomed to ensure uniform spread of chippings.

Immediately after the application of the cover material, the entire surface shall be rolled with a 8-10 tonne smooth wheeled roller. Rolling shall commence at the edges and progress towards the center except in super elevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

3.08.03.3 Construction of Type B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter are thoroughly coated with the former.

The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6-8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.08.04 **Opening to Traffic**

In the case of Type B Seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. However, as regards Type A seal coat, traffic shall not be permitted until the following day.

3.09.00 **Repair of Existing Water Bound Macadam Surface**

Pot holes or patches and ruts in water bound macadam base or surface course, which is to be surface treated, shall be repaired by removal of all loose material by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under :

Pot holes, patches and ruts shall be drained of water and cut to regular shape with vertical sides, and then be filled either with i) coarse aggregate and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer or ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer. Payment for i) shall be done as per items for water bound macadam and for ii) as per item for open graded premix carpet.

The above is only applicable in case of damage to the existing water bound macadam surfaces. In case, however, it is found that there has been damage to the granular sub-base as well, the area of the damaged surface shall be repaired by removal of all loose materials, cut to regular shape with vertical sides & relaid with graded material as per specification of granular sub-base & then surfaced with water bound macadam as per specification for the same.

For the record purposes, measurements for stone metal shall be taken before they are actually used on the work. Pre-measurements of materials taken for record purposes shall simply serve as a guide and shall not form the basis for payment. Thickness of treatment shall be the ruling criterion for payment for repair of water bound macadam surfaces and sub-base.

Payment for repairs shall be made on the basis of unit rates quoted by the Contractor for the items and shall include supply and laying of sub-base, water bound macadam, rolling etc. including labour, materials, tools, plants, tackle etc. required for the work.

3.10.00 **Road Side Drains**

3.10.01 **Formation of Drains**

The road side drains shall be made in sizes and slopes as shown on drawings and/or as instructed by the Engineer. The minimum side slope shall be as instructed by the Engineer. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts, outside plant area, as per instructions of the Engineer.

The excavated spoils shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for the drains shall be as per approved drawing. Lining of drains will be of RCC construction with necessary slopes.

3.11.00 **Culverts**

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Engineer after clearing the site, etc. as per specifications of earthwork. Backfilling with ramming and watering shall be done after construction of the foundations.

The construction of culverts shall be done true to lines and levels and as shown on the drawing. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed, as applicable.

3.12.00 **Pipe Culverts and Drainage Pipes**

3.12.01 **Materials**

The drainage pipes unless otherwise shown on drawings or instructed by the Engineer shall be made of R.C.C. and shall be either Class NP2 or NP3.

Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP3 or of RDSO class for railway as decided by the Engineer or shown in the drawing. All pipes shall meet the requirements of IS:458 - Latest edition and shall be procured from approved manufacturers with collars as per manufacturer's standard specifications. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269 - Latest edition.

Aggregates shall be as per IS:383 - Latest edition - Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller.

Fine aggregates for concrete shall be as per IS:383 - Latest edition.

3.12.02 **Laying of Pipes**

Laying of concrete pipes shall correspond to IS:783 - Latest edition - and to specification given below :

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings or as directed by the Engineer. When trenching is involved its width on either side of the pipe shall not be less than 150 mm nor more than one-third the diameter of pipe unless otherwise instructed/ permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water, etc. as required shall be done by the Contractor without any extra cost to the Owner. Side slips, if there be any, shall be removed by the Contractor without any extra cost to the Owner. After laying of the pipes are completed, backfilling of the trenches shall be done in 250 mm layers, measured loose, clods & lumps broken, watered and compacted with iron rammers to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area, as instructed by the Engineer.

When bed-rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented material, shaped to the requirements and thoroughly

compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

Laying of pipes shall start from the outlet and proceed towards inlet.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from a height.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS:783 - Latest edition - having a projection ratio of not greater than 0.70, in which the pipe is carefully bedded on fine granular materials in an earth foundation carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height, and in which earthfilling material is thoroughly rammed and tamped in layers not exceeding 15 cm in depth around the pipe for the remainder of the lower 30 percent of its height.

If the pipe is laid in trench, pipe bedding shall be first class bedding as per IS:783.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a craddle constructed of concrete having a mix not leaner than M15. The shape and dimension of the cradle shall be as indicated on the drawing or directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete has set.

c) The drop walls shall be made with Fly ash brick or first class clay bricks having compressive strength minimum of 50 kg/cm^2, in 1:4 cement:sand mortar.

d) The pipe culverts shall be made with proper care regarding the invert of the pipe, gradient, if any, etc. as specified on drawings and/or as instructed by the Engineer.

e) Where R.C.C. pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and remaining height of block to be concreted subsequently.

f) The R.C.C pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 parts of clean sand with only enough water for workability. Procedure of jointing shall be as per IS:783 - latest edition.

3.12.03 **Relation with Water Supply Pipeline**

Unless specifically cleared by the Engineer, under no circumstances shall drainage pipes be allowed to come close to water supply pipelines.

3.13.00 **Manholes and Inspection Chambers**

The maximum distance between manholes shall be 30 meter unless specifically permitted otherwise. In addition at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be watertight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels & drains shall be shaped and laid to provide smooth flow.

Connection to existing pipelines shall be through a manhole.

Manholes shall be provided with standard covers, usually C.I. or as directed by the Engineer. The covers shall be close fitting so as to prevent gases from coming out.

3.14.00 **Masonry**

3.14.01 **Brick Masonry**

All bricks shall be Fly ash brick or clay bricks of first class (Class A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws or nodules of free lime. Bricks shall be soaked in water for at least two hours prior to use and shall be laid truly horizontal and vertical in headers and stretchers with cement mortar consisting of one part of cement and four parts of sand, unless otherwise mentioned in the schedule of Items or directed by the Engineer, in layers not exceeding 1.5 M in height. Each layer shall be allowed at least 24 hours to settle itself before another layer is placed on it and every layer cured with water until the starting of next layer above it.

Materials for mortar such as sand and cement shall be of approved quality. Mortar shall be well mixed, first dry mixed and then by adding water slowly to have a thick workable consistency. Mortar shall be mixed in small batches consistent with the rate of consumption so that no mortar is used after one hour of mixing.

Mortar joints shall be kept uniformly 10 mm thick and all joints should be full of mortar. Brickwork shall be carried up regularly in plumb every course being horizontal. No vertical joints shall come directly over one another.

Joints of the brickwork shall be raked minimum 10 mm deep using raking tool while mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. The brickwork shall be kept moist for 14 days.

All bricks which absorb water more than 20% of their own dry weight after being immersed in water for 24 hours shall be rejected. Brick should be as per IS:1077. Bricks shall have minimum crushing strength of 50 kg/Sq.cm.

3.14.02 **Stone Masonry**

All stones shall be from approved quarries, hard, tough, durable, compact grained, uniform in texture & colour and free from decay, flaws, veins, cracks & sand holes. A stone shall not absorb more than 5% of its weight of water after 24 hrs. immersion. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

Stone shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall not be less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.14.03 **Pointing to Masonry**

After raking out of the joints, the brickwork shall be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water, mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finished with suitable tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

3.15.00 **Plaster to Masonry and Concrete**

Before application of plaster the surface shall be cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess water shall be mopped up.

Unless otherwise mentioned in the schedule of items plastering shall be done with cement sand mortar - 1 part by volume of cement to 4 parts by volume of clean, sharp, well graded sand. For sand cement plaster, sand & cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency. For lime gauge plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall than be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No mortar which has stood for more than half an hour shall be used.

Plaster, when more than 12 mm thick, shall be applied in two coats. All plaster work shall correspond to IS:1661 - latest edition.

3.15.01 **Finish**

Generally, all plastered surfaces shall have a standard finish unless otherwise shown on the drawing or directed by the Engineer. The interior plaster shall be finished to a smooth surface by steel trowelling. The exterior surfaces shall be finished with a wooden float.

However, if shown on the drawing or directed by the Engineer the plastered surface shall have a neat cement finish. Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg per Sq.M. and rubbed smooth with a trowel.

3.16.00 **Cement Concrete (Plain and Reinforced)**

3.16.01 **General**

All concrete work shall be according to ISI relevant Codes unless mentioned otherwise herein and the ISI Codes particularly IS:226, IS:455, IS:385, IS:1786 & IS:456 - latest editions - shall form a part of the present specification.

3.16.02 **Materials**

a) Cement : The cement used shall be ordinary portland cement of grade 43 / 53 of approved manufacture and shall be fresh when delivered. Consignments shall be used in the order of delivery. Damaged or partly set cement shall not be permitted to be used and shall be removed from site at once.

Admixture shall be used only if approved by the Engineer. The Contractor shall furnish to the Engineer, the manufacturer's certificate for cement for each consignment, procured by the Contractor direct. If at any time, the Engineer feels that the quality of cement is not upto the specification, he can stop the work and send samples of cement for testing to an approved laboratory. The Contractor shall have no claim for any loss arising out of such suspension of work.

If the cement is procured by the Owner and issued to the Contractor, the Contractor shall satisfy himself at the time of taking delivery that quality and freshness of cement are upto the specified standard. No complaint will be entertained later on from the Contractor for poor concrete work due to the poor quality of cement supplied by the Owner. All rectification work on this account shall be done entirely by the Contractor at his own expenses.

b) Aggregate :

i) General

Aggregate shall consist of natural sand, crushed stone procured from a source known to produce satisfactory aggregate for concrete and shall be chemically inert strong, hard, durable against weathering, of limited porosity and free from adhering coatings, clay lumps, coal and coal residues, clinkers, slag, organic and other impurities that may cause corrosion of the reinforcements or may impair the strength and/or durability of the concrete. They shall conform to IS:383 - latest edition.

ii) Sand and Fine Aggregate :

It shall be clean, sharp and coarse and free from all impurities

and shall be washed and/or screened at the site if so demanded by the Engineer. Sand and fine aggregate shall correspond to IS:383 - latest edition. The fine aggregate shall not contain more than 3 percent of clay or foreign matter. Fineness modulus of sand shall not be less than 2.5.

iii) Coarse Aggregate:

This shall consist of broken trap, basalt or granite or some other suitable stone from a source to be approved by the Engineer and shall meet the requirements of IS:383 - latest edition. The coarse aggregate shall be machine crushed, hard, strong, durable, free from clayey films or loamy admixtures, vegetable or organic matters and shall be washed with water and/or screened if so demanded by the Engineer. The aggregate shall be well graded. The pieces shall be angular in shape and shall have granular or crystalline surface. Friable, flaky and laminated pieces, mica and shell may be present only in such quantities that will not affect adversely the strength and/or durability of concrete and to the approval of the Engineer. The maximum size of coarse aggregate shall be 38 mm for lean concrete and M10 Grade concrete and 20 mm for M15 Grade concrete.

Where permitted by the Engineer, the maximum size of the coarse aggregate may be large. All aggregate shall be uniformly graded. The amount of fine particles occurring in the free state or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% of the weight.

c) Water :

Water shall be clean, fresh and free from organic or deleterious matter in solution or in suspension in such amounts that may impair the strength or durability of the concrete. The Contractor shall, however, satisfy himself that the quality is upto the desired standard and shall also submit an analysis from an approved analyst if so desired by the Engineer, free of charge.

d) Reinforcements :

The reinforcement shall be mild or torsteel bars conforming to the latest edition of IS:432 or IS:1786.

All reinforcing bars must be completely free from grease, oil, dirt, scales, scrapable rust, bituminous material, paint, pitted surface and manufacturing defects.

e) Formwork :

The formwork shall be composed of best quality well seasoned hardwood, steel, suitable plywood or equivalent, well seasoned best quality soft wood (for ornamental works) as directed by the Engineer. Bamboos, small diameter ballies, etc. shall not be used unless specially approved by the Engineer in specific cases.

3.16.03 **Storage of Materials**

a) Cement :

Cement shall be stored at the works in such a manner as to prevent deterioration either through moisture or intrusion of foreign matter. Sufficient storage shall be arranged by the Contractor to ensure continuity of consumption. Cement shall be stored in easily countable stacks.

b) Aggregates :

Aggregates shall be stored on planking, steel plates or concrete. Different sizes shall be separated with wooden, steel, or concrete bulkheads. Care shall be taken to prevent any segregation of various sizes of particles. The aggregates must not be allowed to come in contact with dirt, clay and other injurious substances at any stage. The aggregate shall be stored in easily measurable stacks. Procurements must be at least two months in advance of consumption in dry season and four months in advance in rainy season.

c) Reinforcement :

Reinforcing steel shall be stored as far as possible under cover. It shall be protected from oil, grease, dirt, etc. The stacks shall be easily measurable.

3.16.04 **Workmanship**

a) Reinforcement

i) Bending :

Reinforcement bars shall be bent by machine or other approved means producing a gradual & even motion. All the bars shall be cold bent unless otherwise approved. Bars correctly bent only will be used. Bends and shapes shall comply strictly with the dimensions in the approved bar bending schedule. Bending schedule shall be prepared by the Contractor and got approved by the Engineer before bending and he shall be entirely responsible for its correctness. No reinforcement shall be bent when in position in the work without approval of the Engineer, whether or not it is partially embedded in concrete. Unless described otherwise, lapping dimensions shall conform to IS:456 - latest edition and all bending shall correspond to IS:2502 - latest edition.

ii) Placing in Position :

Fixing of reinforcement shall correspond to IS:2502 - latest edition. Reinforcements shall be accurately fixed & maintained in position by such means as mild steel chairs and concrete spacer pieces, Bars intended to be in contact at passing points shall be securely bound together at all such points by No. 20G annealed soft iron wire conforming to IS:280 - latest edition. Binders and the like shall tightly embrace the bars with which

they are intended to be in contact and shall be securely bound.

The vertical distances between successive layers of bars shall be maintained by provision of mild steel spacer bars at such intervals that the main bars do not sag perceptibly between adjacent spacer bars.

The placing of reinforcements shall be completed well in advance of concreting. Immediately before concreting, the reinforcement shall be examined for accuracy of placing and cleanliness by the Engineer and corrected if it is so desired by him. The cover for concrete over the reinforcements shall be as shown or as specified on the approved drawings. Unless otherwise directed, all laps shall be minimum 52 times the diameter of the bar in case of H.T. deformed bar and 40 times diameter of the bar in case of mild steel. If the bars in a lap are not of same diameter, the smaller will guide the lap length. The laps shall be staggered.

Where concrete blocks are used for ensuring the cover and position, they shall be made of mortar not leaner than one (1) part cement to two (2) parts sand and cured for at least seven days.

b) Formwork :

The formwork shall conform to the shape, line and dimensions as shown on the plans and shall be made of timber close and tight to prevent leakage of mortar with necessary props, bracings and wedges sufficiently strong and stable so that it should not yield on laying of concrete. Formwork shall conform to IS:456 - latest edition - in respect of above and stripping time, cleaning and oiling, etc.

c) Concrete :

Mix : The following concrete mixes shall be used as specified in drawings or as directed by the Engineer :

Grade	**Mix**	**Minimum Cement Content**
M-15	To be designed	325 kg/Cu.M.
M-20	-do-	360 kg/Cu.M.
M-25	-do-	410 kg/Cu.M.
Plain Concrete	1:3:6 (nominal) 1.4.8 (nominal)	

i) Water cement ratio and slump shall be determined to suit strength requirements of the concrete mix.

ii) Mixing : The aggregate and sand shall be washed free from all dust and earthy matter if required by the Engineer. The above materials will then be accurately measured in boxes. The quantity of cement shall be determined by weight. The quantity of water shall be predetermined after allowing for

moisture content in the aggregate. All the ingredients as proportioned shall then be mixed in a mechanical mixer till the mass is uniform in texture and consistency, but in no case the mixing time shall be less than two minutes. Hand mixing if permitted by the Engineer as a special case shall be carried out on a water tight platform using 10% extra cement at Contractor's cost and care shall be taken to ensure that the mixing is continued till the mass is uniform in colour and consistency.

iii) Placing and Compacting : Concrete shall be transported from the place of mixture to the place of final deposit within 45 minutes after water has been added and shall be compacted before initial setting commences and should not be subsequently disturbed. Method of transporting & placing shall be such as to preclude segregation. Concrete shall be thoroughly worked around the reinforcements, etc. and into all corners of formwork. For compaction of concrete, mechanical vibrators shall be used. Concrete shall not be placed in water. Mixing, transporting, placing and compacting of concrete shall conform to IS:456 - latest edition.

iv) Curing : Concrete shall be cured for at least 28 days from the date of placing of concrete.

v) Testing of Concrete : Concrete shall be tested in accordance with IS:516 - latest edition and accepted in accordance with IS:456 - latest edition.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Roads

All testing, as mentioned in the body of the specification and as mentioned in Clause No. 900 of Specification for Roads and Bridge Works, 1983 published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per direction of the Engineer. No extra payment shall be made for such tests.

4.02.00 Masonry and Plastering

Masonry and finish to masonry and concrete shall fully comply with the drawings, specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness and any other special criteria as mentioned in the body of the specification or as shown on drawing.

4.03.00 Cement Concrete

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS:456.

5.00.00 INTERLOCKING PAVING BLOCKS

5.01.00 Area of roads and pavements for vehicular traffic to be paved with precast interlocking concrete blocks shall be placed over 250 mm thick crushed aggregate sub-base and 100 mm thick water bound macadam base. For other pavement areas these are to placed over 150 mm thick crushed aggregate sub-base and 100 mm thick water bound macadam base.

5.02.00 A stable edge shall be provided to retain the paving units and sand bedding by means of precast concrete edging unit or kerb set in-situ concrete.

5.03.00 The paving blocks shall be laid true to levels and grades for the finished work over a sand bedding of 50 mm uncompacted thickness.

5.04.00 The sand for bedding shall be a fine, well graded in a dry to moist condition.

5.05.00 The interlocking paving blocks shall be a minimum of 80 mm thick and the concrete quality shall be approved by the Engineer. The mix of paving block shall contain a water repelling additive. The sample of paving block shall be submitted to the Engineer for approval. No orders shall be placed with the manufacturer until the Engineer's approval has been given.

5.06.00 The paving blocks shall be laid in accordance with the manufacturer's instruction and shall be compacted at completion of each days work.

PART-II
TECHNICAL SPECIFICATION FOR CONSTRUCTION OF WET MIX MACADUM ROAD

1.0.0 WET MIX MACADAM

1.1.0 Description

Wet mix macadam shall consist of clean, crushed, graded aggregates premixed with water and laid and shall be rolled to a dense mass on a prepared sub-grade, sub-base, base or existing pavement as the case may be. In each case the construction shall be carried out to conform to specified lines, grades and cross-sections.

1.2.0 Materials

1.2.1 Aggregates - General Requirements

The aggregates shall consist of hard, durable particles of crushed stone, crushed gravel or crushed slag of requisite quality as stated hereinafter. These shall satisfy the physical requirements set forth in Table-1.

Table-1

Physical Requirements of Aggregates for Wet-Mix Macadam

Sl. No.	Type of Construction	Test Method	Test	Requirement
1.	Sub-base	Los Angeles Abrasion Value	IS:2386 (Part IV)	Max. 60%
		or		
		Aggregate Impact Value*	-do-	Max. 50%
2.	Base	a) Los Angeles Abrasion Value*	-do-	Max. 50%
		or		
		Aggregate Impact Value*	-do-	Max. 40%
		b) Flakiness Index	IS:2386 (Part I)	Max. 30%

Note :

1. *Aggregates may pass the requirements of either the Los Angeles Test or Aggregate Impact Value Test.

2. Fraction of the aggregates passing 425 micron sieve when tested in accordance with IS:2720 (Part V) should not have a PI value of more than 6.

1.2.2 **Crushed Stone/Gravel**

Crushed stone/gravel shall be free of flat, elongated, soft and disintegrated particles. They shall also not contain an excess of dirt or other objectionable matter.

1.2.3 **Crushed Slag**

Crushed slag shall be manufactured out of air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free of any thin, elongated and soft pieces, as well dirt or other objectionable matter. Crushed slag shall not weigh less than 1120 kg. per m' or absorb more than 10 percent water by its weight when tested in accordance with IS:2386 (Part III).

1.2.4 **Aggregates - Grading Requirements**

As far as possible, aggregates for wet-mix macadam shall conform to one of the gradings given in Table-2.

Table-2

Grading Requirements of Aggregates for Wet-Mix Macadam

	Percent by Weight Passing the Sieve	
Sieve Designation (IS:460)	**Grading 1 Max. Nominal Size 40 mm**	**Grading 2 Max. Nominal Size 20 mm**
50 mm	100	
40 mm	95-100	
25 mm	-	100
20 mm	60-80	90-100
10 mm	40-60	-
4.75 mm	25-40	35-55
2.36 mm	15-30	-
600 micron	8-22	10-30
75 micron	0-8	2-9

The nominal size of aggregate to be used in a given case shall depend on availability. While both the grading can be used for base/sub-base course construction, preferably layers of grading No. 1 shall not be used above layers of grading No. 2.

Generally it should be possible to obtain aggregates conforming to the above gradings directly from the crusher. However, where this is not so for any reason, necessary quantities of missing fractions shall be blended as to bring the grading of the mixed material upto the specified limits.

1.2.5 Quantity of Aggregates

Approximate quantity of aggregates required for 75 mm & 100 mm compacted thickness of wet-mix macadam will range from 1.1 to 1.2 cu.m and 1.45 to 1.6 cu.m respectively per 10 sq.m area.

1.3.0 Construction Operations

1.3.1 Preparation of Foundation for Receiving the Wet-Mix Macadam Courses

The sub-grade, sub-base or base to receive the wet-mix macadam course shall be prepared to the required grade and camber and cleaned of all dust, dirt and other extraneous matter. Any ruts or soft yielding places that have appeared due to improper drainage, service under traffic, or other reasons, shall be corrected and rolled until firm. If necessary, the existing surface may be scarified and reshaped to achieve this objective.

Where the existing road surface is black-topped, 50 mm x 50 mm furrows shall be cut in the existing surface at 45 deg. to centre line of the carriageway, spaced every one metre, before proceeding with the laying of the coarse aggregates.

In all cases, the foundation shall be kept well drained throughout the construction operations.

1.3.2 Provision of Lateral Confinement of Aggregates

Before starting with wet-mix macadam construction, necessary arrangements shall be made for the lateral confinement of aggregates. This could be done by constructing side shoulders in advance to a thickness corresponding to the compacted layer of the wet-mix macadam course. After the shoulders are ready, their inside edges shall be trimmed vertical and the included area cleaned of all spilled material, thereby setting the stage for spread of aggregates. The practice of constructing the macadam in a trench excavated after finishing formation shall be completely avoided.

1.3.3 Mixing of Aggregates with Water

Aggregates for wet-mix macadam shall be mixed with the requisite quantity of water in a power mixer of suitable capacity and optimum moisture for mixing shall be determined in accordance with IS:2720 (Part VII) after replacing the aggregate fraction retained on 20 mm sieve with material of 4.75 mm to 20 mm size. While adding water due allowance shall be made for evaporation losses. However, at the time of compaction, water in the wet mix shall not vary from the optimum value by more than $\pm$ 0.5 percent. The mixed material shall be uniformly wet and no segregation shall be permitted.

1.3.4 Spreading of Aggregates

Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared base in required quantities. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base to be permitted. The aggregates shall be spread to proper profile by using templates placed across the road about 6 metre apart.

Where possible approved mechanical devices may be used for this purpose so as to minimise the need for their manipulation by hand.

Wet mix macadam course shall normally be constructed in layers each not exceeding 75-100 mm in compacted thickness. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles shall be allowed. The aggregates as spread shall be of uniform gradation with no pockets of fine materials.

1.3.5 Rolling

After aggregates have been laid to the required thickness, grade and camber, these shall be compacted to the full width by rolling with either three-wheeled power roller of 8 to 10 tonnes capacity or an equivalent vibratory roller.

The rolling shall begin at edges with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road, uniformly lapping each preceding rear wheel track by one half width.

On super elevated portions of the road, rolling shall commence from the lower edge and progress gradually towards the upper edge of the pavement.

Rolling shall not be done when the sub-grade is soft or yielding or when it causes a waver-like motion in the base course or sub-grade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface shall be loosened and aggregates added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and cross-section. The surface shall also be checked transversely by template for camber, and any irregularities corrected in the manner described above. In no case shall the use of un-graded material or fines permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 100 percent of the maximum dry density for the material determined in accordance with the procedure explained in para 1.3.3. After completion the surface of any finished layer shall be well-closed, free from movement under compaction plant or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and re-compacted.

1.4.0 **Opening of Traffic**

Preferably no vehicular traffic of any kind shall be allowed on the finished wet-mix macadam surface till it has dried and the wearing surface laid. In exceptional cases, construction traffic may be permitted for short durations once the course is completely dry provided vehicles move over the full width avoiding any rutting or uneven compaction.

1.5.0 **Surface Evenness of Wet-Mix Macadam Course**

The surface evenness of the completed wet-mix macadam course in the longitudinal and transverse directions shall be within the following tolerances :

i)	Longitudinal profile when tested with a 3 metre straight edge	Maximum permissible variation	12 mm
ii)	Cross profile when checked with a camber template	Maximum permissible variation	8 mm

The longitudinal profile shall be checked with a 3 metre long straight edge at the middle of each traffic lane along a line parallel to the centre line of the road. The transverse profile shall be checked with a series of three camber boards at intervals of 10 metres.

1.6.0 **Rectification of Defective Construction**

Where the surface irregularity of the wet-mix macadam course exceeds the tolerances specified in Para 1.5.0, or where the course is otherwise defective due to sub-grade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and recompacted in accordance with Para 1.3.1 thru' 1.4.0. The area treated in the aforesaid manner shall not be less than 10 sq.m. In no case shall depressions be filled up with un-graded material or fines.

TECHNICAL SPECIFICATION
FOR
XI) ROADS AND DRAINAGE

PART-III : CONSTRUCTION OF RCC ROAD WITHIN PLANT

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA

XI) ROADS AND DRAINAGE

PART-III : CONSTRUCTION OF REINFORCED CEMENT CONCRETE ROAD WITHIN PLANT

1.00.00 SCOPE

This specification covers all work required for the construction of road including box-cutting, edging, reinforced cement concrete pavement slab on lean concrete base, water bound macadam sub-base including preparation of subgrade etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification also includes all work required for drainage including road side drain, R.C.C. culverts, pipe-culverts, drainage pipes, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.

b) Submit for approval detailed schemes of all operations required for executing the work e.g., material handling, placement, services, approaches etc.

c) To carry out and submit to the Engineer results of tests whenever required by the Engineer to assess the quality of work.

2.02.00 Work to be provided for by Others

No work under this specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and Codes of Practice.

1. Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.

2. IRC-19 Standard specifications and Code of Practice for Water Bound Macadam.

3. IRC:SP-11 Hand Book of Quality Control for Construction of Roads and Runways.

4. IS:456 Indian Standard Codes of Practice for Plain and Reinforced Concrete.

5. IS:2212 Code of Practice for Brickwork.

6. IS:783 Code of Practice for Laying of Concrete Pipes.

7. IRC:15 – 2002 Standard Specifications and Code of Practice for Construction of concrete roads

8. IRC:58 - 2002 Guidelines for the design of plain jointed rigid pavements for Highways.

9. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard Specification, AASHTO and any other standard practice as may be specified by the Engineer shall be followed.

2.04.00 **Conformity with Designs**

The contractor shall carryout the work as per the drawings issued to him and/or contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be Used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.06.00 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used.

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for road works are described hereinafter.

i) Horizontal Alignments

Horizontal alignments shall be reckoned with respect to the center line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of $\pm$ 25 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be $\pm$ 40 mm.

ii) Longitudinal Profile

The levels of the sub-grade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer, beyond tolerances mentioned below:

Sub-grade	± 25 mm
WBM Sub-base	± 20 mm
Lean concrete Base	± 15 mm
RCC Pavement Slab	± 10 mm

Tolerance in RCC Pavement Slab shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6 mm.

iii) Surface Regularity of Sub-grade and Sub base WBM

The surface regularity of completed sub-bases and base courses in the longitudinal and transverse directions shall be within the tolerances indicated in Table-I of Technical Specification for Roads and Drains – Part-I (flexible pavement.

iv) Surface regularity and surface texture of Reinforced Cement concrete pavement

The surface levels and regularity of concrete pavement shall be within the tolerance indicated in Section 600 of MORT&H (Ministry of Road Transport & Highways) – specifications for Road and Bridge Works.

Texture depths shall not be less than the minimum required when measurements are taken as given in Table 600-2 of MORT&H nor greater than a maximum average of 1.25mm.

TABLE- : 600-2. Texture Depth

Time of Test	Number of Measurements	Required Texture Depth (mm)	
		Specified Value	Tolerance
1. Between 24 hours and 7 days after the constn., of the slab or until the slab is first used by vehicles	An average of 5 measurements	1.00	±0.25
2. Not later than 6 weeks before the road is opened to public traffic	An average of 5 measurements	1.00	+0.25 -0.35

After the application of the brushed texture, the surface of the slab shall have a uniform appearance.

Where the texture depth requirements are found to be deficient, the Contractor shall make good the texture across the full lane width over length directed by the Engineer, by retexturing the hardened concrete surface in an approved manner.

v) Minimum thickness of RCC pavement slab will be 300mm of M25 grade concrete. Reinforcement bars will not be less than 0.18% of Gross cross-sectional area. Reinforcement bars shall be placed in both layers – top & bottom. Minimum cement content will be 360 Kg/cum.

vi) Design and detailing of RCC pavement shall be done in accordance with IRC:58 – 2002 and IRC:15 – 2002. The spacing of control joints shall be as follows:

a)	Transverse expansion joint	=	30m (maximum)
b)	Transverse crack control/ contraction joint	=	4.5m (maximum)
c)	Longitudinal separation joint	=	One at centre for 7.5m wide road

Tender drawing no. K9213R-DWG-S-0007 may be referred for details of joints.

3.00.00 EXECUTION

3.01.00 Shall be as per Technical Specification for Road & Drainage Part-I and MORT&H specification for Road and Bridge.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Shall be as per Technical Specification for Road & Drainage Part-I and MORT&H specification for Road and Bridge.

TECHNICAL SPECIFICATION
FOR
XII) REINFORCED CONCRETE CHIMNEY

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA
5.00.00	INFORMATION TO BE SUBMITTED

I) REINFORCED CONCRETE CHIMNEY

1.00.00 SCOPE

This specification covers plain and reinforced cement concrete work, lining and insulation work, miscellaneous steel and metal work, painting and protective treatment work, lightning protection system and aviation obstruction lighting system, connected with construction of RCC Chimney.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

Work to be provided by the Contractor, unless specified otherwise, shall include but shall not be limited to the following :

a) Furnish all labour, supervision, services, insurance, material, power, fuel, forms, templates, supports, scaffolding, tools, plants, construction equipment, approaches, transportation etc. required for the entire work.

b) Design and prepare working drawings for formworks, scaffoldings, supports, staging etc. and submit them for approval.

c) Prepare and submit for approval, as per approved schedule, detailed drawings for R.C. work in foundation, shell, hopper, platforms & ground floor & bending schedules for reinforcement bars, showing the positions and details of spacers, chairs, supports, hangers, openings etc.

d) Prepare detailed fabrication and erection marking drawings for steel and metal works and submit them for approval.

e) Prepare detailed shop drawings for various inserts, anchors, sleeves, frames, templates, anchor bolts etc. showing relative locations of their installations and submit them for approval.

f) Prepare and submit for approval the detailed schemes for operations like material handling, placement of concrete etc. and for items like approaches, services etc.

g) Design and submit for approval the mix proportions for concrete to be adopted on job.

h) Furnish samples and submit for approval the results of tests for various properties of the following materials :

   i) Ingredients of concrete
   ii) Concrete
   iii) Metal work components
   iv) Acid proof bricks

v) Fire bricks
vi) Castable refractories
vii) Insulation material
viii) Paints
ix) Electrical Items.

i) Provide all incidental items not specified or shown on drawings in particular but reasonably implied or necessary for successful completion of the work in accordance with drawings and specifications.

j) Produce, if directed by the Engineer, a guarantee, in approved proforma, for satisfactory performance, for a specified period, of material manufactured by specialist firms.

2.02.00 **Work by others**

No work under this specification will be provided for by agency other than the Contractor for this Contract unless specifically mentioned otherwise in the Contract.

2.03.00 **Codes and Standards**

All works under this Specification, unless specified otherwise, shall conform to the latest revisions/replacements of the following Indian Standard Codes, Criteria, Specifications, alongwith those mentioned therein. In case any particular aspect of work is not covered by Indian Standards, other standard specification, as may be specified by the Engineer, shall be followed. 'IS Specification' shall mean Codes, Criteria etc. of ISI :

IS:6 Moderate heat duty fire clay refractories, Group-A.

IS:104 Ready mixed paint, brushing, zinc chrome, priming.

IS:158 Ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and heat resisting for general purposes.

IS:269 Ordinary, and low heat Portland cement.

IS:383 Coarse and fine aggregates from natural sources for concrete.

IS:432 Mild steel and medium tensile steel bars.

IS:456 Code of practice for plain and reinforced concrete.

IS:516 Methods of test for strength of concrete.

IS:732 Code of practice for electrical wiring installations (System voltage not exceeding 650 Volts).

IS:800 Code of practice for general construction in steel.

IS:808 Rolled steel beam, channel & angle sections.

IS:813	Scheme of symbols for welding.
IS:814	Covered electrodes for metal arc welding of structural steel.
IS:816	Code of practice for use of metal arc welding for general construction in mild steel.
IS:817	Code of practice for training and testing of metal arc welders.
IS:818	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS:822	Code of procedure for inspection of welds.
IS:9595	Recommendation for Metal Arc Welding of Carbon and Carbon Manganese steels.
IS:1139	Hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcements.
IS:1161	Steel tubes for structural purposes.
IS:1199	Methods of sampling and analysis of concrete.
IS:1200	Methods of measurement of building works.
IS:1239 (Part-I)	Mild steel tubes.
IS:1367	Technical supply conditions for threaded fasteners.
IS:1526	Sizes and shapes for firebricks (230 mm. series).
IS:1566	Hard-drawn steel wire fabric for concrete reinforcement.
IS:1608	Methods for tensile testing of steel products.
IS:1730	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
IS:1731	Dimensions for steel flats for structural and general engineering purposes.
IS:1786	Cold-twisted steel bars for concrete reinforcement.
IS:1791	Batch type concrete mixers.
IS:1977	Structural steel (ordinary quality).
IS:2062	Steel for general structural purposes
IS:2074	Ready mixed paint, red oxide - zinc chrome priming.

IS:2309	Code of practice for the protection of buildings and allied structures against lightning.
IS:2386	Methods of test for aggregates for concrete. (Part-I) Particle size and shape.
IS:2386	Estimation of deleterious materials & organic (Part-II) impurities.
IS:2386	Specific gravity, density, voids, absorption and (Part-III) bulking.
IS:2386	Mechanical properties. (Part-IV)
IS:2386	Soundness. (Part-V)
IS:2386	Measuring mortar making properties of fine aggregate. (Part-VI)
IS:2386	Alkali aggregate reactivity. (Part-VII)
IS:2386	Petrographic examination. (Part-VIII)
IS:2502	Code of practice for bending & fixing of bars for concrete reinforcement.
IS:2505	Concrete vibrators, immersion type.
IS:2506	Screed board concrete vibrators.
IS:2633	Methods of testing uniformity of coating on zinc coated articles.
IS:2722	Portable swing weigh batchers for concrete (single and double bucket type).
IS:2750	Steel scaffoldings.
IS:2751	Code of practice for welding of mild steel bars used for reinforced concrete construction.
IS:3025	Methods of sampling and test (Physical and Chemical) for water used in industry.
IS:3346	Method for the determination of thermal conductivity of thermal insulation materials (two slab, guarded hot-plate method).
IS:3495	Method of test for clay building bricks. (Part-I to IV).
IS:3550	Methods of test for routine control for water used in industry.
IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.

IS:3677 Unbonded rock and slag wool for thermal insulation.

IS:4014 Code of practice for steel tubular scaffolding. (Part-I&II).
IS:4031 Method of physical tests for hydraulic cement.

IS:4634 Method for testing performance of batch-type concrete mixers.

IS:4687 Gland packing asbestos.

IS:4860 Acid-resistant bricks.

IS:4990 Plywood for concrete shuttering work.

IS:4998 Criteria for design of reinforced concrete chimneys. (Part-I).

IS:5410 Cement paint, colour as required.

IS:5445 Long fluted machine reamers with Morse taper shanks.

IS:5495 Sizes and shapes for firebrick (300 mm. and higher series).

IS:8112 High strength ordinary portland cement.

CP326 British Standard - Protection of structures against lightning.

NEPA 78 Code of protection against lightning.

Draft Code of Practice for the protection of buildings against lightning - 1954 of Institution of Engineers (India).

The Indian Electricity Rules.

The requirements of Department of Civil Aviation, Govt. of India.

2.04.00 **Conformity with drawings and specifications**

The Contractor shall carry out all the work in strict accordance with the drawings stamped 'Released for Construction' and specification issued to him and as per Contractor's detailed drawings approved by the Consulting Engineer. Prior to concreting, the Contractor shall prepare a check list on a set format of all items of work involved, and inform the Engineer well in advance so that the Engineer shall have the opportunity of satisfying himself if the works mentioned in the format are done according to drawings and specification, and he can allow the Contractor in writing to start pouring of concrete. The entire operation of concreting shall be carried on as per specification, to the complete satisfaction of the Engineer. No deviation from the drawings will be allowed unless otherwise directed by the Engineer in writing.

For steelwork and metal work, the Contractor shall design all connections, inserts for scaffolding, supply and fabricate all steelwork and metal work and furnish all connection materials in accordance with approved shop drawings prepared by him and/or as instructed by the Engineer, keeping in view the

maximum utilisation of the available sizes and shapes for metal components.

2.05.00 **Materials to be used**

2.05.01 **General Requirement**

All materials, whether to be incorporated in the work or to be used temporarily for the construction, shall conform to the relevant IS specifications unless stated otherwise and shall be of the quality approved by the Engineer.

2.05.02 **Cement**

Generally, cement shall be 43 grade / 53 grade ordinary Portland Cement conforming to IS-8112 / IS 12269. In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Engineer :

a) 33 Grade ordinary Portland Cement conforming to IS-269.

b) Rapid hardening Portland Cement conforming to IS-8041.

c) Portland slag cement conforming to IS-455.

d) Portland Pozzolona Cement (fly ash based) Conforming to IS-1489 (Part-1).

e) Portland pozzolona Cement (calcined clay based) conforming to IS-1489 (Part-2).

f) Hydrophobic Cement conforming to IS-8043.

g) Low heat Portland Cement conforming to IS-12600.

h) Sulphate Resisting Portland Cement conforming to IS-12330.

2.05.03 **Coarse Aggregate**

Coarse aggregate shall be graded crushed or broken stone from approved sources, free from impurities and shall be screened free of dust and other deleterious matter. It shall conform to IS:383 or IS:515 and shall be washed clean, if necessary. The max. size of coarse aggregate for chimneys shall be 20 mm. down graded, unless otherwise stated (vide serial 5(b) of clause 3.3.6). Grading for a particular size shall conform to relevant IS Codes and shall be such as to produce a dense concrete of specified proportion and strength and shall be of consistency that will work readily into position without segregation.

2.05.04 **Fine Aggregate**

Fine aggregate shall be river or pit sand, free from any clay, earth, vegetable matters, salt or other impurities and shall be clean and fit for use, to the satisfaction of the Engineer. Sand acceptable for the work shall normally have a grading falling within the limits of one of the three grades, mentioned

in the relevant IS Specifications.

2.05.05 **Water**

The water for both mixing and curing of concrete shall be clean, free from oil, acid, alkali, organic or other deleterious substances. Contractor shall test the water as and when required by the Engineer, at no extra cost to the Owner.

2.05.06 **Reinforcement**

Mild steel or Medium or High Tensile steel deformed bars specified for reinforcement shall conform to the latest relevant IS Specifications and shall be of tested quality under ISI Certification Scheme. The reinforcement shall be free from any oil, foreign material or mill or rust scales.

Reinforcement bars shall be procured from approved manufacturers for example SAIL/ TISCO/ VIZAG Steel or equivalent.

2.05.07 **Structural Steel**

All steel materials to be used in construction of Chimney ladder, hand rails, flue opening frame, access door frame, door shutters etc. shall comply with IS:2062, IS:1239, IS:1367, IS:1608 & with other relevant IS Specifications.

2.05.08 **Paints**

Paints to be used for shop coat of fabricated steel shall conform to the IS:2074. Paint for treatment of outside face of Chimney shall be with Poly .urethane paint.

2.05.09 **Fire Bricks, Acid Resistant Bricks and Castable Refractories**

Fire Bricks for the internal lining of the shell shall conform to IS:6-1967 Group-A and IS:5445. Acid resistant bricks for internal lining of shell and hopper shall conform to IS:4860. Castable refractories shall be of hydraulic setting, rapid hardening type. It shall have refractory properties similar to Fire bricks conforming to IS:6, Group-A and working temperature shall be upto $1350^{o}C$.

2.06.00 **Storage of Materials**

2.06.01 **General**

All materials shall be so stored as to prevent deterioration & intrusion of foreign matter and to ensure the preservation of their quality and characteristics for the work. Any material, which is deteriorated or is damaged or is otherwise considered defective by the Engineer, shall not be used for construction and shall be removed from site immediately, failing which the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain an upto date accounts of receipt, issue & balance of all materials issued by the Owner.

2.06.02 **Cement**

Contractor shall store cement in water-tight and properly designed stores so that the Cement can be kept dry and the stock can be handled in rotation. The doors of stores shall be at least 30 cm above G.L. Deteriorated cement shall be removed immediately from the site. Not more than ten bags of cement shall be stacked one above the other.

2.06.03 **Aggregate**

Different materials shall be transported, handled and stored separately in such a manner as to prevent damage, deterioration or contamination. Stock piles of fine and coarse aggregates shall be allowed to drain, so that aggregates do not contain too much water.

2.06.04 **Reinforcement**

Reinforcement shall be stored preferably under cover and stacked off ground in size and grade-wise separate stacks for easy identification.

2.06.05 **Steel, Metal and Fittings**

All steel, metal & fittings to be used for fabrication and erection shall be stored sectionwise and lengthwise in separate stacks, off ground, so that they can be handled, inspected, measured and accounted for easily at any time. If required by the Engineer, the materials may have to be stored in a covered shed.

2.06.06 **Paints**

Paints shall be stored under cover, in air-tight containers. Paints supplied in sealed containers shall be used as soon as possible once the container is opened. Left over paints shall be kept in air-tight containers.

2.06.07 **Bricks**

Bricks shall be stored in systematic stacks for ease of handling and counting. While unloading the bricks from trucks, they shall be stacked right away and shall not be dumped in a heap.

2.06.08 **Insulation Material**

All insulation materials like glass or mineral wool, asbestos ropes etc. shall be stored in packing boxes, under covered shed, avoiding their coming in contact with objectionable matter.

2.06.09 **Electrical Items**

All electrical items shall be stored properly under covered water-tight shed so that they do not come in contact with moisture or cement dust.

2.07.00 **Quality Control**

Contractor shall establish and maintain quality control for different items or work and materials as may be directed by the Engineer to assure compliance with contract requirement and submit to the Engineer records of the same. The Contractor shall submit all records and test results in original to the Engineer for his approval, if so desired by him.

The quality control operation shall include but shall not be limited to the following items of work :

a)	Cement	:	Test to satisfy relevant IS Specifications if supplied by the Contractor.
b)	Aggregate	:	Physical, Chemical and Mineralogical qualities, grading, moisture contents and impurities.
c)	Water	:	Impurities Test.
d)	Reinforcement	:	Material tests or certificates to satisfy relevant IS Specification if supplied by the Contractor
e)	Structural Steel	:	Material tests or certificate to satisfy relevant IS Specification if supplied by the Contractor.
f)	Bricks	:	Compressive strength, water absorption, efflorescence, warpage.

3.00.00 **EXECUTION**

3.01.00 **Concrete**

3.01.01 **Trial Mix, Grades of Concrete**

At least three weeks before commencing any concreting in the work the Contractor shall make trial mixes using samples of coarse aggregates, sand, water and cement, typical of those to be used in the work. A clean dry mixer shall be used for mixing and the first batch shall be discarded.

For guidance in designing the mix, standard tables for maximum allowable water-cement ratio, minimum cement content, maximum proportion of aggregates and limits of consistency may be used by the Contractor. The Contractor's design mix shall fall within limits of the following tables :

i)	Strength requirements of concrete	:	Table-2 of IS:456-2000.
ii)	Concrete Mix Proportion	:	Design mix concrete as per Clause no.9 of IS:456-2000.

iii) Minimum cement content/Cu.m. of finished concrete shall be as per Table 5 of IS:456-2000 unless otherwise stated (vide serial 5(c) of clause 3.3.6).

iv) Limit of consistency : Refer Table in Item 3.1.4 of this specification.

v) Cement/Total Aggregate Ratio : As per the following table.

TABLE-II

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO (FOR GUIDANCE)

CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/ CEMENT RATIO	RATIO BY WEIGHT OF CEMENT TO GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT TO CRUSHED STONE AGGREGATE	
		20 mm size	38 mm size	20 mm size	38 mm size
Very low Slump 0-25 mm	0.4	1:4.8	1:5.3	1:4.5	1:5.0
	0.5	1:7.2	1:7.7	1:6.5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low Slump 25-50 mm	0.4	1:3.9	1:4.5	1:3.5	1:4.0
	0.5	1:5.5	1:6.7	1:5.0	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7.0
	0.7	1:8.0	1:8.5	1:7.4	1:8.0
Medium Slump 50-100 mm	0.4	1:3.5	1:3.8	1:3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5.0
	0.6	1:6.0	1:7.3	1:5.2	1:6.2
High Slump 100-175 mm	0.4	1:3.2	1:3.5	1:2.9	1:3.3
	0.5	1:4.4	1:5.2	1:3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

Note: 1 Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

Note: 2 It should be noted that such high aggregate cement ratios will be required or concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.

The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

For each grade of concrete, a set of eighteen cubes shall be made. Of these not more than six may be made on any day and further, of the six cubes made in one day not more than two cubes may be made from any single batch. Nine of these cubes each representing a different batch of concrete shall be tested at the age of seven days and remaining at twenty-eight days. The making of the cubes, their curing, storing, transporting and testing shall be in accordance with the relevant IS Specifications. The test shall be carried out in laboratory approved by the Engineer. If the average strength of the concrete cubes falls below the requirement, the method described above shall be repeated till acceptable results are obtained. The method may have to be repeated whenever there is a significant change in the quality of any of the ingredients for concrete, at the discretion of the Engineer. All cost for trial mixes and tests shall be borne by the Contractor and shall be included in the contract rates.

3.01.02 **Batching of concrete**

For controlled concrete, only weigh batching shall be allowed. All concrete ingredients, except water, shall be batched by weight, using an approved make of weigh batcher. Batching shall be accurate to 1/2 Kg. The batcher shall be tested for accuracy of calibration, first before commencement of work and at least once a fortnight or as directed by the Engineer thereafter. Water shall be batched by weight or by volume measures, as approved by the Engineer.

3.01.03 **Mixing of Concrete**

Materials for concrete shall be emptied in rotation into the mixer. When all the ingredients are in the drum, the drum will rotate for one minute for dry mixing. After that water shall be added in measured quantities in the manner specified. The mixer shall then rotate for at least two minutes, or at least forty revolutions or until there is apparent uniform distribution of the materials and till the mass is uniform in colour. The entire content of the drum shall be discharged before the ingredients for the succeeding batch are fed into the drum. The mixer shall be thoroughly cleaned to the satisfaction of the Engineer, before a different quality of concrete is put through the mixer and also at the end of day's work.

3.01.04 **Workability of Concrete**

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments, and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. 15 mm. to 40 mm. slump in chimney works shall be adopted

subject to Engineer's approval unless stated otherwise (vide serial 1(d) of clause no. 3.3.6). The usual limits of consistency for various types of structure are given below:

LIMITS OF CONSISTENCY

Degree of workability	**Slump in mm. with standard concrete**		**Use for which concrete is suitable**
	Min.	**Max.**	
Very Low	0	15	Large mass concrete work with heavy compaction equipment.
Low	15	35	Uncongested wide and shallow RCC structures.
Medium	35	65	Deep and wide RCC structures with congestion of reinforcement and inserts.
High	65	100	Very narrow and deep RCC structures with congestion due to reinforcement and inserts.

Note :

The above table is for guidance only. Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately, to keep the ratio of water to cement same, as adopted in trial mix design, for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively, where facilities exist or if required by the Engineer, the compacting factor test, in accordance with IS:1199, shall be carried out.

3.01.05 **Placing and Compaction of Concrete**

Concreting shall proceed in a manner directed by the Engineer, concrete shall be placed in forms as soon as possible but in no case later than twenty minutes, after mixing.

The height of any single lift of concrete, for different structural members, shall be decided by the Engineer. The concrete shall be placed in the forms gently and not dropped from a height which may cause segregation of aggregates. Each layer of concrete shall be compacted fully before the succeeding layer is placed and separate batches shall follow each other so closely that the succeeding layer shall be placed and fully compacted before the layer immediately below has taken an initial set.

The concrete, after placing, shall be consolidated only by power driven vibrators. The vibrators shall be of a make and size, approved by the Engineer. In using the vibrator, the standard practice and the Engineer's directions, shall be followed.

Vibration shall begin as soon as one batch of concrete has been placed and shall continue till the entire section being poured has been thoroughly consolidated.

To secure even and dense surfaces, free from aggregate pockets, vibration shall be supplemented by tamping or rodding by hand in the corners of forms and along the form surfaces while the concrete is plastic, without damaging or endangering the stability of the formwork.

A sufficient number of spare vibrators including petrol vibrators shall be kept readily accessible to the place of deposition of the concrete to assure adequate vibration in case of breakdown of those in use.

3.01.06 **Curing of Concrete**

Curing of exposed surface of concrete shall commence immediately after the concrete has set. Exposed sides shall be covered with canvas etc. immediately after stripping of forms, and curing shall be continued for a period of not less than 14 days, reckoned from the date and hour of completion of concreting. All surfaces of the pour shall be kept wet with water at all times after concreting and till the curing period is over. The Contractor shall plan and employ proper equipment and sufficient labour considered adequate by the Engineer under able supervisor for curing and all cost for this purpose shall be borne by him.

3.01.07 **Construction Joints**

In concreting the chimney shell one full ring lift shall be completed in a day's pour. Before the formwork for the following pour starts the horizontal surface of the Chimney shell shall be chipped, cleaned and washed with water, and when the formwork is complete, the surface shall be cleaned and washed again and covered with 1:2 sand cement slurry before fresh concrete is placed. The horizontal construction joints shall be so arranged and made that they are regular and neat. No vertical joint shall be allowed. No separate payment shall be allowed to the Contractor for forming joints or chipping and cleaning them or cover with slurry prior to concreting. The number of construction joint shall be kept minimum and the spacing should not exceed three (3) meters. The Contractor shall submit to the Engineer, any proposal of providing construction joints to facilitate his work, for the study and approval of the Engineer well in advance.

3.01.08 **Ordinary Concrete**

Ordinary concrete like lean concrete shall be of nominal mix as per relevant clauses of IS:456.

3.02.00 **Reinforcement**

3.02.01 **Bending of Reinforcement**

All bars shall be carefully and accurately bent by the Contractor in accordance with approved Drawings and bar bending schedules. Special care shall be taken to ensure correct lengths of laps. The bars shall not be bent or straightened in any manner that will injure the bars or impair the bond between reinforcement & concrete. Bends and hooks are to be provided as laid down in the IS:2502.

3.02.02 **Placing**

All reinforcement shall be placed and maintained in the position shown in the drawings. Contractor shall provide approved type of cover blocks to suit the requirement of the Drawings. Where reinforcement is to be provided on two faces of the shell, the Contractor shall provide adequate number of separators, with the approval of the Engineer. Any additional support to the reinforcing cage, if required at the time of concreting, shall also be provided, to the satisfaction of the Engineer. Lapping of reinforcement as specified in the drawings or as directed by the

Engineer, shall be provided. Laps shall be staggered and too many laps shall be avoided. Welded laps shall be provided only when directed or approved by the Engineer.

3.02.03 **Fixing of Reinforcement**

18 SWG annealed steel wire shall be used as binding wire. Bar crossing one another and contact laps shall be bound with this wire twisted tight to make the skeleton or network rigid so that the reinforcement is not displaced during placing of concrete.

3.03.00 **Forms**

3.03.01 **Design and Material of formwork**

The shuttering for the chimney shell shall be either steel formwork or steel framed plywood formwork of adequate thickness, proper surface texture and with requisite supports and battens to produce a shell surface which will be even, smooth and of uniform curvature and batter as per Drawing and free from all blemishes.

The Contractor shall be responsible for designing the formwork, alongwith its supports etc. Contractor shall obtain the approval of the Engineer for the design of forms, before assembling them. Approval of the Engineer does not relieve the Contractor of his responsibility to ensure the soundness of formwork.

3.03.02 **Installation of Formwork**

All formwork shall be set to plumb and to line and level, or curvature or batter as per drawing. All shutters shall be adequately supported, to the satisfaction of the Engineer, to prevent deflection under dead weight of concrete, imposed load of workmen, materials and plant and to withstand vibration.

No joint in any props shall be allowed. The joints in formwork shall be watertight. Surface of formwork shall be oiled with approved quality mould oil which shall not stain the surface of the shell.

3.03.03 **Tolerance**

The formwork shall be so made as to produce a finished concrete true to shape, lines, levels, plumb and dimensions, as shown on the drawings, subject to the following tolerances, unless otherwise specified.

a)	Out of plumb between two consecutive lifts	:	3 mm.
b)	Errors in level	:	3 mm.
c)	Errors in sectional dimensions	:	5 mm.
d)	Out of plumb in general	:	1 in 1000 of height subject to a maximum of 200 mm.

However, the Contractor shall aim at improving upon this figure. Should the limitations exceed, the Contractor shall, if directed by the Engineer, demolish that portion of work and recast at his own cost, to the complete satisfaction of the Engineer. No tolerance shall be allowed between the two consecutive plates of the formwork either radially or vertically placed.

3.03.04 **Stripping of formwork**

Unless otherwise permitted in writing by the Engineer, the minimum period of keeping formwork in position after the completion of pouring of concrete shall conform to relevant clause of IS:456. For the chimney shell the stripping time shall be 48 hours minimum.

Formwork shall be so arranged as to permit removal without jarring or damaging the concrete. Immediately after stripping of formwork, the Engineer shall be informed by the Contractor. The Contractor shall ensure that the site is cleared of stripped shuttering nails or any other material which might hinder the inspection, so that the Engineer can inspect the concrete surface.

3.03.05 **Re-use of formwork**

Before re-use, all forms shall be thoroughly scraped, cleaned, examined, repaired, and treated with mould oil as specified herein before. Formwork, declared unfit or unserviceable, by the Engineer, shall not be used or reused.

3.03.06 **Construction by slip-form Method**

Slip-form construction will be encouraged if proposed by the Tenderer. Type of Slip-form proposed should be indicated in the offer with sketches, drawings and construction statement as explained hereinafter. Number, type and capacities of jacks, the control system and achievable rate of progress in mm/hour should also be indicated. The chosen scheme shall be of a past proven design. A certified performance record of the scheme should be submitted with the offer to guarantee workability of the scheme both from execution time and safety point of view.

The Tenderer should furnish a brief but comprehensive statement indicating the planning & programme and method of work to be followed, for the approval of Owner at the time of submitting Tender. This statement shall include the following items :

i) Type and description of Slip-form equipment and its accessories.

ii) Design of scaffolding and staging.

iii) Description of materials including admixtures to be used for construction.

iv) Manpower planning, construction spaces required, standby arrangement.

v) Rate of Slip-forming.

vi) Proposed workability requirement of concrete and type of cement & admixture to be used.

vii) Quality assurance programme.

viii) Method of Transportation of material

ix) Method of curing and rectification of defects.

x) Planned interruption, if proposed, and activities during planned interruption. Treatment of construction joint.

xi) Contingency solution for unplanned interruptions.

xii) Time of completion.

While selecting the Contractor, due consideration will be given to the merit of the above mentioned statement proposed by the Tenderer and minimum time of completion, apart from his past experience in such types of work as also technical and financial resources of the Tenderer.

Not withstanding what have been specified in earlier clauses, following guide lines are being presented which should be kept in view by intending Tenderers, while quoting for Slip-form method of construction :

1. Care to be taken to prevent dragging of concrete alongwith upward movement of the shuttering. For this purpose following steps are advisable :

   a) Shutter plates have to be smooth and should be thoroughly clean. Before fixing them in position all the surfaces which will be coming in contact with concrete to have a coat of epoxy paint.

   b) In areas where concrete thickness is 750 mm or more rate of pouring should be such that minimum slipping of shuttering is 100 mm per hour.

   c) Mix design should be so done that it will be self-lubricant at the contact face of shutter and concrete and thus reduce friction. Suitable cement of approved manufacturer (conforming to relevant I.S. Specification) may be used for the purpose. An optimum ratio of coarse/fine aggregate should be established to suit the purpose depending on availability of aggregates.

   d) Mix design also should be so done that it has a slump of 50 mm at the point where concrete is placed under an ambient temperature of around 40^{o}C. This will also keep vibration by needle vibrators to required minimum. Slump should not drop down to zero in less than 45 minutes. Suitable retarding agent or plasticizer of approved manufacture may be added in mix to achieve this purpose. These admixtures to be properly identified by preliminary tests both for performance and for compatibility with particular type of cement proposed to be used.

      Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40^{o}C.

2. Care must be taken to prevent twist, which predominantly occur in the initial stages because of low slipping rate, in the horizontal plane of Slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes interval. One person should exclusively be assigned this work together with rectifying any defect.

3. Every endeavor has to be made so as not to occur any tilt in the shutter assembly. To achieve this following steps need be taken

   a) Performance of jacks has to be closely observed and any defective one needs immediate replacement. Difference in levels of opposite jacks at any instant of time should not exceed 5 mm.

   b) Loading on Slip-form truss/yokes has to be fairly equal.

c) Sleeve through which jacking rod passes has to be of sufficient length so that later gets an uniform clearance and does not get any chance to tilt. Sleeve should have a minimum wall thickness of 3.25 mm and should be such that jacking rod gets a maximum clearance of 1 mm to 1.5 mm around.

4. For taper walled chimneys overlapping of shutters which are kept to effect the tapering, needs careful attention otherwise these may be filled with concrete slurry.

5. In designing the mix following aspects should be borne in mind:

a) Cement used should have an initial setting time of not less than 50 minutes and preferably should have a specific surface around 3600 Sq.Cm. per gram.

b) Coarse and fine aggregates should be well graded and rounded aggregates offer better performance in Slip-form technique. These help to keep down water/cement ratio and also offers better lubrication between concrete and shutter surface. 40 mm down size of coarse aggregates should preferably be used unless reinforcement detailing calls for lesser size aggregates.

c) From the point of view of creep, shrinkage as well as initial setting property of concrete, cement content should not preferably be more than 400 Kg. per Cu.M of concrete.

d) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slipform proceeds should be between 0.1 to 0.2 Newton/ Sq.mm.

e) It is advisable to use cement from a single source during the entire operation of slipform technique since once the system starts, there might not be any time left for conducting trial mixes if the source of procurement of cement changes.

6. Large dia. vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter and to 40 mm diameter - only in exceptional cases. At least two nos. standby vibrator units should always be maintained on top of working deck at all time during the entire period of slipform operation.

7. It is preferable to have membrane curing compounds sprayed on fresh surfaces emerging out of shutter panels for ensuring proper curing at great heights.

In case such spraying is not envisaged then elaborate arrangement has to be made for adequate supply of water both on inside and outside vertical surfaces with spraying arrangement, necessary length of pipelines and pump of adequate head to serve the purpose. It is always advisable to have a stand-by pump for effective utilisation of the system.

8. If Slipforming is carried out in summer, rate of slipping should be around 400 mm per hour. If lesser value is contemplated appropriate retarders should be specified.

9. Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.

   It is desirable that jacking system, based on which the entire slipform system works, should consist of jacks 3 Tonne/6 Tonne capacity and a hydraulic pump with necessary pipe connections.

   Spacing of yoke legs should preferably be kept within 2 metres to prevent overloading on jacks and consequent failure resulting in twist of the formwork.

   Jacking rods should be of 25 mm diameter for 3 Tonne Jacks and 32 mm diameter for 6 Tonne Jacks.

10. At least 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump alongwith a set of loose pipes in perfect working condition on top of working deck.

11. In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slipform yoke.

12. For effective utility of this technique following areas need careful attentions at the very conceptual stage:

    a) Detailed quality assurance programme.

    b) Advance Planning and preparations.

    c) Arrangement for on site supervision and adequate access facilities.

13. Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, description and frequency of various checks and tests for Slipform technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared beforehand by executing agency and to be approved by Engineer before starting the actual work.

14. Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement.

Vertical reinforcements should be kept vertical by providing suitable holders within the slipform system.

15. It is desirable to have a break of at least one day for every two weeks of continuous operation. Such break should be utilised for various maintenance activities, removal of jack rods etc.

16. Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and reinforcement. If felt necessary one hoist may be exclusively earmarked for transporting concrete.

    For movement of personnel supervising the work a separate hoist must be arranged for.

17. The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system alongwith slipform.

18. Winches for lifting men and material and mixers, if located within unsafe area around chimney, should be protected by adequate shelter from possible damage.

19. Proper tele-communication system has to be established between the personnel working on top of Chimney and control room below.

20. A small laboratory should be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube testing machine may also be installed at site for getting quick feed back results.

    Apart from using plumb bobs, level and theodolite instruments for survey purpose arrangement should also be kept for lasers.

21. In case of interruption in the course of slipping of formwork following measures should be taken:

    a) Provision of a key and additional reinforcement at the junction of new and old concrete.

    b) Slipform system should be brought up freely to have a minimum overlap of 100 mm or so over previously cast concrete.

    c) Washing of old concrete surface with compressed air and water jet and thereafter pouring a layer of neat cement grout.

    d) Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Engineer.

e) Neatly finishing the interface of old or new concrete as soon as it comes out of shutter panel.

22. It is preferable to suspend the construction work under high wind condition.

23. It is of utmost importance that for effective implementation of this system an Engineer fully conversant with Slipform technique with enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid level supervisory staff, skilled workers and operators.

24. Operation of slipform method of construction is a continuous one and it demands continuous/intermediate inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.

25. While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety Engineer.

Safety measures as listed below must be adhered to but should not be limited to only these:

a) Safety helmets and belts to be provided to all supervising staff and workers.

b) Safety nets to be provided below both inside and outside platforms as instructed by Engineer.

c) Handrailing and toe guard to be provided around all openings and platforms.

d) Regular maintenance of equipment, checking of hoists, scaffoldings etc.

e) Passenger hoist must have multiple ropes.

f) Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the Specification and to be operative in case of sudden power failure Emergency standby generator must be kept ready during the entire period of slipform method of construction.

g) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

26. Permissible construction tolerances should be limited to the following:

Variation in wall thickness : (-) 5 mm, (+) 25 mm

Variation from Design Diameter	:	(±) 25 mm or (±) 12.5 mm per 3 m dia. whichever is larger, but in no case more than (±) 75 mm.
Out of Plumb in General	:	1 in 1000 of height subject to a maximum of 200 mm.

Although deviations in general will not be encouraged, the Contractor, however may mention in his offer the additions to or deviations from drawings/Technical Conditions/Schedule of items issued with the tender papers and any other special requirement implied with the adoption of the Slipform method, which may include but need not be limited to the following items as applicable:

a) Particular requirement of type and brand of cement, if any.

b) Special admixture to be added to concrete.

c) Any change required in the geometry of the Chimney including the shell thickness or side slope from that shown in the N.I.T. drawing.

d) Any change/special requirement in the arrangement of reinforcement.

e) Implications if any of necessary insitu bending of rebars for corbels/ brackets etc. and straightening/cleaning of the same prior to casting of brackets.

f) Any additional constructional opening in the shell required at ground level for concreting.

All deviations from tenders must be justified and tender price shall include all such variation/deviation. Such deviation without assigning any reason will be rejected.

3.04.00 **Chimney Steel and Metal Work**

3.04.01 **General**

All workmanship shall be of best practice in modern structural shops, and shall conform to the provisions of the IS:800 and other relevant IS Specifications, unless otherwise specified.

3.04.02 **Fabrication**

Rolled materials, before being used for fabrication, shall be straight and shall be within the tolerance laid down in the IS:852. Straightening, if necessary, may be done by mechanical means and if required, by applying localised heat the temperature of the material not exceeding 600 Deg.C locally. Cutting of mild steel members shall be effected by power saw or gas cutting. If gas cutting is used, allowance shall be made in working out the effective length,

based on the shop drawing and templates. Care shall be taken in gas cutting so that the member does not bend or warp. Edge preparation for welding may be done by gas cutting with necessary precautions and cleaning. Holes shall be drilled with power drill. Arrangement shall be made for clamping the member to be drilled so that the member is not displaced while drilling is in progress. When two or more members are to be drilled together, all the parts shall be clamped together. After drilling they shall be separated and burs shall be removed with power driven hand grinder. Bolt holes shall not be formed by a gas cutting torch.

3.04.03 **Assembly**

Riveting, bolting and welding shall be carried out as per requirements laid down in IS:800. Shop assembly of elements of platforms or the entire platforms, brackets and similar items if required and/or asked for by the Engineer, shall be arranged so as to check the accuracy of fit. Necessary temporary supports like props, cross bracings etc. shall be provided to keep the parts in place both for mock up and at the time of erection. Each steel piece shall bear erection marking, written in paint.

3.04.04 **Painting**

If steel and iron members are to be painted as per contract, it shall be done as per requirement laid down in IS:800. A coat of shop painting shall be applied to all steel and metal work, unless stated otherwise. All steel ladder, platforms, balconies, hand railing, frames, doors etc. which are specified for painting shall be painted first with two coats of red oxide zinc chromate paint conforming to IS:2074 and then with two coats of Synthetic enamel paint (as per IS:2932 & 2933) or aluminium paint (as per IS:2339) of approved quality or acid resisting paints as specified in drawing or elsewhere.

Total dry-film thickness of paints provided on structures located outside windshield shall be 190 microns and that on inside be 125 microns minimum.

All paints shall be of make and shade as instructed and approved by the Engineer. Necessary test certificates, manufacturer's literature & samples shall be submitted to the Engineer, for his approval, before bulk purchase is made.

The metal surfaces which are to be painted shall be prepared properly by rubbing, washing, treating prior to application of paint as per paint manufacturer's specifications and as per relevant IS Specifications.

3.04.05 **Galvanizing**

All steel including threaded bolts, nuts and washers, unless specified otherwise in contract, shall be hot dip galvanized in accordance with American Society for Testing and Material Specification ASTM 123 or IS:2629 - Recommended practice for Hot- Dip Galvanising of Iron and Steel.

All members to be galvanized shall be cleaned thoroughly, to the satisfaction of the Engineer, by the process of pickling. Pickling shall be carried out in an acid bath containing sulphuric or hydrochloric acid of suitable and adjusted

concentration and temperature. Pickling process shall be completed by rinsing the members thoroughly in warm water.

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath and it shall meet all the requirements when tested in accordance with IS:2633 and IS:4759. The zinc coating shall be of uniform thickness. If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage and if so directed, the galvanizing may have to be redone in the similar manner stated above.

3.04.06 **Erection**

Erection of structural members and C.I. Chimney caps shall be done as per requirement of IS:800. The Contractor shall submit to the Engineer a programme of erection for his approval. All plant, equipment, tools, tackle and any other accessories required for the erection shall be provided by the Contractor. Storing and handling of fabricated materials for erection, setting out of members, providing temporary supports, bracing, fasteners, bolts, nuts etc. shall be the responsibility of the Contractor and shall be taken into account in quoting the rate.

3.04.07 **Cast Iron Chimney Cap**

The cast iron cap, fitted at the top of the chimney, shall be of thickness not less than 10 mm. This shall preferably be a single cap covering both the concrete shell and the lining, with the segments bolted together securely and properly anchored inside the concrete in such a manner as to form a complete annular unit, allowing for unequal circumferential and vertical expansion and contraction of concrete shell and lining and for deflection of shaft due to wind.

All bolts, nuts, washers, rag bolts and other fasteners as required for fixing cast iron cap shall be of bronze material. Gaps between segments are to be filled with asbestos mill-board or fiber-glass packing. Casting is to be assembled to match with the dimensions specified in drawings, before despatch to site. C.I. caps to be painted with two coats of acid resisting paints over primer coats as recommended by paint manufacturer.

3.05.00 **Insulation and Protective Treatment**

3.05.01 **Acid and Heat Resistant Paint**

The inside surface of concrete shell and corbels and outside surface for height as specified in the drawing shall receive a protective treatment of three coats of acid and heat resistant black paint. The quality and type of the paint shall have the prior approval of the Engineer. For this, a small area shall be painted and a sample of paint shall be shown to the Engineer.

The surface to be painted shall be prepared and primary coat, if required as per the paint manufacturer's specification and direction of the Engineer, shall be applied. The paint shall conform, unless otherwise stated, to the requirement of IS:158. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for his approval.

The surface to be painted shall be completely dry before the paint is applied and the drying time between consecutive coats shall not be less than 5 hours.

3.05.02 **Cement Paint**

The outside face of the Chimney shell, unless specified otherwise, shall be painted with Cement waterproof paint. The quality shall be approved by the Engineer. Necessary samples shall be submitted to the Engineer for his approval. The surface of the shell shall be prepared as per paint manufacturer's specification. In addition, care shall be taken that the surface is free from stain, honey comb and any rough and uneven surface. The joints between two shuttering and two lifts of shuttering shall be so prepared that any unevenness, if by chance exists, shall be removed. If one coat of paint is not sufficient to give the required finish, the Contractor, at his own cost, shall repaint the surface, until the Engineer is satisfied with the workmanship. The paint shall conform, unless otherwise stated, to IS:5410. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for approval.

3.05.03 **Acid Resistant Brick Lining**

The Contractor shall use acid resistant bricks for the job as indicated in the Drawing. They shall be fine grained in texture, dense and homogeneous. The brick shall be sound, true to shape, flat and free form flaws and other manufacturing defects affecting their utility. The bricks shall conform to IS:4860-1968 Class-I for acid resistant bricks. The bricks shall be of necessary curvature and of taper so that the lining conforms to the inner radius of the flue lining and hopper surface. No attempt shall be made to use straight bricks and than to try to match with the inner radius of the lining of chimney by providing extra mortar. No broken bricks shall generally be used. The compressive strength of the bricks shall not be less than 700 Kg/Sq.cm as per IS:4860 Class-I. The Contractor shall provide sample for visual inspection and approval. For testing purposes, the Contractor shall select, at random, bricks from the stack, in presence of the Engineer. The sample bricks thus collected, shall be sent to laboratory for testing of compressive strength, acid resistance and water absorption. The cost of sending to the laboratory, testing and any other incidental expenditure shall be borne by the Contractor and the rate should include such test.

The Contractor shall submit to the Engineer the original test results for his scrutiny and approval.

Bricks shall be thoroughly wetted before using. The mortar to be used shall have similar characteristics, i.e., it shall also be acid resistant. The mortar shall be acid-proof mortar-potassium silicate type (resistant to sulphuric acid) as per IS-4832 Part-I & IS-4441. The mortar shall also be tested at Contractor's cost, in a laboratory approved by the Engineer. The mortar shall be used immediately after mixing. The water cement ratio and the workability shall be strictly maintained. The brickwork shall be flush pointed, after necessary raking of joints and cleaning of surfaces. The lining shall be kept wet for a period of at least 3 days, after which exposed face shall be thoroughly cleaned. The air space and all ventilation holes in the shell and corbels shall be kept clean of any mortar for thorough ventilation. The mortar

between bricks shall not be more than 3 mm thick and the mortar used shall be freshly prepared, used within the setting time. No retampering shall be permitted.

3.05.04 **Fire Brick Lining**

The Contractor shall use fire bricks for lining of the Chimney and hopper as shown in the drawing. The bricks shall be of necessary curvature and of taper so that the lining conforms to the inner radius of the flue lining. No attempt shall be made to use straight bricks and then to try to match with the inner radius of flue lining of chimney by providing extra mortar. Fire bricks shall be well burnt, compact and of homogeneous texture generally white to yellowish white in colour and free from cracks and other flaws; no broken bricks shall be allowed to be used except for closing the course. The crushing strength of the bricks shall be not less than 200 Kg./Sq.cm and shall be of Group-A conforming to IS:6-1983, Specification for Moderate Heat Duty Fire clay Refractories, Group-A. The water absorption of the bricks shall not exceed 13% and the density of bricks shall be approximately 1800 to 2000 kg/Cu.m. Thermal conductivity of fire brick shall not exceed 1 kcal/hr.m.deg.C. Sample of bricks shall be submitted by the contractor for approval of the Engineer. For testing of bricks sample shall be taken according to the scheme given in IS:1528-1962, IS for Sampling and Physical Testing of Refractory Material; and cost for testing and incidental expenditure shall be borne by the Contractor and rates quoted shall include the cost.

The brick shall be laid with air setting fire clay mortar free from potassium/ Sodium silicate. The mortar may be "Tataset-FK-40" manufactured by Tata Refractories Ltd. or equivalent. The material shall be kept in a cool place under covered shed before use. The mortar shall be applied strictly as per manufacturer's instructions.

Thickness of mortar joint shall not be more than 3 mm. The bricks are to be laid one course of header followed by two courses of stretchers and so on or as directed by the Engineer. The exposed face shall be true to the line, parallel to the Chimney shell unless shown otherwise. Steel starps made of flats shall be provided on the exterior surface of brick lining both circumferentially and vertically for both acid resistant brick lining and firebrick lining. The steel straps shall be double hot dip galvanised.

3.05.05 **Insulation and Packing**

All packing and insulation material shall be of thickness, diameter and type, shown in the drawing. The packing and insulating material shall be made of asbestos rope, vermiculite concrete, slag or mineral wool and asbestos mill boards.

a) **Asbestos Rope**

The diameter of the rope shall be as per drawing. The material shall be of best quality available in the market and shall be purchased after a sample is approved by the Engineer. The rope shall be plain, Grade-I, conforming to IS:4687-1968. The strand shall be long, well twisted and no torn thread shall stick out. The rope shall be firmly packed so as to prevent gas leakage.

b) **Slag or mineral wool**

The thickness of packed slag wool shall be as shown in the dwg. The packed density of the wool shall be within the range of 175 to 200 Kg./cu.m and the co-efficient of thermal conductivity shall conform to the requirement of IS:3677 at a mean temperature of 150 Deg.C. The material shall be well packed in position where possible. IS:3677 for Rock and Slag wool mats for thermal insulation may be referred for guidance. The co-efficient of thermal conductivity and packed density shall be tested according to IS:3677 and IS:3346.

c) **Vermiculite Concrete**

Vermiculite concrete shall be made by mixing exfoliated vermiculite, portland cement and water. It shall be of Grade-B, having a density of 210 Kg./Cu.M. The vermiculite aggregate size shall be maximum 6 mm. The mix shall be 1 cement and 8 vermiculite by volume.

d) **Asbestos Mill Board**

Asbestos mill board shall be of thickness as indicated in drawing. It shall be of best quality of standard make available in the market and samples shall be submitted to the Engineer for approval. It shall be plain, dense and homogeneous texture, without cracks, flaw and any other manufacturing defect. It shall be laid directly onto the concrete bed after removing any loose material or any aggregate. The concrete shall be prepared without mortar so that the board can have a good seating.

3.06.00 **Lightning Protection System**

3.06.01 Refer electrical specification volume II F / 2, Section – XV – “Technical Specification fpr Chimney and Natural Draft Cooling Tower – Electrical Works.”.

3.06.02 Not used.

3.06.03 Not used.

3.06.04 Not used.

3.06.05 Not used.

3.07.00 **Aviation Obstruction Lighting System**

3.07.01 Refer electrical specification volume II F / 2, Section – XV – “Technical Specification for Chimney and Natural Draft Cooling Tower – Electrical Works.”.

3.07.02 Not used.

3.07.03 Not used.

3.07.04 Not used.

3.07.05 Not used.

3.07.06 Not used.

3.08.00 **Sampling Port**

Sampling ports of minimum 0.1 m dia. shall be provided in the Chimney as shown in the drawing to maintain records of emission. Minimum length of port shall be 0.5 m measured from inside face of the lining to the outside end of the port. The port shall be provided with industrial flange capped when not in use. Location of port shall be at least two times the top diameter below the stack exit and at least eight times the stack diameter above the last obstruction. One meter below sampling port a working platform has to be provided at least 1 m wide with safe guardrail and access ladder. Ladder well shall be located at least 1 m away from ports. There shall be no obstructions within 1 m horizontal radius on platform beneath ports. A power source of 220 V, 15A single phase 50 Hz AC shall be located on the platform. There shall be two ports 90 Deg. apart when stack dia. is less than 3 m plus port length and 4 ports when stack dia. is more than 3 m plus port length.

3.09.00 **MS insert plates for mounting of instruments for the measurement of amplitude of vibration and wind speed**

For mounting of accelerometer and wind speed censors 600 x 600 x 20 thick, MS inserts with 25 nos. threaded (1/2" whitworth) holes shall be fixed on the outer circumference of the chimney shell with MS lugs as shown on the drawing. During casting, the holes shall be temporarily plugged to prevent concrete from filling in the holes. Two nos. of such inserts shall be fixed at the top of the chimney for mounting accelerometers and a set of four nos. of such inserts shall be fixed at one-third and two-third heights of the chimney for mounting wind speed censors. A working platform of 1 meter width with safe guardrail shall be provided 1 metre below each level of these inserts as shown on the drawing.

For laying of cables, the same cable tray used for illumination/ aviation light shall be utilized.

4.00.00 **TESTING AND ACCEPTANCE CRITERIA**

4.01.00 **General**

The Contractor shall carry out all sampling and testing in accordance with the relevant IS Specifications and as supplemented herein, for the following items or any other item as may be required by the Engineer, at his own cost, unless otherwise specified in this specification. The Contractor shall get the specimens tested in laboratory, approved by the Engineer and shall submit to him, the original test results in triplicate, within seven days after the completion of the test.

4.02.00 **Cement**

Representative samples shall be taken as per the relevant IS Specification from each consignment of Cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time, compressive strength and soundness tests, and the Contractor shall carry out the above tests as per relevant Indian Standard. If the cement is supplied by the Contractor the test shall be carried out by him at his own cost.

4.03.00 **Aggregate**

The Contractor shall carry out any or all the tests on aggregates as may be required by the Engineer, in accordance with IS:2386 Parts-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant IS specifications.

4.04.00 **Water**

Sampling and testing of water being used for concrete works shall be carried out as per IS:3550, by the Contractor, at regular intervals and whenever directed by the Engineer. The final acceptance criterion in case of doubt shall be as per IS:3025.

4.05.00 **Concrete**

The Contractor shall take cubes for works test as per requirement laid down in IS:516 regularly from the day's pour. The number of test cubes to be taken shall be as per IS:456. The Engineer may also use his discretion in deciding the rate of cubes to be taken. The acceptance criteria is to meet the requirement of IS:456. If the cube test results indicate that some portions of the work is below the required strength, the Engineer may order demolition of that portion of work which is below strength and ask the Contractor to rebuild, provided a satisfactory method of load testing is not possible. Such testing or demolishing and rebuilding shall be carried out by the Contractor at his own cost.

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

The following technical information are required with the tender:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used. All details as per clause 3.3.6 to be submitted, if slip form method is proposed to be used.

e) Proposal for lifting of men and material in constructing the chimney.

5.02.00 **After Award**

The following information and data including samples where necessary, shall be submitted by the Contractor, progressively during the execution of the Contract.

5.02.01 **Programme of execution and requirement of materials**

Within 30 days of the award of the Contract, the Contractor will submit a Master Programme for completion of the work giving monthwise requirement of materials, particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms & conditions of the Contract. In case the Contractor proposes to take on hire any machinery or tools and plants from the Owner, the detailed phased out programme of such hire is also to be submitted.

The master programme may have to be reviewed and updated by the Contractor quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day to day programme of every month is to be submitted by the Contractor before the commencement of the month.

5.02.02 **Samples**

Samples of all materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities, free of cost, for approval. All samples shall be submitted well in advance of starting work at site. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying material of specified quality.

5.02.03 **Design Mix**

Design mix as per details of this specification giving proportions of ingredients, sources of aggregates and cement along with accompanying test results of trial mixes as per relevant IS Specifications shall be submitted to the Engineer, for his approval, before it can be used on the work.

5.02.04 **Detail Drawings**

Following items shall be provided by the Contractor which are to be approved by the Owner.

a) Detail drawings and designs of form work including scaffolding to be used. If slipform method of construction is adopted, then detail drawings showing all the arrangements for slipform technique including methods for reducing internal diameter and providing required slopes on outer diameter.

b) Detail drawings and bar bending schedules for concrete components.

c) Shop drawings for steel and metal work, including inserts etc.

d) Detail drawings for templates and temporary supports for embedments.

e) Detail lining drawing.

5.02.05 **Reports**

Following Test Reports shall be furnished by the Contractor:

a) Mill Test Report for cement and reinforcing steel if the materials are supplied by the Contractor.

b) Inspection Report of formwork and reinforcement.

c) Reports of tests of various material and concrete.

d) Any other data or report or test result required by the relevant IS Specifications and if required by the Engineer for satisfactory quality control of the workmanship.

TECHNICAL SPECIFICATION
FOR
XIII) PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIAL

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	MATERIALS
3.00.00	STORAGE AND HANDLING OF MATERIALS

XIII) PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIAL

1.00.00 **SCOPE**

The scope of this Section is to specify the properties, storage and handling of common building materials unless otherwise mentioned in drawings or schedule of items.

2.00.00 **MATERIALS**

a) **Bricks**

Bricks for general masonry work shall conform to IS:1077-1970 and for face brick work shall conform to the specifications in IS:2691-1972.

Bricks for general masonry work shall be of class 10, well burnt, of uniform size, shape and colour free from cracks. This brick will have average compressive strength of 50 kg/cm^2. Fractured surface shall show uniform texture free from grits, lumps boles etc. Compressive strength shall be 50 Kg/cm^2 minimum for face bricks. Water absorption after 24 hours immersions shall not exceed 15% by weight for common bricks & 12% for face bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for common bricks and 3% for face bricks. All bricks shall have rectangular faces & sharp straight edges. Maximum permissible chippage for face bricks shall be 6 mm at the edges and 10 mm for corners. The bricks shall show no efflorence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved sample shall be retained by the Engineer for future comparison and reference. The colour and texture of face bricks shall be upto the specification and defective bricks shall be removed immediately from site at the Contractor's own cost.

ai) Fly ash bricks conforming to IS 12894-2002 shall be used where good quality burnt clay bricks are not available or specifically desired by the owner. The Minimum compressive strength shall be 100 Kg/Sq.Cm Only full size bricks shall be used for masonry work. Brick bat shall be used only with permission of engineer to make-up required wall length or boundary. Conventional brick bats with the approval of site Engineer may be used.

b) **Stone**

All stones shall be from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of

water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) **Lime**

Lime shall be stone lime and conform to the specification Building Limes - IS:712. Lime putty may be prepared from hydrant lime or quick lime. Hydrated lime shall be mixed with water to form a putty and stored with reasonable care to prevent evaporation for at least 24 hours before use. Quick lime shall be shaken with enough water to make a cream, passed through a No. 0 Sieve and then stored with reasonable care to prevent evaporation for at least 7 days before use.

d) **Cement**

Cement used shall be ordinary Portland Cement conforming to Code for ordinary cement in IS:8112 / IS:12269, Portland Pozzolona Cement (PPC) conforming to IS 1489 (Part-1) or IS 1489 (Part-2) and shall be fresh when delivered. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If the cement is procured by the Owner and issued to the Contractor, the Contractor shall satisfy himself at the time of taking delivery that the quality, quantity and freshness of cement are upto the specified standards. No complain later on regarding the cement supplied by the Owner shall be entertained and all rectification work on this account shall be done by the Contractor at his own expense. If at any time, the Engineer feels that the cement being used by the Contractor is not upto specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

e) **Coarse Aggregates**

Coarse aggregates shall be as per IS:383 latest edition, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS:383 and shall be such as to produce a dense concrete of the specified proportions and strength and of consistency that will work readily into position without segregation.

f) **Sand**

Sand shall be hard, durables, clean and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosions to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded. Unless otherwise directed by the Engineer all sand shall pass through IS Sieve No. 240 and 15 to 35% of and for masonry mortar and 5 to 50% of sand for plaster shall pass through IS Sieve No. 30. Sand for concrete shall conform to IS:383.

g) **Water**

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

h) **Reinforcement**

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings which may impair proper bond. Structural steel shall conform to IS:226. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS:432 Cold twisted steel bars shall conform to IS:1786. Hexagonal wire netting shall conform to IS:3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

3.00.00 STORAGE AND HANDLING OF MATERIALS

a) **Bricks**

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded, to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) **Stones**

Stones shall be stored at site in manner approved by the Engineer. Dressed stone for wall facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.

c) **Lime**

Lime shall be stored in weatherproof sheds.

d) **Cement**

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

e) **Coarse and Fine Aggregates**

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass or any other injurious substances at any stage. Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

f) **Reinforcement**

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

TECHNICAL SPECIFICATION
FOR
XIV) ANTI-TERMITE TREATMENT

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XIV) ANTI-TERMITE TREATMENT

1.00.00 **SCOPE**

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 **EXECUTION**

2.01.00 **General**

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 **Chemicals and Rate of Application**

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals		**Concentration by Weight, Percentage**
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	:	0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	:	1.0

2.02.01 **Treatment of Column Pits, Wall Trenches and Basement Excavations**

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface & sides of excavation (up to a height of about 300mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres/M^2 of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres/M^2 of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding

the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

2.02.02 **Treatment of Top Surface of Plinth Filling**

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres/M^2 of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.02.03 **Treatment of Soil Surrounding Pipes, Wastes and Conduits**

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.02.04 **Treatment of Expansion Joints**

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.02.05 **Treatment at Junction of the Wall and the Floor**

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.

A small channel 30x30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 **ACCEPTANCE CRITERIA**

The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period at no extra cost to the owner.

4.00.00 **I.S. CODE**

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981: Code of Practice of Anti-Termite Measures in Buildings

Pre-constructional chemical treatment measures.

TECHNICAL SPECIFICATION
FOR
XV) MASONRY AND ALLIED WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	I.S. CODE

XV) MASONRY AND ALLIED WORK

1.00.00 **SCOPE**

This specification covers supplying, Laying, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied work for use in structures and locations covered under the scope of the Contract.

2.00.00 **INSTALLATION**

2.01.00 **Soling**

2.01.01 **Brick Soling**

The ground shall be dressed, consolidated by ramming or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of Item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

2.01.02 **Stone Soling**

The stones for soling shall be selected on the basis of thickness of soling shall be 230mm thick or as directed by the site engineer as per site condition. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

2.02.00 **Brick Edging**

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

2.03.00 **Masonry**

2.03.01 **General**

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

2.03.02 **Mortar**

Mix for mortar shall be as specified in the general specification of Architectural work unless mentioned otherwise mortar shall be cement sand mortar of proportion as specified in schedule of item.

If cement lime and sand mortar is specified in the schedule of item lime shall be hydrated lime and shall be mixed with water to form putty and stored with care to prevent evaporation for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream, passed through a No. 10 sieve and stored avoiding evaporation for seven days before use.

Lime putty and sand in proper proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in a mortar mill. This mix shall be transferred to a mechanical mix, required quantity of cement added and the content mixed for at least 3 minutes. Mixtures of lime putty and sand may be stored avoiding drying out.

For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct to add additional cement and same shall be made without any extra cost. No mortar, which has stood for more than half an hour, shall be used.

2.03.03 **Brick Masonry**

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

2.03.04 **Exposed Brickwork (Not Used)**

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by especially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of windowsills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified in the Schedule of Item, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of

work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

2.03.05 **Reinforced Brickworks**

Reinforcements shall be as specified in the General Specification of Architectural work. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. Columns or welded to steel stanchions.

2.03.06 **Stone Masonry (Not Used)**

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. Al least two stones shall run the full width of the wall for every square meter of surface area.

2.03.07 **Exposed Stonework (Not Used)**

Stonework, which is to be kept exposed, shall be as shown on drawing or described in the Schedule of Items. Especially skilled mason shall execute it. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or the Schedule of Items or instructions. A sample wall, 10 sq.m. In area shall be built and approved by the Engineer and all works shall match with this sample.

2.03.08 **Hollow and Solid concrete block Masonry (Not Used)**

Hollow and solid concrete block shall conform to the requirement of I.S 2185. Hollow concrete block shall be sound, free from broken edges; free from cracks, honeycombing and other defects, which may give a defective work, impaired the required strength.

Dimensional stability: concrete masonry units shall be made of proper sizes and shape to suit the construction need and shall be in neutral of the following sizes:

The nominal size of concrete block /solid concrete block.

Length : 400,500,600.

Height : 200,100

Width : 50,75,100,150,200,250,300.

In addition block shall be manufactured in half-length of correspondence to full length. Maximum tolerance of length shall be (±) 5mm and in height &with shall be ± 3mm.

The average crushing strength shall be determined as per I.S 2185 and shall be of Load bearing wall density of block shall be not less than 1500 kg /mm^3 and minimum average compressive strength of units shall be 3.5 to 7 N/mm^3 and minimum strength of individual unit shall be 2.8 to 5.6 for block density less than 1500 kg /mm^3 but not less than 1000 kg /mm^3 average compressive strength of units shall be 2.0 to5 N/mm^3 and minimum strength of individual unit shall be 1.6 to 4.0 N/mm^3

For non load bearing wall block density shall be not less than 1000kg / mm^3 and minimum average compressive strength of units shall be1.5 N/mm^3 and minimum strength shall be 1.2 N/mm^3**.**

2.03.09 **Composite Masonry (Not Used)**

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and intervels as desired by the Engineer.

2.03.10 **Expansion & Separation Joints**

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

2.03.11 **Moldings, Cornices, Drip Course**

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

2.03.12 **Curing**

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

2.03.13 **Embedding of fixtures**

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required and shall be grouted with concrete.

2.03.14 **Encasing of Structural Steel**

This shall be done by building masonry work round flanges, webs etc. and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer.

The minimum lap in chicken wire mesh shall be 50 mm. Architectural standard details shall be referred for encasement details.

2.04.00 **Damp Proof Course**

Unless otherwise specified Damp-proof course shall be 50 mm thick PCC in proportion 1:1-1/2:3 cemen :sand: stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

2.05.00 **Damp Proof Membrane**

Damp proof treatment using fiber or Hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as mentioned in the Schedule of Items. Sequence or work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150mm lap under slabs on grade.

3.00.00 **I.S. CODES**

Some of the important relevant codes for this section are:

IS: 1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.

I.S 2185 : Code Practice for hollow concrete block.

IS: 1597 : Code of Practice for Construction of stone Masonry.

IS: 1609 : Code of Practice for laying Damp-proof treatment using bitumen felts.

IS: 2212 : Code of Practice for Brickwork.

IS: 2250 : Code of Practice for preparation and use of Masonry Mortar.

IS: 5134 : Bitumen Impregnated Paper & Board.

TECHNICAL SPECIFICATION
FOR
XVI) FINISH TO MASONRY AND CONCRETE

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XVI) FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.00 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brush to remove all loose dust from joints and thoroughly washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 Plastering

2.02.01 Mortar

Mortar for plastering shall be as specified in the General Specification and design criteria for Architectural work.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 **Application of Plaster**

Plaster, when more than 15 mm thick, shall be applied in two coats - a base coat followed by the finishing coat. For 20 mm thick external plaster Thickness of the base coat shall be sufficient to fill up all unevenness in the surface and shall be 12 mm thick and mortar shall be 1:1 Cement Sand plaster. Top coat shall be 8 mm thick with cement sand mortar 1:3. No single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat as indicated in the General Specification and design criteria for Architectural work. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be thrown on rather than applied by trowel.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, door jambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, moldings and cornices as required or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. Drip course shall be provided over all windows, ventilators, louvers and all external doors, rolling shutters and External openings where such course is required for dripping of the water or as instructed by the site engineer. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 **Finish**

Generally, the standard finish shall be used unless otherwise indicated in the General specification or Standard Architectural drawings attach to the documents or directed by the site Engineer. Wherever any special treatment to the plastered surface is indicated in the General Specification for Architectural work, the work shall be done to the entire satisfaction of the Engineer regarding the texture, colour and finish.

a) **Standard Finish**

Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) **Neat Cement Finish**

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. Per Sq.M and rubbed smooth with a trowel. Unless otherwise indicated in the General Specification of Architectural work minimum 300 high neat cement finish shall be provided over plastered external surface from top of plinth protection level.

c) **Coloured Plaster Finish (Not Applicable)**

This shall be done, if indicated in the General specification for Architectural work, in the same way as specified in clause **2.02.01** but using coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest edition.

Samples of colouring material shall be submitted to the Engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) **Pebble-dash Finish (Not Applicable)**

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering clause **2.02.01**. While the mortar is still plastic small pebbles or crushed stone of size generally from 10 mm to 20 mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) **Rough-Cast Finish (Not Applicable)**

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 mm as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) **Scraped Finish (Not Applicable)**

Ordinary plaster as described under Clause **2.02.01** after being levelled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) **Textured Finish (Not Applicable)**

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause **2.02.01** Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) **Textured Finish with Granules**

Surface where Textured granules finish specified shall be prepared Specially as per approved manufacturer's specification and recommendation. Granules shall be mixed thoroughly in colour pigmented resin and shall be applied uniformly with devices as per manufacturer recommendation and by the authorized applicator of the manufacturer. Texture and shade shall be as approved by the owner during detail engineering stage. Textured finish brand shall be HERITAGE or SPECTRUM or Approved Equal.

2.02.04 **Curing**

All plastered surfaces after laying, shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 **Pointing to Masonry (Not applicable)**

All joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 **Plaster with Metal Lath**

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 BG thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two layers. The mortar for plastering shall consist of 1 part cement, and 4 parts sand by volume, mixed

as specified in plastering, Clause 6.1.2.2.1. The application, finish etc. shall be as specified under relevant clause above. Where called for in the Schedule of Items, a 2 mm Plaster of Paris punning shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

Brick encasing of steel beams shall be plastered over wire mesh provided during encasing of Steel beam with bricks.

2.05.00 **Lime Punning (Not Applicable)**

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 **Plaster of Paris Punning (Not Applicable)**

a) Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

b) **Wall Putty Finish to interior & Exterior Surfaces.**

Plastered surfaces, where specified shall be finished with wall putty of approved manufacturer. Wall putty shall be white cement based with a mix of high performance special chemicals and polymers and shall be suitable for both internal and external finishes. Wall putty finishes shall be 1.5 mm -2mm thick as per the condition of the surfaces to be treated.

Wall putty shall be water, fungus and algae resistant. Wall putty manufactured by Birla Cement/ MYK Laticrete India shall be provided for the work.

2.07.00 **Stone Facing**

a) Stone facing where specified shall be done as shown on design drawings & approved shop drawings. The stone shall be as specified e in the General Specification for Architectural work. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 20-25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern approved by the owner. They shall be fastened to wall with suitable noncorrodable anchorage as approved by the Engineer or as indicated in the General specification. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanised (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer. The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Alternately Stone slab shall be fixed with Laticrete 254 platinum thin set adhesive of MYK Laticrete India Pvt. Ltd. or approved equal over plastered surface with 2mm joints in between. Joints shall be filled with matching colour filler grout of the same manufacturer. Thickness of adhesive shall be according to size and weight of the slab and manufacturer specification shall be strictly followed. This alternative fixing system if not indicated in the general specification for Architectural work can be adopted with the approval of owner.

b) **Wall finishes with Vitrified, Ceramic and Terracotta tile**

Wall tile facing where specified shall be done as shown on design drawings and approved shop drawings. The Tiles shall be as specified on drawings and/or schedule of items. Samples of Tiles shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing tiles shall be as specified in the schedule of items or in drawing. Tile shall be fixed over Plastered surfaces with approved Chemical mortar of high bonding strength of approved manufacturer.

c) **Wall finish with Aluminium Composite Panel (ACP)**

Wall facade interior or exterior surface shall be plastered prior to installation of ACP. The exterior plaster surface shall be specially treated with water proof treatment with SIKA top seal or two coats of EMUFAL TE rubberized modified bituminous emulsion of TEXSA or approved equivalent prior to installation of ACP. Water proof treatment shall be made as per manufacturer specification and by manufacturer's authorized applicator.

ACP cladding system shall be based on rain screen principle, with provision for natural ventilation of the space between cladding panels and wall.

Panels shall be fixed as per general arrangement shown in approved drawing. Each panel shall be fixed over extruded aluminium sections as per approved manufacturer details and shall be fastened to Sub structure.

All fasteners shall be concealed within the panel joints. No silicon or similar sealant shall be used within the panel joints. All joints shall be of toughened acrylic adhesive similar to PERMABOND F-245 or as recommended by the manufacturer. All fixing and joint details shall be designed to provide for the expected thermal expansion and contraction and to accommodate structural movement.

Design criteria:

All aluminium composite panel shall be designed to meet the specified performances required to for the prevailing weather conditions.

Design wind load shall be 20N/Sq.m. no cladding element shall sustain permanent deformation or failure under loading equivalent to 1.5 times the design wind pressure specified.

Deflection: deflection of any aluminium frame shall not exceed 1/150 of the clear span.

All cladding shall be minimum 4.0mm thick for external use and minimum 3mm thick for interior paneling and shall conform the approved manufacturer recommendation.

Aluminium composite panel (ACP) shall comprise of polyethylene core sandwiched between two skins of aluminium alloy. Skin shall be of approved shade.

Finish shall be factory pre-finished with a PVDF (Flurocarbon) coating of super polyester coating and shall be suitable to withstand most aggressive climate. DFT of coating shall be minimum 20 micron. Finished surface shall be protected with self adhesive peel off foil. The reverse side of the panel shall be standard factory finish.

Vendors shall furnish general arrangement drawing with details of fixing and also furnish samples for ACP, structural stability assurance with necessary calculation and manufacturer guide lines for fixing and recommended specifications for selection and approval of the material.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 **I.S. CODE**

Important relevant code for this Section:

a) IS: 1661: Code of practice for cement and cement-lime plaster finish on walls and ceilings.

b) IS: 4101: Code of practice for external facings and veneers.

TECHNICAL SPECIFICATION
FOR
XVII) SINGLE SHEET / SANDWICH / DOUBLE SKIN METAL CLADDING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	GENERAL
2.00.00	PRODUCTS
3.00.00	DOUBLE SKIN INSULATED METAL CLADDING
4.00.00	EXECUTION

XVII) SINGLE SHEET / SANDWICH / DOUBLE SKIN METAL CLADDING

1.00.00 **GENERAL**

1.01.00 **Description**

1.01.01 This section covers the furnishing and installation of sandwich i.e., double skin metal / single sheet metal cladding with or without insulation for wall/roof as shown in contract drawings including making cut outs for various openings for doors, windows, ducts, pipes etc and fixing of such components with the cladding arrangement with necessary flashing, sealant as required as per contract drawings. The contractor shall furnish all labour, materials, tools and equipment required to complete the work.

1.02.00 **Applicable Codes and Standards**

1.02.01 The following codes and standards are intended to provide an acceptable level of quality for materials and products. The contractor may propose alternative codes and standards provided they give an equivalent degree of quality as the referred codes and standards and are submitted for consultants/ owner's approval.

1.02.02 ASTM American Society for Testing Materials

1.02.02.1 A446 Zinc-coated (Galvanized) steel sheets of structural quality. Coils and cut lengths.

1.02.02.2 A611 Steel, cold rolled sheet.

1.03.00 **Submittals**

1.03.01 The contractor shall submit to the owner the following items for review before commencing work.

1.03.01.1 Samples

Three 300x300 mm pieces of each type of precoated and preformed metal sheet for top skin and bottom skin. Bottom skin is required for sandwich cladding only.

Type of insulation proposed for use and its thickness in case sandwich cladding.

Fabricated sandwich metal cladding. Sample size shall be 300 x 300 mm three nos.

Edge sealing and flashing.

1.03.01.2 Manufacturer's literature indicating the nature of preformed profiled, colour coating, manufacturer's recommended installation, instructions and maintenance procedure.

1.03.01.3 Manufacturer's certification of compliance with each delivery.

1.03.01.4 Shop Drawings

Showing fabrication details of sandwich/double skin/Single metal cladding with or without Insulation as the case may be, preformed sheet profile and total colour thickness for profiled top skin and slightly ribbed bottom skin, thickness and nature of insulation in case of sandwich cladding, installation and erection, anchorage, fasteners and details of accessories, metal flashing and its fixing including various openings for doors, windows, louvres, pipes etc.

1.03.02 Test Reports

Two copies of Test Reports and Source of Quality Control Tests.

1.03.03 Supplier Certificates

Two copies of technical data showing that the proposed finish product is suitable for the environmental conditions of the job site and that the materials meet specification requirements.

1.04.00 **Product Handling**

1.04.01 Delivery of Materials to job site in manufacturer's original unopened packaging.

1.04.02 Identify contents with name of manufacturer, brand name, thermal value and applicable standard.

1.04.03 Store materials in an area protected from adverse climatic conditions, moisture and open flame or spark and shall be stored off the ground with one end elevated for drainage. The sheets shall be protected from inclement weather with a waterproof covering with ventilation to avoid condensation.

2.00.00 **PRODUCTS**

2.01.00 **General**

2.01.01 all goods and products covered by these specifications shall be procured from manufacturer duly approved by the owner

2.01.02 Roof insulation in case of sandwich roof cladding shall have a minimum R-value of 2.083 M2 oK/Watt. Thickness of sandwich cladding shall be as required to meet the specified "R" values.

2.01.03 Sandwich material shall be of "Rib and Flute" design to ensure wide spanning and quick recovery after being subjected to excessive load. Double skin materials shall be as per approved manufacturer sheet profile and sizes and inner sheet shall be mild rib & flute type profile to ensure quick recovery after being subjected to excessive load.

2.01.04 Material

2.01.04.1 Base Material — High tensile steel

2.01.04.2 Metal protection — Galvalume. This shall be steel sheet with Zinc Aluminium coating offering high corrosion resistance.

2.01.04.3 Organic coating — Silicon Modified Polyester (SMP) or Fluoro polymer (PVF2) and plastisols to resist aggressive climate of the jobsite or as per approved manufacturer's specification and recommendation.

2.01.05 Material shall be single skin or sandwich as per contract requirement in case of sandwich cladding material shall be prefabricated sandwich panel with polystyrene insulation/ resign bonded high density rock wool insulation shall be conformed to relevant ASTM or alternative codes and standard. Insulation shall be bonded to steel sheet with industrial grade adhesive. Sheeting material shall be preformed and precoated profile sheeting of thickness 0.5 mm to 0.55 mmTCT (Total coated thickness) or as recommended by manufacturer to resist the climate of the jobsite. Top skin (Weather side) and Bottom skin or inner side slightly ribbed type and minimum 0.5 mm thick or as recommended by manufacturer of similar pre coated panel. Single skin metal Cladding shall be similar to external top skin specified for Sandwich metal cladding.

2.01.06 Insulating core shall vary from 25 mm to 100 mm thick according to the climatic requirements of the site and shall be either polystyrene block or rock wool slab made to profile of the sheet. The maximum density shall be 32.35 Kg/M3 for polystyrene and shall have minimum R-value 2.083 M2 oK/Watt. And for Rock wool insulation density shall be 48kg/ M3 as per IS: 8183.

2.01.07 Panel size shall be largest available size.

2.01.08 Warranty for precoated profiled metal single skin/ sandwich /double skin cladding shall be for a minimum period of 40 years.

2.01.09 Sealants

Penetration and end laps in sheeting shall be sealed with a non-hardening approved sealant as recommended by the manufacturer.

2.01.10 Profile HDPE Filler

2.01.10.1 Profile HDPE Filler shall be die cut in profile to match the profile of the sheet.

Metal flashing shall be of similar material and match the colour of top skin.

3.00.00 DOUBLE SKIN INSULATED METAL CLADDING

3.01.00 General

3.01.01 Metal cladding may be of double skin separated by an approved insulation in between.

3.01.02 External cladding both for single and Double skin/sandwich wall cladding shall be comprising of external panels manufactured out of0.5mm to 0.55 TCT sheet or as per approved manufacturer sheet detail. Zinc Aluminium coated steel sheet (Galvalume sheet) shall have Coating comprised of 55% Aluminium, 43% Zinc and 1.5% silicon. Coating shall be of class AZ-150 as per AS: 1397, which means 150 gms/sq.m minimum coating mass total of both sides. The base material is steel which shall be high tensile steel of 550MPa. Coating on both sides shall be organic coating as indicated above in cl. No. 2.01.04.3. Coating thickness shall be as per manufacturer specification to resist most aggressive climate. Sheet shall be of approved shade with profile depth 28mm and 195mm pitch with two small additional ribs in between two profiles. Sheet shall be clipped on to the concealed runners and shall be overlapped with each other. The inner sheeting incase of sandwich cladding shall be Hi Rib minimum 0.5mm TCT silicon modified polyester coated galvalume steel (AZ-150 gsm aluminium-Zinc alloy metal metallic coating of total 550 Mpa yield stress as per AS-1397).The external panels shall be of profile mentioned above. The inner sheet shall have 1000-1020 mm cover width 28-30 mm high crests @250-255mm c/c with side laps. The inner sheet shall be fixed to structural system by means of corrosion protected self-drilling, self-tapping fasteners. The sub girts of size 50mmx50mmx50mm manufactured out of 16 G G.I (1.6mm) 'Z' shape shall be fixed to inner sheeting on face side at purline locations. The external panels shall be fixed with the help of concealed runners 34.5 wide x48mm deep out of 0.95 mm thick aluminium strip with cut outs to hold the panels in a module of sheet width as per approved manufacturer standard product and details fastened on side girts @ 1600c/c minimum. The runners shall be concealed and no fasteners are to penetrate the panels. An insulation of 50mm thick resin bonded rock wool insulation of density 48kg/m3 shall be fixed in the cavity between two sheets. Contractor shall make cut out of doors, windows, louvres, pipe, ducts or other cut outs as required as per contract drawings along with flashing, leak proof sealing etc as required for these cut outs/wall openings.

4.00.00 EXECUTION

4.01.00 Inspection

4.01.01 The contractor shall examine the area, which will be covered, and the masonry wall where the edge of the single sheet cladding /sandwich/double skin cladding will be fixed and the structural alignments.

Contractor shall correct any unsatisfactory conditions prior to start of work.

4.02.00 **Installation**

Single sheet panel/Sandwich panel shall be fixed over structural members with joints overlapped and fastened using stainless steel fasteners self-drilling type or as recommended by the manufacturer.

Wall cladding shall be installed strictly as per manufacturer specification and details.

All end laps of profiled sheeting and joints of flashing shall be sealed properly with non-hardening natural cure silicon sealant or as recommended by the manufacturer.

Accessories like fasteners, tape, and foam fillers, flashing etc. as required shall be provided as per recommendation of manufacturer.

4.03.00 **Clean-Up**

Remove sealant splatters and smears remove steel particles generated by drilling to avoid damage.

TECHNICAL SPECIFICATION
FOR
XVIII) CARPENTRY AND JOINERY

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XVIII) CARPENTRY AND JOINERY

1.00.00 **SCOPE**

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for in the schedule. This shall also include the supply and fixing of all hardware and fixtures.

2.00.00 **INSTALLATION**

2.01.00 **Materials**

a) **Timber**

Unless otherwise specified, all timber shall be best quality well seasoned C P teakwood free from large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenter's work, the Tendered shall have the rough timber approved by the Engineer.

b) **Plywood**

Plywood shall be commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde resin of BWR grade conforming to IS: 848.

c) **Decorative Laminated Plastic Sheets**

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number or joints in one surface.

d) **Flush Doors**

Flush doors shall be hollow or solid core doors with commercial or decorative faces and hardwood edges. The core for solid core doors shall be of block board or wood particleboard. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is phenol formaldehyde of BWR grade, conforming to IS: 848. The thickness shall be as specified in the "Schedule of Items".

e) **Panel Doors**

Panel door shall be of teakwood shutter frame unless otherwise noted and panels with teakwood/commercial ply/teakwood particleboard as per "Schedule of Items". Other considerations shall be as mentioned in item (d) above.

f) **Fixtures**

Fixtures for doors, windows, furniture, etc. shall be as shown on drawing or specified in the "Schedule of Fixtures".

2.02.00 **Workmanship**

2.02.01 **General**

Skilled carpenters as per details shown on drawing or instructed by the Engineer shall do the work.

Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. that will come in contact with masonry after fixing shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particleboard. The edge of all plywood, block board and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long MS holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M. S. grills or guard bars shall be provided to windows where called for in the drawings or schedule of items.

2.02.02 **Finish**

All carpentry work after finishing shall be sand papered smooth. Prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 **Surface Treatment**

When shown on drawings or called for in Schedule, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 **ACCEPTANCE CRITERIA**

3.01.00 **Door and Window Frames**

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 **Door and Window Shutters**

Shall be of proper size, shape and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 **Partitions, Paneling, Pelmets, Furniture, etc.**

3.03.01 **General**

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 **Partition**

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 **Pelmets**

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 **Cupboard Shutters**

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 **Drawers**

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 **Loose Furniture**

When placed on a level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 **IS CODES**

Some of the important relevant Codes for the Sections are:

IS: 4021	-	Timber door, window and ventilator frames
IS: 1003	-	Timber paneled and glazed shutters.
IS: 2191	-	Wooden flush door shutter (Cellular and hollow core type)
IS: 2202	-	Wooden flush door shutters (Solid core type)

TECHNICAL SPECIFICATION
FOR
XIX) METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	INFORMATION TO BE SUBMITTED
5.00.00	I.S. CODE

XIX) METAL DOORS, WINDOWS, VENTILATORS, LOUVRES, ETC.

1.00.00 SCOPE

The work in general shall consist of supplying and erecting and installing of all metal doors, windows, ventilators, louvres, glazed partitions, etc. as stipulated here or as specified elsewhere in the general specification for architectural work with all materials complete including supply of glass and glazing and all other materials as required. The scope of work shall also include the assembly of various components.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified in Architectural standard drawing.

Steel sheets for frames, shutters, louvre blades etc. shall be of gauge/ thickness mentioned here or as indicated in the drawing attached or General specification of Architectural work.

For pressed steel door frames steel shall conform to IS 513.

Aluminium sections for fabricating doors, windows, partitions, etc. shall be extruded sections conforming to sections manufactured by HINDALCO.

Hardware and fixtures of the best quality from approved manufacturers shall only be used. The bidder shall l specifically state the particular manufacturer's materials he proposes to use. Best quality fixtures as per approved sample shall be provided and fixed in true alignment. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility and shall be replaced without any extra cost.

All hardware and fixtures shall be able to withstand repeated use. Door closers shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated elsewhere in this document. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the door closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements & endurance test stated in IS: 3564 Appendix-A.

The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for verifications of bulk supply. The samples shall be returned to the Contractor towards the end for incorporation in the job.

The caulking /sealant shall be of best quality from a manufacturer approved by the Engineer. In general, Polysulphide or silicon sealant as approved by the Engineer shall be provided.

2.02.00 **Fabrication**

2.02.01 **Steel Doors, Windows, Ventilators, Louvres, etc.**

a) **Door Frames**

Frames shall be fabricated from 1.6 mm thick steel sheets. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place.

b) **Double Plate Flush Door Shutters**

Door shutters shall be 45 mm thick, completely flush design and shall comprised of two outer sheets or 1.25 mm thick steel sheets, rigidly connected and reinforced inside with continuous vertical 1mm thick steel stiffeners, spot welded in position at not more than 150 mm on centers.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting stile edges beveled or rebated. Where shown on drawing or called for in the schedule of items the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown in drawing, provision shall be made for fixing glazing, vision panels, louvres etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvres blades shall be V or Z shaped and made out of 1.6 mm thick steel sheets.

c) **Single Sheet Door Shutters**

Single sheet doors shall be made from best quality 1.25 mm thick mild steel sheets and shall present a flush surface on the outside. The inside shall be stiffened with semi-tubular edge and central stiffening rail, which shall convey the lock and other furniture. The frames shall be made from best quality 1.6 mm thick mild steel sheets.

Wherever required for vision panel, louvers for air inlet for ventilation through toilet doors provisions for fixing glass panes louvres, etc. shall be made.

The manufacturing shall be done as specified in **2.02.01 b** "Double Plate Flush Door Shutters".

d) **Sliding Doors**

Sliding doors shall be double plate construction made out of 1.25 steel sheets with adequate stiffeners. The Contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. The Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) **Fire Proof Door**

Fire proof doors shall be provided at all fire exit points and also restrict spread of fire generated either in internal or external area.

These doors shall conform to the requirements as stipulated in IS: 3614 (Part I & II) and shall have minimum 2 hours fire rating or as required as per fire rule of the statutory authority.

Fire proof doors shall be of approved manufacturer and shall be double plated metal door with core Packed tightly with insulation or teak wood or yellow pine boards shall include panic exit devices as hardware.

f) **Door Threshold**

Door threshold shall be provided for all external doors. Doors without threshold shall have bottom tie of approved type.

g) **Steel Windows, Sashes, and Ventilators etc.**

These shall conform in all respects to IS:1038 and IS:1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc.

All welds shall be dressed flush on all exposed and contact surfaces.

Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions as per IS 1038/1361. All windows shall be outside glazed fixed with putty or metal glazing beads. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (HIndalco Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer over unexposed side before fixing to windows.

h) **M.S grill**

Mild steel grill shall be provided for windows in specified areas for security reasons. M.S flats of minimum size 20x5 mm shall be used. Opening size shall not be more than 75 mm. all joints of the grill shall be properly welded. Grill shall be fixed to the window frame by welding. Steel primer shall be applied before installation.

2.02.02 **Aluminium Door, Windows and Frames**

Extruded sections of HINDALCO shall be used. All sections shall be approved by the Engineer before fabrication is taken up. Doors, frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15 micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent cover shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job and ready for erection. Shop joints shall be made to hairlines and then welded or braced by such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 **Shop Coat or Paint**

The shop paint for steel doors, windows, etc. shall be best quality two pack epoxy primer enriched with metallic Zinc of approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

All steel doors, windows etc shall have one shop coat and one site coat and two coats of finishing paint unless indicated in these specifications.

Portions of aluminium frame which come in contact with masonry construction shall before shipment from workshop be protected with a heavy coat of alkali paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 **Handling & Storage of Fabricated Material**

All metal doors, windows, etc. shall be packed and crated properly before dispatch to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

All metal doors, windows, etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminum products by rust, mortar, etc.

2.05.00 **Assembly & Erection at Site**

In general, the fixing of steel doors, windows, ventilators, louvres, etc. shall conform to IS:1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvres, etc. including transoms and mullions for composite units in respective places as shown on drawing keeping proper lines and levels, and in approved workman like manner to give trouble free and leak-proof installations. The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take every precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the mastic cement in original sealed containers of manufacturer and shall apply it as per the instructions. Caulking shall be done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metre from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

3.00.00 **ACCEPTANCE CRITERIA**

3.01.00 **For Fabricated Items**

a) Overall dimensions shall be within ±1.5 mm of the size shown on drawings.

b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.

c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 1.5 mm.

d) Door leaves shall be undercut where shown on drawings.

e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.

f) All welds shall be dressed flush on exposed and contact surfaces.

g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures.

h) Provisions for hardware and fixtures to be installed at site.

I) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed aluminium surfaces shall be free from scratches, stains and discolouration. Anodised surfaces shall present a uniform and pleasing look.

m) Glass shall be as per specification for “Glass and Glazing” given elsewhere in this document

3.02.00 **For Installed Items**

a) Installations shall be at correct location, elevation and in general on a true vertical plane.

b) Fixing details shall be strictly as shown on drawings or as per manufacturer details.

c) Assembly of composite units shall be strictly as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.

d) All frames on external walls shall be caulked with sealant either polysulphide or silicon sealant as per type of materials to prevent leakage through joint between frames and masonry.

e) All openable section shall operate smoothly without jamming.

f) Locks, fasteners, etc. shall engage positively. Keys shall be non-interchangeable.

g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

h) Aluminium doors, windows, etc. shall be free from scratches stain or discolouration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

a) Names of manufacturers for doors, windows, etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

b) He shall submit a programme of work to be done for the approval of the Engineer.

c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for verification of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.00.00 I.S. CODES

Following are some of the important I.S. Codes as relevant to this section:

Steel doors, windows and ventilators	-	IS: 1038
Steel windows for industrial buildings	-	IS: 1361

Aluminium doors windows and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows, And ventilators.	-	IS: 1081

TECHNICAL SPECIFICATION
FOR
XX) ALUMINIUM FRAMED GLAZED CURTAIN WALLS AND STRUCTURAL GLAZING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XX) ALUMINIUM FRAMED GLAZED CURTAIN WALLS AND STRUCTURAL GLAZED WALL

1.00.00 SCOPE

This specification covers supply, erection & installation of Aluminium framed glazed curtain wall/ Structural glazing work for wall including fabrication and erection of tubular aluminium frames for large panel glazing work.

It also includes furnishing and installation of glass, aluminium frames, aluminium brackets, angles, tubes, sheet, Shadow box to hide the floor beams and other members as required, adhesive of approved quality, Toughened heat reflecting tinted imported glass etc. For the completion of curtain wall or structural glazing work, a firm specialised in executing similar type of work and duly approved by the Engineer shall be engaged to execute such work.

2.00.00 INSTALLATION

2.01.00 System and Materials

Curtain Wall is a façade with visible supporting frame work for fixing glass. The frame Consist of vertical mullion and horizontal transoms.

Supporting system shall be fixed in one of the following method as per schedule of item.

- **Stick wall system**

  In this system the mullions are first installed to the slabs of the building and then transoms are fixed with or without connecting brackets.

- **Ladder or semi-unitized system**

  In this system Prefabricated mullion and transom frames are taken to site and installed in units of 3 or 4 frames in the same way of stick system.

- **Unitized system**

  Prefabricated frames with split mullions are installed frame by frame between slabs.

Supporting frame and glass fixing arrangement shall consist of mullions, Transom, purlins i.e., continuous cross bars, brackets as connector for mullions and transoms, wall brackets for fixing mullion to slab, pressure plate/ glazing plate to hold the glass, Cap/Cover plate to cover glazing plate and fixing screws.

Aluminium sections for curtain walls with or without doors, windows etc. Shall be approved extruded sections from alluminium alloy of HINDALCO.

Hardware and fixtures shall be of approved manufacturer. Doors, windows and frames shall also conform to the technical specification of "Metal, Doors, Windows, Ventilators, Louvers" inserted in this document.

All aluminium-extruded sections shall have dark brown electro coloured coating irrespective of any indication in General Specification for architectural work. Glass shall be tinted glass as per approved sample as indicated in General specification for Architectural work.

Glazing and insulating gaskets shall be EPDM. Fasteners exposed to outside and inside shall be stainless steel. Brackets and reinforcement shall be aluminium flashing shall be aluminium 16 G. Sheet. Glass and glazing shall conform to the technical specification of "GLASS AND GLAZING". All aluminium members shall be isolated from dissimilar metals/concrete etc. and unexposed surface coming in contact with other structures, walls, etc. shall be painted with a coat of zinc chromate primer.

Water proofing on the rafters shall be achieved by means of continuous slip in gasket above and below the glass. Under no circumstances glass shall come in contact with metal. Weep holes shall be provided at the lower portion of the aluminium bar for drainage of condensed moisture.

Contractor shall provide hardware; fix doors, and windows so that perfect operation is assured. Doors shall stand in any position to operate smoothly.

Silicon sealant shall be used at expansion joints, gasket joints and gaps between the surrounding wall and the glazing members to make the system waterproof.

Aluminium finish shall be electro colored of approved shade conform to minimum 15 microns thick or as recommended by the manufacturer to witness aggressive climatic conditions.

Structural glazing

Structural glazing is a façade without any visible external element ie supporting member profiles. Glass panels are fixed with the frames by using a structural Silicone sealant.

The sealant contract dimension and thickness shall be designed to :

i) Provide a method of structural support to glass

ii) Provide airtight and weather tight seal.

iii) Provide a flexible rubber anchorage that absorbs differentials movements between dissimilar materials from thermal or seismic loading.

Structural glazing shall also be fixed any of the three system as stated for Curtain wall fixing above.

Both Curtain wall and structural glazing shall be designed by the approved vendor. General arrangement showing location and type of windows and doors if required and structural system considering most aggressive climatic condition including sizing of supporting members, required glass thickness and panel size and contact adhesive dimensions etc. shall be submitted for approval. Vendor's drawing with necessary structural design calculation are to be submitted by the vendor for approval of the owner.

3.00.00 INFORMATION TO BE SUBMITTED BY CONTRACTOR

3.01.00 After award of contract

After award of contract and prior to construction contractor shall furnish vendor drawings based on GA drawings and technical data given with details of assemblies, flashing, anchorage, expansion joints, accessories and other necessary items for approval of the owner.

Samples of materials are to be submitted for approval prior to construction and a prototype 750 mmx750 mm In size curtain wall/structural glazing finished in all respect shall be submitted for approval of the Engineer-in-Charge. The samples shall be retained by the Engineer for comparison of supply and returned to the contractor towards the end of the construction.

Vendor drawing shall be submitted prior to fabrication. Shop drawing shall indicate the following information.

i) Plans, elevations and sections of all aluminium curtain walls/ Structural glazing .

ii) Detail of frames and glazing.

iii) Details of hardware locations with dimensions.

Approval of vendor drawings by the owner's side shall be for arrangement only and not for structural system and its stability and shall not relieve the contractor of his responsibilities for errors, omissions or the accuracy of his own dimensions, structural strength and stability, flexibility to thermal condition, weather conditions and other movements.

4.00.00 ACCEPTANCE CRITERIA

4.01.00 For fabricated items

Refer technical specification of Metal Doors, Windows, and Ventilation etc.

4.01.01 For installed items

Refer technical specification of Metal Doors, Windows etc.

5.00.00 **I.S. Code**

IS-12118: 1987: (Part I & II)	Specification for two parts polysulphide based sealants

TECHNICAL SPECIFICATION
FOR
XXI) ROLLING STEEL SHUTTERS AND GRILLS

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXI) ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 **SCOPE**

This specification covers the design, supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 **INSTALLATION**

2.01.00 **Components**

a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 m wide and not less than 2.25 mm thick for shutters 5.5 m wide and above, machine rolled at 75 mm rolling centres, interlocking with each other. The profile, will be such as to prevent excessive deflection under specified wind load.

b) Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia. rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise in the Schedule.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M or as specified in Schedule.

f) Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as described in Schedule or as described by the Engineer.

i) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in Schedule or drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

j) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

2.02.00 **Manually Operated Shutters / Grills**

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general manually operated shutters shall be push pull type for openings upto 9 sq.metre in area. Larger shutters shall be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as described in Schedule or as desired by the Engineer.

2.03.00 **Power Operated Shutters / Grills**

These shall be operable from a push butten station conveniently located beside the door or as shown on drawings. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for in Schedule, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 **Shop Coat**

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.05.00 **Erection**

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS:6248 - Metal rolling shutters and rolling grills.

TECHNICAL SPECIFICATION
FOR
XXII) GLASS AND GLAZING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXII) GLASS AND GLAZING

1.00.00 **SCOPE**

The work in general shall consist of supplying and fixing all glass and glazing including all clips, putty, mastic cement etc. wherever required as stipulated here or elsewhere in the General specifications for Architectural work. Architectural standard drawings including supply of snap glazing beads, EPDM gaskets and all materials as required for completion of the work.

2.00.00 **INSTALLATION**

2.01.00 **General**

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvres, miscellaneous glazing and partitions from approved manufacturer & shall have uniform refractive index and free from flaws, specks and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

a) Glare reducing or heat absorbing glass if provided shall be of approved manufacturer and special care shall be taken to grind smooth and round off the edges before fixing.

b) Clear glass shall be float glass and shall be at least 6 mm thick. for windows and for doors shall be minimum 6mm thick or as indicated in the General specification of Architectural work. Glass for Seamless glazed door shall be 12 mm thick.

c) Wired glass shall be 6mm thick rolled glass with centrally embedded wire mesh of Georgian type. This may be of clear glass.

d) Obscure/ground glass shall have a cast surface in one side.

e) Colour glass shall be as per approved sample.

f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty glass is used where it shall be non-setting type.

g) EPDM gaskets with snap-fit glazing shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.02.00 **Glazing, Setting and Finish**

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing clips shall be provided per glass pan, except for large panes where six or more clips shall be used as per Engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where moulding or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Necessary glazing clips, putty, mastic cement etc. shall be supplied by the Contractor. After completion of glazing work, the Contractor shall remove all dirt stains, excess putty etc. clean the glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the Contractor's own cost.

3.00.00 **ACCEPTANCE CRITERIA**

a) All installation shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by EPDM gaskets to give a leak proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

c) No separate payment shall be made for cutting of glass to require size, edge finishing etc. if the glass is supplied by the Contractor.

d) Payment shall be made for cutting of glass to required size edge finishing etc. if the glass is supplied by the Owner.

e) No separate payment shall be made for cleaning the glass after installation.

4.00.00 **I. S. CODES**

Following are some of the important I.S. Codes relevant to this Section :

IS : 3548 - Code of practice for glazing in building.

IS : 1083 - Code of practice for fixing and glazing metal doors, windows and ventilators.

TECHNICAL SPECIFICATION
FOR
XXIII) FLOOR FINISHED AND ALLIED WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXIII) FLOOR FINISHED AND ALLIED WORK

1.00.00 **SCOPE**

This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes and allied items of work as listed below :

a) **In Situ Finishes**

i) Integral finish to concrete base

ii) Red Oxide of Iron finish

iii) Terrazzo finish

iv) Granolithic finish

v) Patent Stone

vi) Metallic Hardener like “Ironite” finish

vii) Non Metallic hardener finish

viii) Mastic Asphalt finish

ix) Chemical Resistant finish

b) **Tiled Finishes**

i) Terrazzo tile

ii) Chequered tile

iii) Glazed tile

iv) Tesserae (Mosaic etc.)

v) Chemical Resistant

vi) Rubber, Vinyl etc.

vii) Stone slab

viii) Vitrified tile finish

1.01.00 **Base**

The base to receive the finish is covered under other relevant specifications.

1.02.00 **Sequence**

Commencement, scheduling and sequence of the finishing work shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damage whatsoever till handing over.

2.00.00 **INSTALLATION**

2.00.01 **Special Materials**

Basic materials are covered under Specification “Properties Storage and Handling of Common Building Materials”. Special materials required for individual finishing items are specified under respective items. In general, all such materials shall be as per relevant I.S. Codes where available. In all cases these materials shall be of the best quality available indigenously, unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialised manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain the construction schedule.

2.00.02 **Workmanship**

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer’s permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 **Preparation of the Base Surface**

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado & similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water & hard brush & detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification under individual item.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 **In Situ Finishes**

2.01.01 **Integral Finish to Concrete Base**

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and leveled but the concrete is still green a thick slurry made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin a possible by using 2.2 kg. of cement per sq.m. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after laying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings. The marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 **Red Oxide of iron finish (Not Applicable)**

It shall consist of an underbed and a topping over already laid and matured concrete base.

a) **Thickness**

Unless otherwise specified the total thickness of the finish shall be minimum 50 mm or as per schedule of item for horizontal and 20 mm or as per schedule of item for vertical surface of which the topping shall (not less than 10 mm) while the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finishes. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius off 25 mm.

b) **Mix**

i) **Underbed**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume. For vertical and similar surfaces the mix shall consist of 1 part cement to 3 parts coarse sand by volume.

ii) **Topping**

For the topping cement, screened through a fine mesh and red oxide of iron pigment powder similarly screened shall be dry mixed thoroughly in right proportions to produce the desired colour when laid. The mix shall then be prepared with 1 part cement (mixed with pigment) and 3 parts coarse sand by volume. The whole quantity required for each visible area shall be prepared in one batch to ensure uniform colour.

c) **Laying**

The underbed shall be laid in panels of mixing area 5 Sq.M. each and no side shall be more than 2.5 along. For outdoor locations the maximum area shall be 2.0 Sq.M. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. If specified aluminium or glass dividing strips shall be used.

The panels shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid until the contraction of the latter has taken place. The underbed shall be laid, compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. The surface of the underbed shall be roughened for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by trowelling and finished smooth with a slurry made with already prepared cement and pigment mixture. About 2.0 kg. of the mixture shall be consumed/ per sq.m. for horizontal surface and 1.0 kg. for vertical surface. The surface shall be cured for seven days by keeping it moist.

d) Polishing

About 36 hours after laying when the surface has hardened sufficiently it shall be polished with polishing stone till a smooth shiny surface to the satisfaction of the Engineer, is achieved. The finish shall be washed and cleaned just before handing over.

2.01.03 **Terrazo Finish : In Situ (Not Applicable)**

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) **Thickness**

Unless otherwise specified the total thickness of the finish shall be minimum 50 mm for horizontal and 20 mm or as per schedule of items for vertical surface of which the topping shall be not less than 10 mm or as per schedule of items. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary

slopes. The vertical surface shall project cut 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radious of 25 mm.

b) **Mix**

i) **Underbed**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1.½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) **Topping**

The mix for the topping shall be composed of cement, colour pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or grey or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from white marble and shall be finer than IS Seive No. 30. The size of marble chips may be between 1 mm to 20 mm.

Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) **Laying**

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat "green" but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) **Curing**

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) **Grinding and Polishing**

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no. 60) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no. 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no. 320) to get smooth surface without any pinhole. The grinding shall be done by a suitable machine. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no. 60), second rubbing with medium grade (no. 80) and final rubbing and polishing with fine grade (no. 120).

The surface shall be cleaned with water, dried and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. sq.m. water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy but not slippery.

2.01.04 **Granolithic Finish**

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) **Thickness**

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) **Mix**

The mix shall consist of 1 part cement : 1 part coarse sand : 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) **Laying of Monolithic Topping**

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully "green" the topping shall be laid evenly to proper thickness & grade. If considered necessary the surface of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly & work vigoraously and quickly to secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stonechips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) **Laying of Topping Separately on Hardened Base**

The base concrete shall be prepared as stated in clause 2.01.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

e) **Curing**

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) **Grinding**

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.03 (e) shall be followed. However, the ultimate polish required shall be decided upon by the Engineer.

g) **Finishing**

Where specified, sodium silicate or magnasium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as specified in the Schedule of Items. The concentration and method of application of the solutions shall be as specified in IS:5491.

2.01.05 **Patent Stone**

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) **Thickness**

The patent stone finish shall have thickness as stipulated under clause 2.01.03(a) except that the topping shall be 6 mm thick.

b) **Mix**

i) **Underbed**

The mix shall be as stipulated under clause 2.01.03 (b).

ii) **Topping**

The mix for the topping shall consist of 1 part cement and 1 part fine sand by volume.

c) **Laying**

The Patent Stone finish, including the underbed shall be laid in alternate bays or in chequered board pattern. No panel shall be as in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M long.

A cement grout shall be applied and worked into the surface to receive the finish, the underbed then laid, compacted and levelled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.06 **Metallic Hardener Like "Ironite" Finish**

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is "Green".

a) **Thickness**

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) **Material**

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the engineer, actual samples shall be tested.

c) **Mix**

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) **Laying**

The concrete floor shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The forms, if any shall remain sufficiently projecting to take the finish. The surface shall be roughened by wire brush as soon as possible.

The finish shall be laid while the concrete underbed is still very "green" within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06(A) **Non Metallic Hardener Like SIKA' Chapdur' Finish**

Non metallic hardener shall be of hard granules of mineral origin. Floor hardener shall be laid by authorized applicator of the Manufacturer as per specification and recommendation of the manufacturer. For heavy duty finish 5.5 to 6kg/Sq.m for a thickness of 3mm surfacing shall be provided. The ready made Chapdur compound of SIKA shall be spread over newly laid smooth concrete surface at a stage when a nail mark of 3 to 4 mm will be obtained at standard pressure. Spreading shall done by hand @ of approximately 6.0 kg/Sq.m for heavy duty finish.

While the mixture will be uniformly moistened by the surface water the surface shall be made smooth with the mechanical hand trowel.

Curing shall be made to protect the surface from rapid drying. Curing shall be made for at least for 3 days by means of wet guny bags or pooling water on the surface.

Floor using time shall be as per manufacturer recommendation.

2.01.07 **Mastic Asphalt Finish (Not used)**

This is a one layer treatment on concrete or brick base.

a) **Thickness**

The thickness shall be as specified in the drawing or schedule of items.

b) **Materials**

Bitumen shall be industrial bitumen of the grades 90/15 and 75/15 conforming to IS:702.

Mineral filler shall be dry stone dust passing through 75-micron IS Sieve.

Fine aggregate shall be crushed and graded natural lime stone or other hard-work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick and 10 mm chips for thicker finish.

c) **Composition**

Bitumen mastic shall conform to IS:1195 and shall be either brought to site in blocks weighing about 25 Kg. or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers & coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205^{o}C.

d) **Laying**

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 15 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.08 **Chemical Resistant in Situ Finish (Not used)**

Chemical resistant in situ finish shall be an epoxy resin with suitable filler material over a primer or called for in the Schedule of Items. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The Contractor shall get it done by a specialised manufacturer, get guarantee of performance from the organisation and pass it on to the Owner in addition to his own guarantee.

2.02.00 **Tiled Finish**

These shall include finish tiles, stone slabs and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 **Terrazzo Tile Finish**

The finish will consist of manufacture terrazzo tile and an underbed.

a) **Thickness**

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) **Tiles : Terrazzo**

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.Cm.

Each tile shall bear on its back permanent and legible trade mark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform

throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness ± 3 mm. Face of the tile shall be plane, free from pin holes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary grey cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.03 (b).

The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) **Mix : Underbed**

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) **Laying**

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02 (c) may be used for dividing the work into suitable panels.

c) **Grinding and Polishing**

Procedure shall be same as Clause 2.01.03(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02 **Heavy duty Cement Concrete (Carborundum) tile**

Heavy duty concrete tile shall be procured from reputed manufacturers only. This tile shall be produced in a well set up factory under strict quality control. Tiles should be compressed under a high pressure of about 0.15 t/sq.cm. Samples of the tile shall be submitted to the Engineer for approval before starting regular production.

IS:1237 shall be followed as general quidance for the specification of heavy duty concrete tile.

Size of the tile shall be 300x300 mm unless otherwise specified. Minimum thickness shall be 22 mm. However, actual thickness shall be as per designed strength requirement.

Store grit shall be used in the bottom layer of tile and the mix shall not be leaner than 1:3. Thickness of wearing layer shall be not less than 8 mm. For top layer nominal proportion of cement to aggregate shall be 1:1.5 unless otherwise agreed. Distribution of chips appearing over top surface should be uniform for aesthetic appearance. For darker shade of colours, 50% white cement of the total cement content shall be used. However, for lighter shade of colours, only white cement shall be used. Aggregate shall be hard stone chips of different colours. Carborundum, granite, quartzite chips shall be used. Properly graded-aggregate upto 10 mm size shall be used. Marble chips shall not be used unless specifically approved by the Engineer and shall not exceed 10% of the total quantity. Only good quality pigment having durable colour shall be used. Organic colours and lead pigments shall not be used. Manufacturer should ensure durability of the colour against possibility of any colour fading. Matching of colour between different batches shall be ensured. Physical properties and dimensional tolerance of the tile shall be as per IS:1237. However, surface hair cracks shall not be acceptable. For slipperage prone areas, rib tile/fluted type or chequered tiles shall be used. Tile shall be supplied with initial grinding (preferably twice) at factory premises. For laying and finishing of tile, IS:1443 shall be followed for general guidance.

For bedding, Lime-surkhi mortar shall be used as specified for Terrazo tiles.

Joints between tiles shall be filled with matching grouting same as used in topping and shall be supplied by the manufacturer of the tiles.

Grinding shall be done as per recommendations of the manufacturer including use of special type grinding stone. At least two additional grindings shall be done at site after laying, besides the initial grinding at factory premised. Oxalic acid polishing shall be done after grinding.

2.02.02 (A) **Chequered Tile Finish**

The finish shall consist of manufactured grey or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) **Thickness**

Thickness shall be same as in clause 2.01.03(a).

b) **Tiles : Chequered**

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm c/c, Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain grey cement or colour pigment added to cement as specified.

c) **Underbed**

As per clause 2.01.03 (c).

d) **Laying**

As per clause 2.01.03 (d).

e) **Grinding and Polishing**

As per clause 2.01.03 (e) except that the tiles shall be ground and polished by hand after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 **Glazed Tiles/Ceramic Tiles Finish**

This finish shall be composed of glazed earthenware tiles/Ceramic tiles with an underbed laid over a concrete or masonry base.

a) **Thickness**

The total thickness shall be 50 mm including Underbed for floor.

The total thickness shall be between 20 mm and 25 mm including underbed for wall finish.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) **Tiles : Glazed/ mat finish Ceramic tiles**

The floor tiles shall be of earthenware, covered with mat white or coloured, plain or with designs, of nominal sizes 300x300 mm 7.2 mm minimum thick approximately as per approved manufacturer product unless otherwise specified. The tolerance shall be $\pm$ 1.5 mm for length and breadth and $\pm$ 0.5 mm for thickness specials like internal and external angles, beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be matt unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

For wall finishes Tiles shall be ceramic tiles Matt / glazed as per General specification of Architectural work and size of tiles shall be 300x200x5 to 6mm thick or 300x450x7.2 mm - 10 mm thick approximately of approved manufacturer. Tile shall be laid over prepared base in 15 mm thick cement sand mortar 1:3 including cement slurry and jointing with approved matching filler.

c) **Mix : Underbed**

The mix for the underbed for floor shall consist of 15mm 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified. Under bed with 1:2:4 PCC shall be provided as required for total floor thickness of 50 mm.

d) **Laying**

Same as clause 2.02.01 (d).

e) **Finishing**

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handing over.

2.02.03 (A) **Vitrified tiles**

Vitrified tiles shall be of approved manufacturer and premium quality. Size of tiles shall be 600x600x10 mm thick. Tiles shall be made from special quality ball clay and high quality minerals and shall be formed by compression in a PH3590 T press and fired in a kiln at an ultra high temperature of 1200 degree salcius for vitrification.

Tiles shall be absolutely non porous and water absorbtion shall not be more than 0.05% and shall be high resistance to chemicals, stains and free from bacteria breeding. Edges of the tiles shall be perfectly in right angles, perfectly flat and straight to give hair joints between two tiles and shall be dimensionally perfect. The hardness of the tiles shall be 8 on MOH scale. Deviation in length shall be limited to +/- 0.08% and in thickness +/- 2%.

Straightness of sides +/- 0.1%. Tiles shall be pre polished, ready to use and of high gloss.

Tiles shall be fixed over under bed with minimum 15mm thick cement sand mortar of 1:3 and necessary cement slurry.

Joints shall be filled with approved filler.

2.02.04 **Tesserae Finish (Mosaic etc.) (Not Used))**

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) **Thickness**

The total thickness including the underbed shall be between 16 mm and 25 mm.

b) **Tesserae Finish**

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass or similar hard wearing, strong and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) **Mix : Underbed**

Same as clause 2.01.03(b)

d) **Laying**

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.01.03(d) shall generally be followed. However, instead of grey cement the slurry shall be made with white cement to fix the panels. The paper mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.05 **Chemical Resistant Tiled Finish**

This shall include all varities of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) **Tiles**

The chemical resistant tiles as detailed in the Schedule of items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour and textures.

Glazed tiles if permitted to act as chemical resistant finish shall be considered under clause 2.01.03.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/Cm2. The surface shall be abrasion resistant and durable.

b) **Laying**

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 **Rubber, Vinyl or Vinyl Asbestos Tiles Finish**

This shall include various types of tiles manufactured from rubber, vinyl, etc. set with a adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) **Thickness**

The thickness of the tiles shall be mentioned in the Schedule or in drawing.

b) **Tiles**

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trade mark, the thickness, sizes, batch number and date of manufacture.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) **Mix : Underbed**

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty : 1 part cement : 4 parts coarse sand mixed with just sufficient water to make it workable.

d) **Laying**

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive

squeezed out through the joints shall be removed immediately.

e) **Finishing**

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried and polished with an approved type of polish just before handing over.

2.02.07 **Store Slab Finish : Marble, Stone and Similar Fine Grained Stone**

a) **Thickness**

The underbed shall be composed of PCC 1:2:3 and Cement Sand mortar !:3 minimum 15 mm and average 20 mm thick remaining portion shall be PCC underbed. The slabs may be 20-25 mm, 30 mm or 40 mm thick as specified.

b) **Stone Slab**

The stone slabs shall be made from selected stock which are hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of $\pm$ 5 mm in dimensions and $\pm$ 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm or as specified elsewhere in the documents.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) **Mix : Underbed**

Same as clause 2.01.03 (c).

d) **Laying**

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed clean before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, a thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, grey/white/mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid

and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) **Polishing, Finishing**

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.01.03 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 **Stone Slab Finish : Sand Stone & Similar Coarse Grained Stone Finish**

Generally clause 2.01.03 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto $\pm$ 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to $\pm$ 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement.

2.02.09 **Base and Sub base for Flooring**

Ground Floor shall consist of the following:

i) Well compacted (90-95%) earthen sub grade.

ii) 230 mm thick dry rubble soling on rammed earth. Rubble shall be hand packed as directed by the Engineer. This shall be laid closely in position on sub grade. The stones for soling shall be selected on the basis of thickness of soling as directed by the Engineer. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

iii) 75 mm thick PCC 1:4:8 or as specified elsewhere in this document with 40mm nominal size stone aggregates laid over compacted rubble soling.

iv) RCC floor slab shall be laid over PCC

v) Floor finish 50 mm thick including under bed as specified shall be laid over RCC floor slab.

3.00.00 **ACCEPTANCE CRITERIA**

The finish shall be checked specially for :

a) Level, Slope, Plumb as the case may be

b) Pattern and Symmetry

c) Alignment of joints, dividing strip etc.

d) Colour, texure

e) Surface finish

f) Thickness of joints

g) Details at edges, junctions etc.

h) Performance

i) Precautions specified for durability

4.00.00 **I.S. CODES**

Important relevant codes for this section :

IS : 777	:	Glazed earthenware tiles
IS : 1196	:	Code of practice for laying bitumen mastic flooring.
IS : 1197	:	Code of practice for laying of rubber floors
IS : 1237	:	Cement concrete flooring tiles
IS : 1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
IS : 2114	:	Code of practice for laying in situ terrazzo floor.
IS : 3461	:	PVC asbestos floor tiles
IS : 4860	:	Specification for acid resistant bricks
IS : 5518	:	Code of practice for laying of flexible PVC sheet and tile flooring.
IS : 5491	:	Code of practice for laying in situ granolithic floor topping.

TECHNICAL SPECIFICATION
FOR
XXIV) FALSE FLOORING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXIV) FALSE FLOORING

1.00.00 **SCOPE**

This specification covers supplying, installation, repairing, finishing, testing, protection and maintenance till handing over of removable free access false flooring systems consisting of an assembly of panels mounted on adjustable pedestal and supporting steel grid system to provide an under floor space.

The entire Access floor system shall be made from steel cementation in filled access floor tile and shall provide for adequate fire properties, acoustic barrier and air leakage resistance and antistatic floor system.

2.00.00 **FALSE FLOORING SYSTEM**

2.01.00 **Base**

The system shall be placed over a base of R.C.C. floor slab and with necessary grouting etc. to fix the supporting structure.

In general solid feel UFP laminated HPL/PVC panel with rigid under structure support system shall be provided. The Access floor shall be minimum 600 high finish floor from concrete sub floor.

2.02.00 **Supporting Structure**

The supporting structure shall conform CISCA 1986-87 and MS comprise of fabricated jacks made out of 25.5mmOD and 22.5mm ID with 2 mm embossed steel base plate 100x100x2 mm and pedestal head make out of size 75mmx75 mmx4 mm thick steel plate with 45 mm long steel pipe size 27mm ID x32 mm OD tag welded to the head plate and rest on the pedestal with 2 no MS Check nut speedy assembly and removal for relocation and maintenance. Pedestal base shall be secured firmly in position on sub floor.

Stringer:

Stringer channel made of 1.2mm thick galvanized steel sheet and the size of stringer shall be 575 x28mmx20mm.

The pedestal shall be equipped with conducting grounding pad. All MS members shall be treated with steel protective paint. The concrete sub floor shall be painted with two coats of synthetic enamel pain.

2.03.00 **Floor Panel**

2.03.01 Panels shall be made from steel. The bottom of the panel shall be embossed in hemispherical shape to give strength and flexural rigidity. The top sheet shall be plain and resistant welded at various location after the top and bottom sheet have been degreased and phosphate to form a single composite unit (as per CISCA 1986-87). The entire panel shall be coated with epoxy coating on the exposed surface and then the hollow panel shall have factory laminated Antistatic HPL/PVC with 6mm beading on all the sides for

edge protection. Panels shall remain flat, through and stable unaffected by humidity or fluctuation in temperature throughout its normal working life. Panels shall provide for impact resistance top surfaces minimal deflection, corrosion resistance properties and shall not be combustible or aid surface spread of flame. Panels shall be insulated against heat and noise transfer. Panels shall provide qualities of concrete slabs. Panels shall be of size 600x600mm fully interchangeable with each other within the range of specified layout. Panels shall be free standing (Simple supported) onto the understructure.

2.04.00 **Strength**

Each 600 mm x 600 mm floor panel must be capable of supporting an uniform minimum live load of 1220 Kg/Sq. or a concentrated minimum load of 450 Kg. applied through a phenolic caster 75 mm in diameter and 45 mm wide, or a rolling minimum load of 450 Kg. at any point with a maximum deflection of 2 mm.

2.05.00 **Surface Finish**

All removable panels shall have the top surface finished with 2.5 mm thick Anti static Vinyl Flooring bonded to the surface with adhesive as per manufacturer's specification.

2.06.00 **Skirting**

Skirting shall be of the same Antistatic Vinyl tiles, 150 mm. high and 2.5 mm. thick, completely matching with the false flooring surface and shall be fixed with the plastered wall surface as per manufacturer's specification.

2.07.00 **Installation**

All steel surface are to be protected by pointing over a primer as per schedule of items and any damage to the paint during installation shall be made good. Finished floor surface, when specified by the Engineer-in-Charge shall be protected by the Contractor with kraft paper taped and sealed at edges to prevent tearing.

Any damage to the sub floor during installation of the false flooring system shall be made good by the Contractor without any extra cost to the owner.

3.00.00 **ACCEPTANCE CRITERIA**

The false flooring system shall be checked specially for :

a) Level
b) Alignment of joints
c) Thickness of joints
d) Surface finish
e) Colour and texture

TECHNICAL SPECIFICATION
FOR
XXV) PAINTING, WHITE WASHING AND POLISHING ETC.

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXV) PAINTING, WHITE WASHING AND POLISHING ETC.

1.00.00 SCOPE

This specification covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plastered surfaces finished with plaster of paris/ wall putty, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on drawings, schedule or as directed by the Engineer.

Copper, bronze, chromium plate, nickel, stainless steel, aluminium and monel metal shall generally not be painted or finished except if otherwise specified.

The painting Contractor shall inspect the work of others prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting contractor shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing that results.

Before commencing painting, the painting contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.01.00 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint or one shade is obtained the same manufacturing batch. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognised manufacturers and shall be approved by the Engineer.

All colour shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) **White Washing (Not Used)**

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the Engineer, and shall conform to IS:712 latest edition. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank of water for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100grams of gum to 6 litres of white wash water and a little quantity of indigo or synthetic ultramarine blue shall be added to the lime.

b) **Dry Distemper (Not Used)**

Shall be made from suitable pigments, extenders, lime proof tinters, water soluble binders etc. and shall conform to IS:427.

c) **Oil Bound Washable Distemper (Not Used)**

Shall be of oil emulsion type, containing suitable preservatives and shall conform to IS:428.

d) **Waterproof Cement Paint**

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS:5410.

e) **Acrylic Emulsion Paint internal and external use.**

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide. It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild detergent and water without any deterioration in colour, or without showing flaking, blistering or peeling.

f) **Acrylic Washable distemper.**

Acrylic washable distemper shall be similar to **e)** above. The paint, after it is dried, shall be able to withstand washing with mild detergent and water without any deterioration in colour, or without showing flaking, blistering or peeling.

f) **Synthetic Enamel Paint**

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and interior surfaces. White and pastel shades shall resist yellowing and darkening with aging. The paint shall conform to IS:2932 and IS:2933.

g) **Aluminium Paint**

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS:2339.

h) Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) **French Polish (Not Used)**

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS:348.

French polish shall not be used on bare wood. It shall only be used as finishing coat on wood after the wood is pretreated with a liquid wood filler conforming to IS:345 is applied and rubbed out.

2.02.00 **Storage**

The contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement and stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.03.00 **Preparation of Surface**

Before starting the work the contractor shall obtain the approval of the Engineer regarding the soundness and readiness of the surface to be painted on.

2.03.01 **Wood**

All surfaces shall be free from dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails and screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly and extended 25 mm beyond the area. All large, loose or resinous knots shall be removed and filled with sound wood. All work shall be done as perIS:2338.

2.03.02 **Masonry, Concrete and Plastered Surface**

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of re-surfacing may lead to the finishing paint being different in shade from the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with mildew or efflorescence shall be treated as below :

a) **Mildew**

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80 ml. liquor ammonia and diluted to 1 litre with water or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.03.03 **Metal**

All metal surface shall be absolutely clean, dry and free from wax, grease or dried soap films. In addition, all steel and iron surfaces shall be free from rust, surfaces shall be cleaned by mechanical power tools to remove mill scales unless otherwise approved by the Engineer for exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanised iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat.

2.04.00 **Application**

2.04.01 **General**

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings if used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor holes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to be free of sags, runs, crawls or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoats for painting shall be applied by brush only and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable for production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall be done as per IS:1477 (Part 1 & 2). The total dry thickness of the film should not be less than 120 micron.

2.04.02 **White Washing (Not used)**

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before application of the lime solution.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer f eels that one or more coats are required the contractor shall do so without any extra cost to the owner. No brush marks shall show on the finished surface.

2.04.03 **Dry Distemper (Not Used)**

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement plastered surface, the surface shall be washed with a solution of 100 gms. of zinc sulphate to 1 litre of water and then allowed to dry.

Dry distempering shall be done as per manufacturer's instruction. In applying the distempers the brush should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long as otherwise brush marks may result.

2.04.04 **Oil bound Washable Distemper (Not Used)**

The distemper shall be applied after surface is primed with an alkali resistant primer and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.04.05 **Waterproof Cement Paint**

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.04.06 **Acrylic Emulsion Paint**

Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be strictly as per manufacturer's specification.

2.04.07 **Synthetic Enamel Paint**

Shall be applied on properly primered surface. Subsequently coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.04.08 **Aluminium Paint**

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.04.09 **Clear Synthetic Varnish * Not Used)**

The varnish shall be applied on wood surface after (a) filling, (b) staining and (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbour hood. Damp atmosphere and draughts shall be avoided and exposure to extreme heat or cold and dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid fronthing. It shall be allowed to flow on while the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has began to set, shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.04.10 **French Polish (Not Used)**

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the wood shall be filled up with a paste of whiteing in water or methylated spirit with a suitable pigment like burnt sienna or amber.

After application of the filler paste, the french polish shall be applied with a pad of woolen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.04.11 **Chemical Resistant Paint**

For chemical resistant paints, epoxy, chlorinated rubber or vinyl butyl paint system shall be used manufacturer's recommendation regarding the paint system exposed to moderately severe corrosive condition and subject to acid/alkali spillage and fumes, shall be followed.

2.04.12 **Epoxy coating/painting**

On the clean surface of concrete after properly drying of the following system is to be adopted as per manufacturers specification:

One coat of primer of following proportion to be applied over clean and dried concrete surface by brush application.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 840 - 50 Parts by weight

Over the primer, the uneven surface of concrete should be filled with levelling putty as mentioned above. The cost of putty is included in the item rate without fixing prior limit to consumption of putty. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 830 - 45 Parts by weight

HARDENER BY 850 -15 Parts by weight

SILICA FLOUR - 20 Parts by weight

FLOW CONTROL - 2 Parts by weight
AGENT

Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat is applied.

2.05.00 **Protection**

Furniture and other movable objects, equipments, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipments shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.06.00 **Cleaning up**

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been spilled, splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 **ACCEPTANCE CRITERIA**

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes and splatters of paints and varnishes shall be removed from surrounding surfaces.

4.00.00 **I.S. CODE**

Important relevant IS Codes for this Sections are listed below :

IS:348 : Specification for French Polish

IS:427 : Specification for Distemper, dry colour as required.

IS:428 : Specification for Distemper oil emulsion, colour as required.

IS:1477 (I & II)	:	Code of Practice for painting of ferrous metal in buildings.
IS:2338 (I & II)	:	Code of Practice for finishing of wood and wood based materials.
IS:2339	:	Specification for Aluminium Paints for general purposes in dual containers.
IS:2395	:	Code of Practice for painting concrete, masonry and plaster surface.
IS:2932	:	Specification for enamel, synthetic, exterior, type-I.
IS:5410	:	Specification for cement paint, colour as required.

TECHNICAL SPECIFICATION
FOR
XXVI) SUSPENDED CEILING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXVI) SUSPENDED CEILING

1.00.00 **SCOPE**

The work under this Section shall include the supply and insulation of suspended ceiling using insulation / acoustic boards, Gypsum board, Metal linear interlocking strips etc. together with the suspension system as per manufacturer standard details with all materials complete. The work shall also include providing of openings in the ceiling for lighting, air conditioning diffusers, fir fighting detector etc. as shown required or instructed by the Engineer.

Aluminium linear ceiling similar to luxalon shall be provided.

2.00.00 **INSTALLATION**

2.01.00 **Suspension System**

2.01.01 **General**

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses.

All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All M S sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer. All wood supports shall be painted with two coats of “fire resistant paint.

2.01.02 **Metal Grid Suspension System**

Metal grid suspension system shall be provided as per manufacturer specification and details. For gypsum board suspension system of India Gypsum board shall be followed. In case of Linear metal strip interlocking system details of manufacturer shall be followed.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by M S flats angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2 centers. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as per manufacturer specification of the respective materials.

The cross tees shall intersect main runners in pattern shown on drawing and positively looked together with intersection clips. All perimeter areas shall

have angle moldings fixed to vertical wall surfaces and end tees shall rest on the moldings, unless otherwise specified.

2.01.03 **Timber Grid Suspension System (Not used)**

Unless otherwise shown on drawings, the suspension system shall consist of 50 mm x 50 mm pretreated teakwood batten grid suspended in the same manner described for metal grid system. The spacing of timber battens shall be as shown on drawing. Extra battens shall be provided where necessary for openings for light fixtures A C grills etc.

2.02.00 **Ceiling Panels**

2.02.01 **Materials**

Ceiling panels shall be best quality material in thickness and properties and as specified. The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of the following types:

a) Gypsum boards of India gypsum with concealed suspension system.

b) Expanded polystyrene insulation boards (Not Used)

c) Fibre insulation boards (Not Used)

d) Wood particle boards (Not Used)

e) Glass fibre reinforced polystyrene sheets (Not Used)

f) Pre coated (Dry film thickness of coating 15-20 micron thick) aluminium alloy linear interlocking strips of size 84x12.5 deep x 0.5mm thick with concealed suspension system.

Acrylic plastic sheets translucent or figured glass sheets moulded plastic louvres etc. shall be from approved manufacturers and in thickness specified in schedule.

2.02.02 **Installation of Ceiling Panels**

Installation of ceiling panels shall be strictly as per manufacturer's instruction and specification.

For exposed grid ceiling system, tile hold down clips shall be used at the rate of min. 1 per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Engineer.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner as specified by the manufacturer. Where V joints in tiles are called for, these shall begin true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Surface of ceiling boards shall be finished in a true and even surface without undulations with putty to make the surface suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions

with walls, light fixtures, diffusers etc. All hangers shall be fixed to the RCC ceiling with Anchor Fastener.

For interlocking ceiling system carrier shall be roll formed 32 mm wide and 39 mm deep out of 0.9 mm thick aluminium and magnesium alloy with cut up prongs to hold the panels in module 100 mm at maximum 1.6 m center to center. Carrier shall be suspended from roof / truss by galvanized steel rod 4mm dia. in required length with height adjustment galvanized turn buckle. Hanger shall be fixed with the ceiling with anchor fastener.

3.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards, joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

4.00.00 I. S. CODES

IS:2441 - Code of Practice for fixing ceiling coverings.

TECHNICAL SPECIFICATION
FOR
XXVII) SHEET WORK IN ROOF AND SIDING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

SHEET WORK IN ROOF AND SIDING

1.00.00 SCOPE

This specification covers the erection of asbestos, C.G.I., aluminium or other sheet covering to roof and side walls at various elevations and the fabrication and/or installation of asbestos, C.G.I or aluminium gutters, flashings etc

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage. If the materials are issued at site by the Owner, the Contractor shall at the time of issue, satisfy himself about the condition of issued sheets, gutters, etc. and no complaints shall be entertained later.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a water tight finish to the satisfaction of the Engineer fixing of gutters and down pipes shall be according to IS:2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as stated in the Schedule of Items, shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification Hook bolts or J-bolts shall be 8 mm dia. at 305 centres 6 mm dia galvanised iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stiching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used the end laps shall be minimum 100 mm. Holes in C.G.I sheets shall preferably be made on the ground the sheets should be placed on trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washets. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum 305 mm apart. The length of the hook or J-bolts shall be to suit the sections of the bearers.

Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanised iron seam bolts and G.I. flat washers and bituminous washers.

2.02.03 **Fibre Glass Reinforced Plastic Sheeting**

This shall be of thickness and profile as mentioned in the Schedule of Item. Colour and light transmittance shall be as mentioned in drawings and or schedules. Where used in conjunction with C.G.I. or asbestos sheeting the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads as mentioned in schedule of items. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure as mentioned in Schedule.

2.02.04 Precoated metal sheeting for roof shall be of precoated cold rolled sheet of total coated thickness (TCT) 0.58 to 0.68 mm of approved manufacturer. The sheet shall be metallic hot deep coated with an alloy of 55% aluminium, 43% zinc and 1.55 silicon coating mass shall be 150 gms/sq.m. sheet shall be fixed with fastening clip and self tapping fastener. Ridge for slope roof shall be of similar material and shall be fixed with necessary self tapping screws as per manufacturer details.

Thermally insulated sandwiched metal cladding for external facaade shall be of approved manufacturer. Sheeting shall Hi Rib 0.5 mm troughed sheeting manufactured from aluminium alloy high tensile steel (550Mpa) coated with fluro polymer (PV F2 or equivalent) and shall have life span sustenance against aggressive weathering action. Inner profiled sheet shall be with profile sheet of .6 mm thick (total coated thickness) permanently coated galvanised sheet.

Galvanised coating shall be not less than 120 gm/sq.m. and sandwiched insulation of 25 mm thick or as per design requirement shall be bonded mineral wool blanket or equivalent conforming to IS: 8183 (minimum density of 32/kg/cum for glass wool and 48/kg/cum for rock wool) having minimum coefficient of thermal conductivity of 0.49 mW/cm deg C (at 50 degreeC) Cladding shall be fixed to supports/rails by nuts, bolts, hooks, washers self tapping screws of stainless steel Austentic grade) conforming to IS:1367 (part 14) including sealents, gaskets, PVC tape 0.25 mm thick, flashing, black synthetic rubber external trough filler and 25X3 mm aluminium earthing.

2.02.05 **Poly Carbonate Roofing vault etc.**

Poly carbonate sheet shall be translucent thermomoclear multiwall sheet similar to LEXAN of GE Plastic with both side UV protection and thermal insulation properties. Sheet shall be of thickness varying from 6mm to 32 mm thick and shall be multi wall. Sheet shall be fixed over light tubular structure of square hollow steel tube painted with two coats of synthetic enamel paint over coat of zinc chromate primer. Structure shall be of the shape as indicated in General Specification. LEXAN Polycarbonate sheet

Shall be fixed with aluminium flat section 50mm wide 4 mm thick With stainless steel screws. EPDM gasket and shall be sealed with Silicon sealant. Thickness of sheet shall be as specified in the General specification of Architectural work and unless otherwise indicated shall be minimum 8mm thick /2 RS structure.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked :

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing

4.00.00 IS CODES

The following are some of the important IS Codes relevant to this sections :

IS : 3007 : Code of practice for laying of asbestos cement sheets

IS : 2527 : Code of practice for fixing rain water gutters and down pipes for roof drainage

IS : 1626 : Specification for asbestos cement building pipes gutters and fittings

IS : 277 : Specification for galvanised steel sheets (plain and corrugated)

TECHNICAL SPECIFICATION
FOR
XXVIII) ROOF WATER PROOFING, INSULATION AND ALLIED WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE AND STANDARDS

XXVIII) ROOF WATER PROOFING, INSULATION AND ALLIED WORK

1.00.00 SCOPE

This specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof water-proofing, insulation and allied work for buildings and at locations covered under the scope of the Contract.

2.00.00 INSTALLATION

2.01.00 Grading Underbed

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 100 and as directed by the Engineer. Upto an average thickness of 25 mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete.

The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 The grading plaster shall be average 25mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The same and cement shall be throughly mixed dry and them water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.02.00 Concrete

The concrete shall be used where the subgrade is more than average 25mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.03.00 **Insulation**

The Tenderer shall along with the tender send specification of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the treatment as specified, unless otherwise indicated in the General Specification of Architectural work if any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12mm and it shall be cured for seven days

2.04.00 **Foam Concrete (Not Used)**

This shall be of light weight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m degree C. The weight of the insulating material shall be from 0.3 to 0.5 gm/cm.

Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to make the usual work load and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.05.00 **Expanded Polystyrene Blocks**

The expanded polystyrene block insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 KCl m/m degree C. and density Maximum 32.35 Kg/M^3 It must be strong enough to withstand without deformation the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers' supervision at no extra cost to the Owner.

2.06.00 **Fillets**

Fillets at junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix by volume.

2.07.00 **Waterproofing**

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with Bitumen Felts shall be done following relevant IS:1346. Bitumen felt shall conform to IS:1322 and Bitumen primer to IS:3384.

The bonding materials shall consist of blown type conforming to IS:702 or residual bitumen to IS:73 or a mixture of the two to withstand local conditions or prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples of pea sized gravel shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated in the Schedule of Items. Brief details of the various treatments shall be as follows:

a) Normal Treatment : Four courses :

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Hessian base self finished felt, type 3, grade 1

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Pea sized gravel at the rate of 0.006 mU2

b) Heavy Treatment : Six Courses :

With Hessian base felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Hessian base self-finished felt, type 3, grade 1

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Hessian base self-finished felt, type 3, grade 1.

5) Hot applied bitumen at the rate of 1.2 kg/m

6) Pea sized gravel at the rate of 0.006 mU2

Or

With fibre base felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Fibre base self-finished felt, type 2, grade 2

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Fibre base self-finished felt, type 2, grade 2

5) Hot applied bitumen at the rate of 2.5 kg/m and

6) Pea sized gravel at the rate of 0.008 mU2

c) Extra Heavy Treatment : Eight courses :

With fibre based felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Fibre-base self-finished felt type 2, grade 1

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Fibre base self-finished felt type 2, grade 1

5) Hot applied bitumen at the rate of 1.2 kg/m

6) Fibre base self-finished felt type 2, grade 1

7) Hot applied bitumen at the rate of 2.5 kg/m and

8) Pea sized gravel at the rate of 0.008 mU2.

Or

With Hessian base felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Hessian base self-finished felt, type 3, grade 1.

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Hessian base self-finished felt, type 3, grade 1

5) Hot applied bitumen at the rate of 1.2 kg/m

6) Hessian base self-finished felt, type 3, grade 1

7) Hot applied bitumen at the rate of 1.2 kg/m

8) Pea sized gravel at the rate of 0.006 mU2

However, in special cases, more courses or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the pea sized gravel or any other existing top course shall be completely removed and all damaged felts or other defects required.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that loose gravels, felt cuttings etc. do not find their way into rain water down comers.

2.08.00 **Waterproofing by epoxy resin based application**

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be throughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, light traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labours for the application. This item shall carry a guarantee as specified under the relevant item in the Schedule.

2.09.00 **Flashing**

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer, instead of being finished with pea-sized gravel, shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The metal flashing shall be done as shown on the drawings. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer.

2.10.00 **Elastromeric Membrane**

2.10.01 **Primer Coat**

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush /spray with airless spray equipment over the prepared bed as an adhesion coat with an application rate of 6-8 sq.m per litre depending on the surface porosity.

The primer shall be allowed to dry for a minimum period of 2 to 4 hours time before the successive finishing coats of P.U. liquid membrane are applied. In any case successive finishing coat shall be applied within 24 hours.

The substrate shall be properly prepared by removing all loose materials by vigourous brushings, fungal growth with proprietary fungitide as recommended. Priming coat shall not be applied to damp substrate.

2.10.02 **Finishing Coats**

The finishing coats shall consist of two successive liquid coatings of high solid content urethane pre-polymers or equivalent material to form an elastomeric membrane. Application shall be with brush or spray to form an uniform jointless elastomeric membrane. The overall dry film thickness shall be 1.5 mm subject to minimum 750 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for minimum of 150 mm over the finished roof surface or fillet with suitable tucking into the vertical wall surface. It shall be continued into rain water pipes by atleast 100 mm.

The final coat of PU liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a layer of polyscrim cloth/fabric are to be embedded between 2 finishing coats.

The entire work shall be carried out under the suspension of approved authorized agency and as per manufacturer specification.

2.10.03 **Water Proof Membrane**

One coat of Approved water proof chemicals with rubberized bituminous primer (water base) similar to EMUFAL TE manufactured by TEXSA @ 0.300 ltr/ Sq.M. shall be applied.1.5 mm thick self adhesive water proof membrane similar to Texself H.D. of Texsa or approved equivalent over chemical treatment shall be laid including flashing minimum 300 high over parapet wall and shall be secured in a groove in RCC parapet. Area of contact with RCC parapet shall also be treated with the chemical treatment similar to Roof. If specified in the General specification of Architectural Specification the water proof membrane shall be protected with 25 mm thick PCC with 0.56 dia. chicken wire mesh. The PCC shall be cast in panels of size 1.2M x1.2M size and joint shall be sealed with the same material.

The entire work shall be carried out by the Manufactutrer authorized representative and specification.

2.10.03 **Surface Finish**

Areas of roof treatment shall be provided with wearing course consisting of minimum 25 mm thick PCC 1:2.4(using 12.5 mm size aggregate) cast in panel of maximum size of 1.20 m x 1.20 m and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using polysulphide sealant or similar water proof membrane or elastomeric compound for elastromeric water proofing as per General specification of Architectural work.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided. The tiles shall be laid as per IS 1443.

3.00.00 **ACCEPTANCE CRITERIA**

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The Contractor shall give a guarantee in writing for all work executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water-proofing treatment work. The guarantee shall be for materials and workmanship for a period of minimum 10 years. The mode of execution of the guarantee shall be acceptable to the Owner.

4.00.00 **I.S. CODES AND STANDARDS**

a) IS:73 : Paving Bitumen

b) IS:702 : Industrial Bitumen

c) IS:1203 : Methods of testing tar and bitumen

d) IS:1322 : Bitumen felts for waterproofing and damp proofing

e) IS:1346 : Code of Practice for waterproofing of roofs with bitumen felts

f) IS:3384 : Bitumen primer for use in waterproofing and damp proofing.

XXIX) WATER SUPPLY

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	TESTING AND ACCEPTANCE
4.00.00	I.S. CODE

XXIX) WATER SUPPLY

1.00.00 **SCOPE**

This section includes supply of all materials, labour and incidentals for water supply for residential, business and industrial and other types of buildings. The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

1.01.00 **Materials**

All materials, fittings, fixtures and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence order are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

1.02.00 **Pipes and Pipe Fittings**

Under scope of this specification, pipes and pipe fittings may be any or a combination of the following types :

a) Cast Iron

b) Steel : lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanised.

c) Reinforced Concrete

d) Prestressed Concrete

e) Asbestos Cement

f) Lead (Not to be used for potable water)

g) P. V. C.

h) Copper

i) Brass

j) Wrought iron

1.03.00 **Water Reservoirs**

Water reservoirs like pressed steel tanks and G.I. tanks shall come under scope of this specification. Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

1.04.00 **Related Works**

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Specification.

1.05.00 **Regulation**

The work which is required to be carried out under the scope of this section, shall be executed by a licensed plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc. from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities. The fee paid to the Authorities shall be reimbursed by the Owner.

2.00.00 **INSTALLATION**

While basic layouts may be available in the drawings provided by the Owner, the details might have to be supplemented by the Contractor for approval of the Engineer.

Special attention shall be given by the Contractor to economy. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

2.01.00 **Pipe Lines**

2.01.01 **Laying**

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacings as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction & easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer.

2.01.02 **Back Flow**

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely water-tight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

2.01.03 **Contamination**

There shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

2.01.04 **Underground Pipings**

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.

The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.

The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

2.01.05 **Concealed Piping**

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, conduits as necessary. However, the Contractor will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

2.01.06 **Jointing of Pipes**

Jointing of pipes shall be completely leakproof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, usually recommended practices are stated below for guidance :

a) **Cast Iron**

i) **Spigot and Socket Joints**

Lead joint : The joint is made by first caulking in clean spun yarn upto half depth and filling the reminder by running in molten lead taking care that no dross enters the joint and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket. After completing the joint it shall not be allowed to move. For rectification the joint shall be completely redone.

ii) **Flanged Joints :** Flanged joints shall be made by jointing rings of good quality, smooth and hard compressed fibre board of thickness not less than 1.5 mm and of such width as to fit inside the circle of bolt. Diagonally opposite bolts shall be tightened in pairs and in stages so that degree of all bolts in a joint are similar. Damaged gaskets shall be replaced.

b) **Steel**

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove any burr from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

c) **G I Pipes**

Threads shall be cut with sharp tools, and before jointing all scales shall be removed from pipes by suitable means. The screw / threads of the pipe shall be cleaned out and the joint made by screwing the fittings after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

d) **Asbestos Cement Pipes**

Socket and spigot ended pipes shall be jointed by caulking with tarred gaskets and grouted with 1:3 cement sand mortar.

e) **Lead**

Lead and lead alloy pipes shall be jointed with wiped solder joints.

f) **Concrete**

Concrete pipes may be socket and spigot ended collar or band jointed. Joints shall be effected by caulking with 1:3 cement sand mortar.

g) **P. V. C.**

Manufacturer's instruction shall be followed. For heating approved equipment with adequate control shall be used.

h) **Tyton Joint**

The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the jont fully.

2.01.07 **Painting**

Where mentioned in the Schedule, underground steel and cast iron pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I. pipes shall be given a coat of zinc chromate primer, C.I. & M.S. pipes shall be given one coat of red lead or zinc chromate primer. Top coats shall be minimum 2 coats of best quality paint.

2.02.00 **Storage Tank - Pressed Steel Tank**

Unless otherwise mentioned, water storage tanks shall be pressed steel tanks of nominal size and capacity as mentioned in the Schedule and fabricated with all flanges external, all flanges internal, or bottom flange internal and side flanges external, as shown on drawings or schedule of items. The fabricator shall supply 6 prints of fabrication drawings to the Engineer for prior approval showing thickness of plates, method of jointing the plates, all supports, stays, gussets etc. Pads, cleats etc. required for supporting the tanks shall be supplied by the manufacturer. Inlet, overflow vent pipes, manholes etc. shall be arranged and provided as shown on drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50 mm above the bottom of the tank and there shall be a 150 mm free board at the top of the tank.

All tanks shall be supplied with mosquito-proof covered top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 Metre shall be provided with m.s. internal access ladder adjacent to the manhole. Water level indicator shall be provided if asked for. Two coats of anti-corrosive paint over a suitable primer shall be applied to both internal and external surface of tanks. Such paint if used shall not impart any taste or odour to water and be of lead free composition..

Erection of tanks shall be in accordance with detailed drawings and manufacturer's instructions. The two finishing coats of paint shall be applied to outside after erecting is complete.

2.02.01 **G. I. Water Tank**

G. I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanised iron water storage tank shall be made of minimum 2 mm thick galvanised iron sheet. Plain sheets shall be fixed at the corner to angle iron frames by means 6 mm

rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised/iron stay rods, one fixed to angle framing at top and two in the body of the tank for extra strength. Holes for rivetting shall be drilled and not punched. White lead shall be applied to the joints before rivetting.

In case it is desired by the Engineer that corners of tank should be welded instead of rivetted then the sheets shall be welded to form a tank will not have angle iron frame.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on Drawing and 25 mm dia. G.I. overflow pipe. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve permits the entry of water when the tank is empty and disconnects the supply when the tank is full. It consists of a hollow floating ball made of copper, plastic or hand Tubber, 110 mm in diameter, attached to an arm which is so pivoted that the end near the pivot closes the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution pipes. The ball valve shall be fixed to the tank independent of the inlet pipe and set in such a position that the body of the ball valve cannot submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water line. The level of the water in the tank to 75 mm below the lip of the overflow pipe. Free surface shall be about 150 mm above the maximum water filled level.

2.03.00 **Valve, Cocks, Taps**

All valves, stop cocks, taps etc. shall conform to relevant Indian Standard Specification and shall be of best quality from approved manufacturers. These shall be suitable for working pressures mentioned in the Schedule. Nominal size and material shall be as per schedule.

2.04.00 **Protection**

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets or spigot are not damaged and no foreign material can find its way into the pipe line.

Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.00.00 TESTING AND ACCEPTANCE

3.01.00 Inspection Before Installation

All pipes, fittings and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

3.02.00 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/CM^2 or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

3.03.00 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely water-tight. All pipings, fittings and appliances shall be checked for satisfactory support and protection from damage, corrosion and frost.

400.00 I.S. CODES

Important relevant IS Codes for this Specification are listed below :

Latest editions shall always be consulted.

IS:2065	:	Code for Practice for water supply in buildings
IS:1172	:	Code of basic requirements for water supply, drainage and sanitation
IS:1200	:	Laying of water and sewer lines including (Pt.XVI) appcurtnant items.
IS:1239 (Pt. I & II)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter)

IS:1536	:	Specification for Centrifugally cast (Spun) iron pressure pipes for water gas and sewage
IS:1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS:3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter)
IS:3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter)
IS:784	:	Prestressed concrete pipes
IS:458	:	Concrete pipes (with or without reinforcement)
IS:783	:	Code of Practice for laying of concrete pipes
IS:1592	:	Asbestos cement pressure pipes
IS:1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types)
IS:404	:	Lead pipes
IS:3076	:	Low density polyethylene pipes for potable water supplies
IS:4984	:	High density polythylene pipes for potable water supplies
IS:2501	:	Copper tubes for general engineering purposes
IS:407	:	Brass tubes for general purposes
IS:1230	:	Cast iron rain water pipes and fittings
IS:804	:	Rectangular pressed steel tanks

TECHNICAL SPECIFICATION
FOR
XXX) DRAINAGE AND SANITATION

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XXX) DRAINAGE AND SANITATION

1.00.00 **SCOPE**

1.01.00 This section covers the layout and construction of drains for roof water, surface water and sewage together with all fittings and fixtures and inclusive of ancillary works, such as connections, manholes and inspection chambers used within the building and from the building to the connection to a public sewer or to treatment work, septic tank and soak pit dispersion trenches.

2.00.00 **INSTALLATION**

2.00.01 **General**

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipe lines, fittings and fixtures shall be installed leakproof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

2.01.00 **Rainwater Downcomers**

Rainwater downcomers shall be standard Cast Iron or PVC Pipes. In case where specifically desired, M.S. pipes, GI pipes may also be used. M.S. pipes and GI shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater downcomers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure.

All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type or perforated strap iron type and for PVC pipes as per manufacture detail and as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

2.02.00 **Gutters**

The gutters shall be made of G.I. or A.C. All gutters shall be supplied by reputable specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

2.03.00 **Soil and Drainage Pipes**

2.03.01 **Gradients**

If not specified the minimum gradients of soil and drainage pipe line shall be as follows :

100 mm nominal dia : 1 in 35

150 mm nominal dia : 1 in 65

230 mm nominal dia : 1 in 120

300 mm nominal dia : 1 in 200

2.03.02 **Relation with water supply pipe lines**

Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

2.03.03 **Laying**

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

2.03.04 **Support and Protection on Pipelines**

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooh surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows :

a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

2.03.05 **Entry into structures**

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When

openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

2.03.06 **Ducts**

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

2.03.07 **Traps and Ventilating Pipes**

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

2.03.08 **Manhole and Inspection Chambers**

The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. In addition, at every change of alignment gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise.

Manhole shall be constructed so as to be watertight under test. The bending at the sides shall be carried out in such a manner as to provide no lodgement for any splashings in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Manholes shall be provided with standard C.I. covers. The covers shall be close fittings so as to prevent gases from coming out. Suitable heavy duty covers shall be used where necessary as decided by the Engineer.

2.03.09 **Cutting of Pipes**

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

2.03.10 **Jointing**

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water-tight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes :

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centered in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leakproof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Care shall be taken to place the collar centrally over the joint.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar of 1:1 proportion. Then the socket is filled, a fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be covered with damp cloth or other suitable materials.

d) Vitrified clay pipes

These shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, Specification for Building it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1) which shall have very little water and levelled to form a splayed fillet at an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) PVC Pipes

The joints shall be thermo-welded or bolted or joints with rubber lubricant and shall be strictly as per as per manufacturer's instructions and specification.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron soil pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe or drain communicating with a sewer, the beaded spigot end of such cast iron soil pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe or drain and the joint made with mortar consisting of one part of cement and one part of clean sharp sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earthware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

2.04.00 **Trenches and other excavations**

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during handpacking with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

2.05.00 **Fixtures**

The Tenderer shall mention in his bid the type and make of the fixtures he intends to use enclosing manufacturer's current catalogues. In the absence of any such agreement, the Engineer shall be at liberty to choose any type and make.

All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear indentification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3 kg. per 25 mm dia per meter length. Where PVC or similar pipes are allowed the Contractor shall produce the test reports and convince the Engineer about their durability.

Unless specified in the contract the fixtures shall be as specified hereinafter.

2.05.01 **Water closet**

a) Raised type

It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valveless fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as desired by the Engineer.

b) Squatting type

It shall include glazed vitreous china pan with foot rests and high level cast iron flushing cistern with valveless fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The foot rests shall be made of white glazed vitreous china with chequered surface. The flushing cistern shall be painted as desired by the Engineer.

2.05.02 **Urinals**

It shall consist of wall type glazed vitreous china urinals, cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Automatic flushing shall be approximately once every five minutes. For a number of urinals located together may be served by one cistern of adequate capacity. All fittings shall be chrome plated.

2.05.03 **Wash basin**

It shall be made of glazed vitreous china. The basin shall be flat back, wall hung by painted cast iron brackets and complete with pattern with hot and cold brass faucets with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste complete with necessary fittings. All fittings including faucets shall be chromium plated.

2.05.04 **Sink**

It shall be made of glazed stoneware. It shall be wall hung by painted cast iron brackets and complete with one brass faucet with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste with necessary fittings. All fittings including faucets shall be chromium plated.

2.05.05 **Bathroom mirror**

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws and other fittings shall be chromium plated.

2.05.06 **Glass shelves**

Glass shelves shall consist of 6 mm thick clear glass with guard rails and shall be wall mounted with brackets. All brackets, guard rails and screws shall be chromium plated.

2.05.07 **Towel rail**

Towel rails shall be 20 mm dia. chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

2.05.08 **Soap holder**

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium plated screws.

2.05.09 **Liquid soap dispenser**

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

2.05.10 **Toilet roll holder**

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screws shall be chromium plated.

2.05.11 **Installation**

All plumbing fittings and fixtures shall be installed in most workmanlike manner by skilled workers. These shall be perfect in level, plumb, plane, location and symmetry. All items shall be securely anchored to walls and floors. All cuttings in walls and floors shall be made good by the Contractor.

2.06.00 **Septic tank & effluent disposal**

2.06.01 **Septic tank**

Septic tank shall consist of the tank itself with inlet and outlets therefrom complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 mm dia. whose top shall be provided with a suitable mosquito proof wiremesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

2.06.02 **Effluent Disposal**

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

2.06.03 **Soak pit**

The soak pit shall be complete as shown on drawing. It shall consist of a 900 mm dia. pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6) and filled with brick bats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

2.06.04 **Open joined SW Pipe / dispersion trenches**

Minimum dia. of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be minimum 600 x 600 mm pipes. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well graded coarse aggregate. Ordinary soil is used for filling the top of trench.

2.06.05 **Commissioning septic tank**

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.00.00 TESTING AND ACCEPTANCE

3.01.00 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

3.02.00 Testing of Pipelines

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below :

a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

b) Water test

For pipes other than Cast Iron

Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may due to one or more of the following cases:

a) Absorption by pipes and joints

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

For cast iron pipes

Cast iron sewers and drains shall be tested as for glazedware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

c) For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and

ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipe line is not straight.

3.03.00 **Testing Septic Tank**

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm.

3.04.00 **Fixtures etc.**

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

4.00.00 **CODES AND STANDARDS**

Some of the important Codes and Standards relevant to this specification shall be followed : Latest editions shall always be consulted.

IS:1172 - Code of basic requirements for water supply drainage and sanitation.

IS:1200 - Laying of water and sewer lines including appurtenant (Pt. XVI) items.

IS:1239 - Mild Steel Tubes and Mild Steel Tubulars and other (Pt.I & II) wrought steel pipe fittings.

IS:1536 - Centrifugally cast (Spun) iron pressure pipes for water gas and sewage.

IS:1537 - Vertically cast iron pressure pipe for water, gas & sewage.

IS:3486 - Cast Iron spigot & socket drain pipes.

IS:1742 - Code of Practice for building drainage.

IS:5329 - Code of Practice for sanitary pipe work above ground for buildings.

IS:2470 - Code of Practice for designs and construction of septic tank for small and large installations.

IS:3076 - Low density polythelene pipes for potable water supplies.

IS:4984 - High density polythelene pipes for potable water supplies.

IS:1537 - Vertically cast iron pressure pipes for water, gas and sewage.

IS:1538 - Cast Iron fittings for pressure pipes for water, gas & sewage.

IS:1230 - Cast Iron rain water pipes and fittings.

IS:3889 - Centrifugally cast (spun) iron spigot & socket soil waste and ventilating pipes, fittings and accessories.

IS:1729 - Sand cast iron spigot & socket soil, waste and ventilating pipes and accessories.

IS:1626 - Asbestos cement building pipes, gutters and fittings (spigot & socket types).

IS:458 - Concrete pipes (with and without reinforcement)

IS:783 - Code of Practice for laying of concrete pipes.

IS:784 - Prestressed concrete pipes.

IS:651 - Salt glazed stoneware pipes & fittings.

IS:4127 - Code of practice for laying of glazed stoneware pipes.

IS:1726 - Cast Iron manhole covers and frames intended for use in drainage works.

IS:5961 - Cast Iron gratings for drainage purposes.

IS:5219 (Part 1) - 'P' & 'S' traps.

IS:771 - Glazed earthen-ware sanitary appliance.

IS:772 - General requirements of enamelled cast iron sanitary

appliances.

IS:774 - Flushing cistern for water closets & urinals (valveless siphonic type).

IS:775 - Cast Iron brackets & supports for wash basins and sinks.

IS:2548 - Plastic water closet seats & covers.

IS:2527 - Code of Practice for fixing rain water gutters and down-pipes for roof drainage.

TECHNICAL SPECIFICATION
FOR
XXXI) BOILER DRAIN DIVERSION

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	SYSTEM DESCRIPTION
2.00.00	SCOPE OF WORK
3.00.00	DETAILED SPECIFICATION

ATTACHMENTS

ANNEXURE-I	ALTERNATE ROUTE FOR BOILER DRAIN
ANNEXURE-II	EXISTING BOILER DRAIN - SECTIONS

XXXI) BOILER DRAIN DIVERSION

1.00.00 SYSTEM DESCRIPTION

1.01.00 Existing boiler drains of unit #1 to unit #7 need to be diverted for installation of 1 x 800 MW Supercritical Unit #8.

1.02.00 The diverted drain will be connected to a Settling Tank, which shall be located near existing Cooling Tower for unit 7 (between Grids W-100 & W-200) area shown in the Plot Plan drawing of unit #8 (Dwg. No. K9213R-DWG-M-002 Rev- 4).

1.03.00 Pumping System need to be installed in Settling Tank for recirculation as well as discharge of decanted water.

2.00.00 SCOPE OF WORK

The scope of work shall include complete supply, erection, installation & commissioning of diverted boiler drain as detailed hereunder. The minimum requirement of the system have been indicated, however, EPC Contractor shall provide all items/ facilities to make the system complete & suitable for the satisfactory operation.

a) A new RCC channel shall be erected for diversion of boiler drain of Unit #1 to 7.

b) Settling Tank - One (1) no. for unit no. 1 to unit no. 7

c) 3 x 50 % drain pumps to be installed at Settling Tank.

d) Necessary piping, valves, instrumentation for recirculation as well as discharge of decanted water.

e) All Civil and Structural work associated with the scope of work described in 'a' to 'e' above.

3.00.00 DETAILED SPECIFICATION

A. Drain Channel :

Covered RCC channel shall be provided for boiler drain diversion. Tentative routing of diverted drain has been shown in the Plot Plan drawing (Dwg. No. K9213-DWG-M-002 Rev. 4). Alternate route for diverted drain has been shown in enclosed Annexure – I. Actual routing shall be finalized by the Contractor.

The capacity of diverted boiler drain shall be adequate to cater waste water discharge from unit-1 to unit-7. Waste water discharge from unit-1 to unit-7 shall be considered as approximately 475 m3/hr.

Details of existing boiler drain are attached herewith in Annexure – II. However, Contractor shall design & finalize the channel section as required.

B. Settling Tank :

A 12m x 30m x 6.2m deep Settling Tank of RCC construction shall be provided, which shall be connected with the diverted drain. Size of settling tank given here is the minimum requirement. However, EPC contractor shall provide the same of required capacity to make the system complete and suitable for satisfactory operation. Settling Tank shall be located near existing Cooling Tower for unit 7 (between Grids W-100 & W-200) area shown in the Plot Plan drawing for Unit #8 (Dwg. No. K9213-DWG-M-002 Rev. 3). This location will be nearer to the utility location of recirculation water. Settling tank should be provided with baffles and clear water sump at the end of settling tank and pre-settling chamber at shallow depth at the entry, so that heavy particles settle in pre-settling chamber.

C. Drain Pumps :

3 x 50 % capacity drain pumps shall be provided at Settling Tank for discharge of water.

The pump parameters shall be as follows :

a) Rated Capacity (Cu. M/Hr). : By Bidder.

b) Rated Head (MWC) : By Bidder

[NOTE : Capacity of pumps shall be designed considering waste water discharge from unit-1 to unit-7 as 475 m3/hr. A minimum margin of 10% shall be considered on pump capacity and 20% margin shall be considered on pump head.]

Material of Construction of Pumps :

a) Casing : 2.5% Ni-CI as per IS : 210 FG 260.

b) Impeller : Stainless Steel Grade – 316

c) Shaft : Stainless Steel Grade - 410

D. Drain Piping :

Concrete / Steel piping, valves, & instruments as required from the discharge of drain pumps upto the final discharge points (for re-use of water and/or for discharge into the river) shall be provided by the Bidder. For re-use of water piping from the discharge of drain pumps shall be connected to the existing system of re-circulation from existing settling tank to existing plant. The approximate distance is 25 to 30m. The work also includes isolation of existing line for connection. Detailed routing and terminal points shall be finalized during Detail Engineering stage.

TECHNICAL SPECIFICATION
FOR
XXXII) GEO-TEXTILE FABRIC

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	EXECUTION
4.00.00	ACCEPTANCE CRITERIA

TECHNICAL SPECIFICATION FOR XXXII) GEO-TEXTILE FABRIC

1.00.00 SCOPE

The supply, design and construction of Geo-synthetic/Geo-textile lining system with protective earth cover and turfing (or precast concrete blocks/ Brick tiles) shall be under the scope of Contractor. The design of Geo-synthetic lining system shall be done by approved manufacturer or specialized agencies and to be submitted to owner for approval. Laying of Geo-textile grid and covering the same with soil shall be done by the agencies specialized for this type of work.

2.00.00 GENERAL

2.01.00 Work to be provided by the Contractor

Work to be provided by the Contractor unless specified otherwise will include, but not limited to the following:

a) Furnish all labour, supervision, services, materials, scaffolds, equipment, tools and plant, transportation, necessary approaches etc. required for the work.

b) Prepare detail drawing, if needed, for the work, fencing of area for protective measure, provide dewatering arrangement by pumping, if required, etc.

2.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract or prior approval of the Owner is taken in this respect.

2.03.00 Conformity with Designs

The Contractor is to carry out the work as per the specification, drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or Engineer's instructions. If any deviation is likely to occur, then the Contractor should take Engineer's prior approval before starting of such work. Under no circumstances, the work to be performed should deviate from the specification or drawings unless approval of Engineer is taken.

2.04.00 **Materials to be used**

2.04.01 **General**

All materials to be used for the Work, must meet the specification requirements or the provisions of IS Code and should be of best quality available and approved by the Engineer. In case of bought-out items, certificate from the supplier or its deputed agency must be produced along with samples and approval taken from the Engineer before the items are bought.

Decision of the Engineer in cases of bought-out items shall be final.

2.04.02 **Geo-textile**

Property	**Test Method**
Non-woven Geo-textile :	
Tensile Strength	ASTM D1682
Puncture Strength	ASTM D751
Woven Geo-textile :	
Tensile Strength	ASTM D4595
Tensile Elongation	ASTM D5035
Thickness	ASTM D1777
Mass per Unit Area	ASTM D5621
Resiliency	ASTM D1777
UV Resistance at 1,000 hours	ASTM D4355

3.00.00 **EXECUTION**

The Work shall be strictly executed according to the provisions of this specification, final drawings, instructions of the Engineer at site, and/or catalogues of the approved manufacturer of Geo-textile.

All equipments necessary for the placing of Geo-textile fabric shall be approved before the work will be permitted to begin.

The installation of geo-textile shall be in accordance with the manufacturer's recommendation. Overlaps at ends of rolls and at roll widths shall be in accordance with the manufacturer's recommendations or as directed by the Engineer.

4.00.00 **ACCEPTANCE CRITERIA**

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be specifically checked :

a) Geo-textile fabric against mechanical damage if any.
b) Laying of Geo-textile fabric.
c) Method of jointing (Heat sealing).
d) End sealing or, anchoring of Geo-textile fabric.
e) Laying and joints of cover tiles/blocks.

TECHNICAL SPECIFICATION
FOR
XXXIII) LANDSCAPING WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	MATERIAL
3.00.00	LANDSCAPING WORK
4.00.00	MAINTENANCE
5.00.00	ACCEPTANCE CRITERIA
6.00.00	I.S. CODE

TECHNICAL SPECIFICATION FOR XXXIII) LANDSCAPING WORK

1.00.00 SCOPE

The work in general shall consist of preparation of earth/ground including supply & plantation of grass, saplings, plants of trees, shrubs, foliage plants, hedges and potted plants for soft landscaping work. Excavation and removal of top soil up to 300/600 mm depth and Supply and filling with Good earth, if the top soil found to be unsuitable for plantation, are included in the scope of work. Manures, sludge, oil cake, PVC Water supply pipelines & sprinklers with necessary mechanical arrangement like pump & equipment etc for irrigation systems are also included in the supply, preparation and installation work.

Scope of Work also include supply, erection, installation fitting & fixing colored concrete interlocking pavers blocks over well compacted rigid base with 50mm thick sand bed, street furniture like signage, sitting place, trellis made of MS tubes duly painted with anticorrosive paint and electrical fittings and fixtures of approved design and quality for illumination of garden and landscaped area.

Maintenance of Landscape area and landscape elements provided in the work for six(6) months from the date of completion of landscaping work are also included in the scope of work.

Approximate area for both hard and soft landscaping work will be 50,000 Sq.M of ground area spread all over the new plant area. Approximately 5% of this area shall be considered for Hard landscaping.

2.00.00 MATERIAL

i) Good Earth: The earth shall be suitable for gardening and free from kankar, moorum, shingle, rocks, stones, brickbats, building rubbish and any other foreign matter. The earth shall be free from clods or lumps of size bigger than 75 mm in any direction. It shall have PH value, ranging from 6 to 8.5.

ii) Oil cake: (neem or Castor or as available locally) The cake shall be free from husk, dust, grit and any other foreign matter. Sludge: It shall be obtained from approved disposal work.

iii) Grass : grass shall be Mexican grass /Burmese grass type and shall be procured in rolled form from approved nursery.

iv) Foliage plant: Bagonia acutifolia, Cordyline terminails (fire brand), pileas or similar widely used foliage of the region duly approved by the site in charge.

v) Ground cover: Sanscieria trifasciata (snake plant), Helxine soleiroli (baby tears), Gynura, Setecreasea purpurea, Ficus elastacia (rubber plant), Monstera pertusa. In case of non availability of these plants similar ground cover plants available in the region shall be provided with the approval of Site in charge.

vi) Climbers: Philodendron scandens, ficus pumila or similar Climbers available in the region with the approval of site in charge.

vii) Flowering plants: Begonia, impatiens petersiana, Anthuruim, Scherezranium, Hibicus rosa sinensis, Chrysanthemum (Seasonal) or locally available flowering plants with the approval of Site in charge.

viii) Hedges: Ponsettia euphorbia, Coleus (herbaceous), dadonia, duranta, clerendendron, lantana camera, Acalypha. Or available hedges of the region with the approval of site in charge,

ix) Concrete interlocked pavers tiles 60mm thick of two matching colors, for narrow walk ways in the landscaped area and terracing work in the greeneries.

x) Trees: The yellow silk cotton tree, local name kadachogund, The barna local name Varno, the temple tree local name dholo champo and other trees suitable for region like Neem, Ashoka, etc

xi) Earthen Pots with grown up plants: Plants in earthen pots shall be of ornamental variety with color foliages, flowers etc.

Earthen pots shall be made of good earth duly baked and of regular size and shape and free from any crack and defects. Sizes of earthen pot shall be approximately 300 mm high x 300 mm top dia x 200 mm bottom dia. or similar type as available locally. 500 no of pots with grown up plants shall be considered for supply and landscape work.

xii) PVC pipe lines net work shall be of required diameter with approved pop up nozzles sprinklers system at various locations for irrigation of the landscaped areas.

xiii) Electrical fittings and fixtures shall be similar to PHILIPS outdoor luminaries type HCS 370 1xPL-L 18 including lamp 1xPL-L 18 W with all electrical wiring and connections as necessary. Spacing and no of illumination fixtures shall be sufficient to illuminate the landscape area.

3.00.00 LANDSCAPING WORK

3.01.00 Suitability of the soil of the site for landscaping work shall be verified prior to start of the work. For unsuitable soil the top bad soil shall be removed and filled with good earth suitable for plantation. PH value of soil shall be between 6-8.5. Top soil fill up shall be minimum 300 for grassing and minimum 600 for plantations.

Preparation of earth shall be made by trenching of soil. Trenching shall be done to the depth of 300 for grass and 600 for plantations. Trenching of soil shall be done to loosen the soil and turn over and buried the top layer containing weeds etc, in the base and to bring up the lower layers of earth to form a proper medium for plantation.

The trenched ground shall be flooded with water to enable to soil to settle down.

Weeds or other vegetation which will appear on the ground shall be up rooted and removed and disposed off. Trenching shall be done dividing the plot in narrow strips of about, 1.5m width or as directed by the site in charge. Sludge shall be spread evenly over the surface to the required thickness of not less than 75 mm and shall be flooded with water.

After 10 days and within 15 days of flooding the weeds which will appear shall be removed.

The site shall be given fine dressing.

Beds for hedges, shrubberies, plantation shall be generally prepared to width of 750mm to 1250mm and 5 to 6 metres length or as per approved landscape design. The beds shall be excavated to a depth of 600 mm and excavated soil shall be stacked on the sides of the bed. Excavated bed then shall be re excavated for another 300mm and shall be rough dressed. The top earth shall be mixed with manure in the proportion of 8:1 (8 parts earth & 1 part manure). The mixed earth shall be refilled in to the bed and watered profusely. The surface after full subsidence shall again refilled with remaining excavated earth and manure mixture, watered and allowed to settle and finally fine dressed to the level of 50mm below the adjoining ground level. Surplus earth if any shall be removed from site as directed by the site in charge.

Stone brick bats and other foreign matter if met during these activities shall be stacked and disposed off as directed by the site in charge.

Same procedure for preparation of soil shall be made for grass lawn. Grass shall be brought in rolled form from the nursery and spread over the prepared soil.

Earth mound with a small tree at the top of mound and seasonal flowering bed/ foliage bed around the tree may be one of the general features of landscaping.

The retaining wall at coal yard side shall be provided with 750 high IRC Mesh welded to 25 x25 mm hollow steel tube frame. Hollow steel tube post shall be provided @ 1500 c/c and embedded in concrete and shall be provided with anti corrosive paint. Climbing flowering creepers shall be provided from base of the retaining wall up to the top of the Fabric net over retaining wall. This is required to stop the air borne coal dust spreading over the landscaped area.

The embankment around the site shall be landscaped with foliage, seasonal flowering bed and grass. Both sides of the internal roads shall be provided with Hedges of 500 heights and colored flowering plants and dense foliage

bed behind.

Available Spaces around the power house entrance, Service & technical building, Canteen building, fire station building, store building ND Cooling tower area, triangular vista between roads, road dividers shall be landscaped delicately with proper bio aesthetic planning. The Landscaping shall link up building masses in a harmonious whole and enhance their Architectural appeal by presenting a foil of texture, color and form by way of contrast.

Spacing of plants, trees, foliage plants etc shall be as required as per the type and character of the plants and trees. Horticultural norms of the region shall be followed in general.

4.00.00 MAINTENANCE

Details of maintenance schedule shall be as follows:

i) Regular watering of the plants, saplings, trees, grass lawn, hedges and foliages.

ii) Regular weeding of plants to keep the landscaped area free from Weeds.

iii) Supplying manure to plants, trees, shrubs, grass lawn, hedge beds, etc as and when necessary.

iv) Regular lawn mowing.

v) Replacement of dead / ill trees, plants, shrubs, on ground and in pots.

vi) Regular trimming of plants and shrubs and hedges.

vii) Regular cleaning of tree basins and pots.

viii) Earth removal and refill of plants in ground as well as in pots.

ix) Removal of dried leaves and branches of trees and plants.

x) Spraying of insecticides, pesticides as and when required/advised.

5.00.00 ACCEPTANCE CRITERIA

i) Landscaped area shall be neat, and lush green with hue. Free from any debris, scattered earth, brick bats, and any unpleasant elements.

ii) All plants, trees and potted plants shall be well blossomed and shall give a fresh pleasing appearance.

iii) Entry to all important buildings shall be inviting with sprawling greeneries.

iv) Arrangement of plants, ground cover, plant foliage, flowering plants with flower shall give a harmonious blend of hue of colors and greeneries.

v) Drainage system of Large landscaped area shall be such that there shall not be any pocket with stagnant water. The slope of the surface shall be such to drain out all rain water to near by area drainage.

vi) Landscape design work shall be entrusted to a well experienced landscape designer with architectural back ground and registered with the Council of Architecture. Specialized agency experienced in the implementation of landscaping work shall be engaged for the work. .

6.00.00 I.S. CODE

Following are some of the important I.S. Code relevant to this section;

IS : 4919 Glossary of terms applicable to landscape and horticulture work.

VOLUME: IIG/3

TECHNICAL SPECIFICATION
FOR
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

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TECHNICAL SPECIFICATION
FOR
I) LAND SURVEY AND ESTABLISHING REFERENCE GRIDS AND BENCH MARK PILLARS

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	INSTRUMENTS AND CONSTRUCTION MATERIALS
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I) LAND SURVEY AND ESTABLISHING REFERENCE GRIDS AND BENCH MARK PILLARS

1.00.00 **SCOPE**

This specification is intended to cover topographical surveys and preparation of plans (maps) showing all permanent features including buildings, large trees, pucca & kutcha nullas, ditches, (with or without water), nearby roads/ approaches, railway track, culverts, overhead transmission & communication lines, ridges, boundary wall, fencing, demarcation line etc. of the project area as well as sectional views of the drains, ditches, creek, culverts and similar items (with all dimensions and invert levels). Carrying of the Bench Mark (existing reference BM outside the project area) to project site by levelling, establishing bench marks and grids in the field, spot level survey at specified intervals and on change points, contouring, constructing and fixing of bench mark pillars & grid pillars in the field, clearing of jungles & debris and cutting of trees (to the minimum extent as required for the work and as per instruction of the Owner) etc. shall also form a part of the scope of work. In addition, the true north, magnetic north and the angle between the grid lines (established at site) and the true north or magnetic north shall be indicated in all drawings.

It may also be necessary to interconnect the existing grid lines (with measured angles and distances) and level references as well as a few permanent buildings and permanent roads adjacent/near the specified project site area during the proposed survey work and thus incorporate the same in the survey plans/maps.

The Plot Plan drawing gives location of the project and an indication of the project area to be surveyed. These drawings are preliminary and do not cover the entire scope of work. These may be modified, survey area increased/ decreased, and any new drawing may be given before award of the Work or during execution of the work (keeping sufficient time for field survey work and plotting).

Permanent features and levels of a few existing items as given in the above drawings shall not be used as reference without verification by actual survey with precision instruments by the contractor and plotted in his maps/drawings accordingly.

The grid pillars and B.M. pillars shall be maintained and checked frequently to ensure the correctness of the value of the pillar till the completion of the job and handing them over to the Owner. It shall be responsibility of the Contractor to check the pillars jointly with Owner/ Engineer at the time of final handing over of the work to the Owner.

The tenderers should visit the project site, at his own cost, before quoting rates for this tender. No extra claim (in terms of extension of time or revision in rates, etc.) shall be entertained at a later date on the ground of insufficient knowledge about the site or for lack of clarifications on this specification.

2.00.00 **GENERAL**

2.01.00 **Work to be Provided for by the Contractor**

2.01.01 Work to be provided by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish necessary instruments and all other tools and materials including pegs, marking plates for reference grid and bench mark pillars, construction materials for pillars, labour & skilled surveyors, supervision by competent engineers, services, necessary transport, full insurance and all other incidental items as may be necessary for on-time and successful completion of the surveying and mapping work.

b) Furnish original field & level books, notes taken on special features and field drawings with readings & relevant features plotted.

c) Preparation, thorough checking & cross checking in the field and submission of completed survey plans/maps and drawings in specified scale incorporating sectional views and details as included under Section-1.0.

d) Construction and installation of reference grids and bench mark pillars at specified locations.

2.02.00 **Work to be provided for by others**

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 **Information to be Submitted by the Tenderer**

2.03.01 **With Tender**

The tenderer shall indicate in his tender the number of different surveying instruments (with make and year of manufacture), skilled & experienced surveyors, and competent engineers that will be deployed at the site for this work. His experience during last five years in similar survey work shall be detailed in the tenderer's offer which shall also include his present commitments.

2.03.02 **After Award**

The contractor shall inform and satisfy the Engineer regarding deployment of personnel engaged by him for quality work under an agreed time-frame for completion of the work under this Contract.

He shall also prepare, discuss with Owner/Engineer and submit an agreed work programme within seven (7) days of award of the Work and during which period he shall also mobilize his instruments, tools, personnel at the project site.

The survey documents shall be submitted to the Owner/Engineer by the Contractor progressively during execution of the Work in order to enable him to review the work and, if necessary, cross-check at site along with Contractor's surveyor and engineer and point out the deficiencies/ discrepancies, if any, therein. However, the Contractor shall be still responsible for the correctness of the entire work and shall resurvey and replot any portion of the Work which may be found to be defective later on. During such checking/cross-checking as well as supervision during execution of the entire work, the Contractor shall extend all facilities including proper instruments, tools, other materials, surveyors & labour, etc. to the Owner/ Engineer.

The Contractor shall engage qualified engineers, surveyors, drafting persons, etc. for executing the work under this Contract.

3.00.00 INSTRUMENTS AND CONSTRUCTION MATERIALS

3.01.00 Instruments

The entire field surveying shall be done with the combination of transit/ optic Theodolites (which can read upto 20 seconds or less), Prismatic Compass, Precision Levelling Instruments with well-graduated & accurate staff, Chain, Measuring Steel Tapes and Plane Table Survey by Clinometer with the help of Clinograph Scale, ranging rods, etc.

Theodolite should be optically centered and the levels should be tilting type. Measuring tapes shall be used with calibrated tension. The calibration charts for the instruments shall be submitted before the start of the Work.

High quality surveying instruments (particularly, theodolites & levels) of reputed manufacturers shall be deployed for accurate and dependable survey work. Electronic instruments, if available with the Contractor, will be preferred.

3.02.00 Construction Materials for Reference Grid and Bench Mark Pillars

Concrete for pillars shall be of mix 1:2:4 (one cement : two coarse sand : four 20 mm down stone aggregates). All the component materials shall be of best & acceptable quality and conforming to the provisions of the latest version of the Indian Standards.

Steel plates for engraving B.M. value and reference grids shall be of mild steel, conforming to IS : 2062.

4.00.00 EXECUTION

4.01.00 Permanent Adjustments

All permanent adjustments of the instruments shall be made before starting the work, to the satisfaction of the Owner/Engineer.

4.02.00 **Contour Intervals and Scale of Drawings**

4.02.01 **Contour Intervals**

For contouring, spot levels shall be taken at 10 m horizontal intervals or less in both directions to establish the contours at 300 mm intervals for nearly flat terrains and at 0.5 m to 1.0 m intervals for undulating hilly terrains, as per schedule of items and direction of the Owner/Engineer.

4.02.02 **Scale of Drawings**

Depending upon the area to be covered, survey maps shall be prepared in the scale of 1 : 500 or 1 : 1000, as indicated in Schedule of Items, and all permanent features (as indicated under Section - 1.0), grid pillars, bench mark pillars, reference grid and bench mark pillars, contours (as specified in 4.2.1 above) etc. shall be plotted.

Sectional views of the drains, ditches, culverts, roads, etc., however, can be prepared in a scale suitable for furnishing all pertinent dimensions, levels and information, and in a separate drawing sheet.

4.03.00 **Submission of Drawings and Documents**

The following documents shall be submitted to the Owner/Engineer :

4.03.01 Original field and level books and notes taken on special features, plus a photo-copy each of the above documents.

4.03.02 Field drawings with readings and relevant features and sectional views plotted - three (3) copies for review by Owner/Engineer. (One copy will be returned to the Contractor with comments, if any).

4.03.03 Original and one (1) copy of the above field drawings (item 4.03.2 above) after field verification of the comments and incorporating the corrected features.

4.03.04 Original tracing and four (4) prints of the final survey maps and drawings showing other details, all prepared in ink and in clear legible form. Format of and title block on the drawing/map shall be as per direction of Owner/ Engineer.

4.04.00 **Time of Completion**

Time shall be deemed to be the essence of the Contract. The entire survey work including submission of the final survey maps and drawings as well as other documents (ref. : 4.03 above) shall be completed within a period of weeks/months in the following manner :

a) Mobilisation and firming up time schedule and survey groups ….week

b) Completion of field survey work and submission of three (3) copies of the field drawings and a photo-copy of the field & level books and the field notes, etc. (Items 4.03.1 & 4.03.2 above). ... weeks

c) Submission of the final survey maps & drawings and other documents (item 4.03.1, 4.03.3 & 4.03.4 above). ... weeks

Construction and installation of grid and bench marks pillars, however, are to be subsequently completed within weeks of the clearance from Owner/ Engineer.

If the Owner/Engineer feels that the progress of the work is not satisfactory, he shall notify the Contractor to take necessary measures to complete the Work on time. If the Contractor fails to comply with the Owner's directive or fails to complete the Work on time, Owner will be at liberty to get the Work done by any other agency and forfeit the amount related to unfinished works and the Earnest Money/Security Deposit of the Contractor.

4.05.00 **Security Rules and Statutory Regulations**

The Contractor shall strictly follow at site all security rules and regulations enforced by Owner from time to time regarding movement of materials, equipment/instrument, personnel to and from site, issue of identity cards, badges, control of entry and all similar matters.

The Contractor, his employees and agents shall not disclose any information or drawings prepared by him or furnished to him by the Owner/Engineer.

He shall also follow all safety rules and regulations and shall take sufficient measures to adhere to the same.

The Contractor shall conform in all respects with the provisions of any statute, ordinance law, rules, regulations, by-laws of Central, State, Local or other duly constituted Authority. The Contractor shall give all notices and fees to be given or paid.

In respect of labour, the Contractor shall comply with all rules framed by the Government for the protection of health, wages, welfare and safety of the workers. The Contractor shall be responsible for effective insurance under the Indian Workman's Compensation Act., Third Party Liability Insurance, etc. in accordance with the Indian Law and Regulation at his own cost.

In fine, the Contractor shall keep the Owner and Engineer indemnified against all penalties and liabilities of every kind.

5.00.00 TECHNICAL SPECIFICATIONS

5.01.00 Establishing of Bench Marks

At least two permanent bench marks at each site at approved locations shall be established from the existing bench marks. While carrying the bench mark, levels shall be established on permanent objects as directed by the Engineer. Levelling survey shall be done in the forward and reverse direction and the closing error should not be more than ± 05mm.

5.02.00 Establishing of Grid Pillars

Permanent grid pillars shall be established in either direction at every 100m intervals or as directed. *One reference pillar and one reference grid direction shall be provided by the Owner. For carrying reference pillars, additional station points shall be established for traversing or triangulation as directed by the Engineer. The closing error for any closed traverse shall not exceed the specified limits as per clause 5.6. The maximum tolerance for any grid location shall be ± 1 mm. Generally for all angular measurements, transit of theodolite shall be done. Measurement shall be verified by cross-checking the diagonal angle as directed by the Engineer. For observing bearing from magnetic north, care should be taken that no magnetic substance to influence the bearing reading is there. The magnetic north should also be periodically verified.

Reference shall be taken from the existing permanent objects identifying from the Cadestal map for establishing the new grid line and shall be related to true north line where grids are not existing.

5.03.00 Reference Grid Pillars and Bench Marks

All reference grid pillars and permanent bench marks shall be 900 mm x 200 mm x 200 mm cement-concrete pillars with 150 mm projecting above ground. 150 mm square x 12 mm thick steel plates (with two L-shaped 20 cm long M.S. lugs welded to the plate) or 6 mm thick aluminium plates with bolts shall be embedded or bolted on top of the pillars. Grid points & lines shall be accurately punched on the plates as also the numerical values of grid lines and levels. Grid lines and levels as required shall be painted.

5.04.00 Topographical Surveying and Mapping

Positions, both in plan and elevation, of all natural and artificial features of the area in question (including permanent objects) are to be established and subsequently delineating them on survey maps by means of conventional symbols (preferably those of Survey of India maps). Necessary levelling work of the project area shall be combined with methods of establishing horizontal location so that location and sketching of contours for the area can be done at specified intervals and in specified scales on maps. Rock outcrops, springs/falls (if any) and other unusual ground formations/conditions shall be noted and locations plotted on the maps.

The field work shall be done in the following steps :-

a) Establishing horizontal and vertical controls and locating reference grids and bench marks in the area.
b) Levelling and plotting contours.
c) Surveying and locating the natural, artificial and permanent features in details as described earlier.
d) Taking of longitudinal and cross-sections of the corridors for pipe line and road/rail and drains, ditches, waterbodies, culverts, etc.

All survey work shall be related with true north and true north shall be established at site beforehand.

5.05.00 **Traversing and Ground Controls**

Triangulation or Traversing or a combination of the two methods shall be adopted for the purpose of establishing horizontal controls, in order to determine the exact relationships between various existing points/ features on ground, so that surveys required under the present scope of work and in future may be correlated and tied together.

Before commencement of work, the plan showing base lines and the grid lines and their spacings shall be got approved by the Owner/ Engineer at site. First, a traverse covering the entire survey area shall be established with reference to a permanent object/reference grid pillar already existing at Site (as instructed by the Owner/Engineer).

The closing error in traverse (primary/secondary) shall not exceed one in three thousand in terms of length or, L $\sqrt{N}$ second (total) in angular measurement, whichever is less. (Where, L = the least count of the instrument and N = the number of stations).

5.06.00 **Contouring**

Spot level surveying at specified intervals shall be adopted for contouring the area, so that accurate contouring can be done. At places of sharp curvature or abrupt changes in direction and elevation, points selected shall be close to represent the actual ground configuration.

Levelling operation shall always start on a control station / nearby bench mark and end on the same.

5.07.00 **Route Survey**

Route Survey shall be conducted along a narrow strip/belt of the terrain selected after field reconnaissance or as directed by Owner/Engineer at Site. Topographical survey for existing storm drainage lines as well as for routing pipe lines, transportation and communication lines, etc. shall be conducted. Longitudinal profiles as well as cross-sections shall be taken at 50 m intervals or less in nearly flat/undulating terrains and at 20 m intervals in hilly terrains, as per direction of the Owner/Engineer. All cross-sections shall be with reference to centre line of corridor showing levels at every 2 - 5 metre intervals and all breaks in the profile. The width of strip/corridor shall be as specified in the drawing or as directed by Owner/Engineer.

TECHNICAL SPECIFICATION
FOR
II) GEO TECHNICAL INVESTIGATION

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II) GEOTECHNICAL INVESTIGATION

1.00.00 SCOPE

This specification covers the complete soil exploration work including carrying out field tests and laboratory tests to evaluate static as well as dynamic parameters of soil/rock and preparation of detailed report including the recommendations regarding founding level, type of foundation for different kinds of structures/machines and methods of deep excavation.

2.00.00 GENERAL

The contractor shall perform all work under the purview of this specification along with all incidental and related work including setting out, staging, approach to test locations, contractor's office, stores and protection of adjacent buildings, structures or services/facilities. No separate payments shall be made on such accounts. The tenderer should therefore take into account all such relevant items while quoting his unit rates against the schedule of items.

2.01.00 Work to be provided for the Contractor

The work to be provided by the contractor, unless specified otherwise shall include but not be limited to the following.

a) Furnish necessary plant and equipment, tools and tackles, instruments, necessary power, fuel, water, labour, supervision by qualified and experienced engineers and supervisors specialised in the type of investigation, transport of materials, men and equipment etc., services, full insurance and all other incidental items as may be necessary for entire and successful completion of the work as per tender terms, drawings, specifications and instruction of the Owner/Engineer.

b) Locate in the field and in layout drawing all boreholes and other field investigation items.

c) Furnish progressively and periodically field bore logs, investigation observations, test results with relevant data and features in triplicate.

d) Prepare and submit draft (in duplicate) and final (after incorporating comments, if any) sub soil investigation report as per specification, schedule of items and instructions of the Owner/his Engineer.

2.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.03.00 **Location and Levels**

Location of all boreholes and field test points and levels of the existing ground at such locations shall be established by the contractor at his own cost from two reference grids and one bench mark given by the Owner/his Engineer and these shall be subsequently plotted in the layout plan, bore logs and other relevant field test data sheets/tables to be incorporated in the report by the contractor.

Making bench mark pillar (s) and reference line pillars (whatever are required for the work) and maintaining them upto the completion of the work shall be the responsibility of the contractor at no extra cost by the Owner.

2.04.00 **Codes and Standards**

The following is the general list of IS Codes to be used for the soil investigation work and preparation of report. In all cases latest revision along with amendments, if any, shall be referred to.

IS:1498	-	Classification and identification of soils for General Engineering purposes.
IS:1888	-	Method of load tests on soils
IS:1892	-	Subsurface investigation for foundation
IS:1904	-	Structural safety of buildings : shallow foundations
IS:2131	-	Method for standard penetration test for soils
IS:2132	-	Code of Practice for thin walled tube sampling of soils
IS:2720	-	Methods of tests for soils
IS:2809	-	Glossary of terms and symbols relating to Soil Engineering.
IS:2810	-	Glossary of terms relating to soil dynamics
IS:3025	-	Methods of sampling and testing for water used in industry
IS:3043	-	Code of Practice for earthing
IS:4078	-	Indexing and storage of drill cores
IS:4434	-	Code of Practice for in-situ vane shear test for soils
IS:4453	-	Code of Practice for exploration by pits, trenches, drifts and shafts
IS:4464	-	Presentation of drilling information and core description in foundation investigation

IS:4968 (Part-II)	-	Dynamic Cone Penetration Test.
(Part-III)	-	Static Cone Penetration Test.
IS:5249	-	Method of test for determination of dynamic properties of soil.
IS:5313	-	Guide for core drilling observations
IS:5529 (Part I)	-	In situ permeability tests - tests in over-burden
(Part II)	-	In situ permeability tests - tests in bed rock
IS:6403	-	Determination of allowable bearing pressure on shallow foundations.
IS:6926	-	Diamond core drilling for site investigation for river valley projects.
IS:6935	-	Method of determination of water level in boreholes
IS:7746	-	In situ shear test on rock
IS:8009 (Part-I)	-	Calculation of settlement of foundations - shallow foundations subjected to symmetrical static vertical loads
(Part-II)		deep foundations subjected to symmetrical static vertical loading.
IS:8763	-	Guide for undisturbed sampling of sands
IS:8764	-	Method for determination of point load strength index of rocks
IS:9143	-	Method for the determination of unconfined compressive strength of rock materials
IS:9179	-	Method for preparation of rock specimen for laboratory testing
IS:9214	-	Method of determination of modulus of subgrade reaction (k-value) of soils in field
IS:9221	-	Method for determination of modulus of elasticity and poisson's ratio of rock materials in uniaxial compression.
IS:9259	-	Liquid limit apparatus for soils

IS:9640	-	Specification for split spoon sampler
IS:10108	-	Sampling of soils by thin wall samples with stationary piston
IS:10589	-	Equipment for subsurface sounding of soils
IS:10837	-	Specification of moulds for determination of relative density and its accessories
IS:11229	-	Specification for shear box testing of soils
IS:11315 (Part II)	-	Description of discontinuities in rock mass - core recovery and rock quality

3.00.00 SOIL EXPLORATION

3.01.00 Test Boring

Test Boring through different layers of soil shall be carried out by the contractor at the locations marked in the Geotechnical Test location plan prepared by the contractor and approved by the Owner / Engineer and/or at such other locations as directed by the Engineer in a manner described below.

Various methods of boring as described in IS:1892 may be adopted. The tenderer shall furnish in his tender the complete details of the equipment and the method he proposes to follow. Minimum diameter of boring shall be 150 mm.

During the boring operations if rock strata is not encountered, the boring shall be continued upto 30 m depth for two bore holes and upto 20m depth for the remaining boreholes unless stated otherwise. Incase rock strata is encountered within the above depths, boring operations shall be discontinued and drilling operation as enumerated in clause 4.0 below shall be resorted to. If the present formation level is above the natural ground with filled-up soil, the depth of boring mentioned above shall exclude such filled-up soil.

The contractor shall describe in detail the equipment and method of boring he proposes to use. In the absence of dry boring equipment, wash boring at the discretion of the Engineer may be allowed, but the particular way of cleaning the casing by washing has to be approved by the Engineer. However, if the Engineer, at any time, feels that the washing process is disturbing the samples to be taken, he may stop the work and the contractor shall have no claim whatsoever on this score. If the contractor can, however, improve the method to the satisfaction of the Engineer, he may be allowed to resume the wash boring work.

When boring cannot be advanced due to presence of hard material, it should be checked whether there is continuous strata of hard material below before resorting to drilling methods. If only a local boulder is present it should be chopped using suitable chopping bits and the debris removed and normal boring continued.

Ground water level for each bore hole shall be checked during boring operation and shall be recorded in bore log. Sub-soil water samples shall also be collected from each borehole and recorded.

Where possible, completed boreholes shall be capped and a G.I. pipe inserted in order to preserve them for future ground water level observation. The contractor shall use his own materials for this and the unit rate quoted shall be inclusive of the same. These bore holes after completion of observation shall be handed over to the Owner in such condition as to enable future observation of ground water possible. The other boreholes not used for observation shall be backfilled by the contractor using sand fill as and when directed by the Engineer.

3.01.00 **Stabilization of Boreholes**

Boreholes shall is stabilized, whenever required, against caving of the sides of the drill hole and heaving of the bottom of the hole. especially in cases where the hole is carried below the ground water level, by use of drive pipe or casing or by means of drilling fluids (water or mixtures of water and colloidal, gel forming thixotropic clays such as bentonite), grouting (in rack) or other suitable methods.

3.02.00 **Open Trial Pits**

The location of open trial pits shall be as shown in Geotechnical Test location plan and/or at such other locations as directed by the Engineer. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall be upto a depth of 3.5m below natural ground level or not below the ground water table or as directed by the Engineer. In no case, the depth shall be extended over 5m. The size of pits shall be 3.0m x 3.0m or as directed by the Engineer. Samples of undisturbed soil shall be obtained preferably at every 1.5m or where a change in strata is noticed.

The contractor shall provide a suitable access to the bottom of the pits. Sampling in trial pits shall be done as directed by the Engineer.

The contractor shall be paid at contract unit price for each trial pit which will include all costs for earthwork in excavation with necessary side slope and backfilling and shoring/sheeting for side protection, if required. If the pits exceed over 3.5m in depth, the contractor shall be paid at unit price for the extra depths of excavation.

After completion of the test, sampling and visual examination, the pit shall be suitably backfilled as directed by the Engineer. Unless otherwise specified, excavated soil shall be used for this purpose.

3.03.00 **Boring in River Bed**

For carrying out boring in river bed, the barge / boat should be properly anchored so that there is no movement of the platform due to waves which can cause damage to the drill rods and casing.

3.04.00 **Rock Drilling**

During boring operation, once rock strata is encountered, the normal method of boring operation as described under clause 3.01.00 earlier shall have to be stopped and drilling operation will be resorted to for determining depth and nature of rock strata, in a manner as described below.

Rotary core drilling technique with continuous core recovery should be adopted for drilling through rock. The tenderer shall indicate in his tender the type of coring bit he proposes to use. The behaviour of rock mass is governed more significantly by the nature of fractures in the rock then by the type and hardness of the material composing the rock itself. Hence, good drilling technique should be adopted to obtain an intact sample truly representative of the in-situ material and for achieving highest percentage of recovery possible. Variations in the speed of rotation, the downward pressure on the core barrel, the pressure at which the drilling fluid is introduced into the hole and the length of hole drilled (run length) prior to removal of the core are major items which must be controlled by the driller. In general, coring should be initiated with short runs both because the upper portions of rock masses are commonly highly fractured and also because the elevations at which core losses occur can be more accurately determined. If conditions indicate that it is possible, the length of the runs may be determined by the length of the core barrel.

In zones which are highly fractured or where the barrel continuously becomes blocked it is essential that short runs be used even though this means removal of the entire string of drilling tools every 300 mm or less. Reduced bit pressure should be resorted to when rod vibration or chatter occurs. The pressure under which the drilling fluid should be introduced into the hole will be the minimum to be consistent with adequate removal of cuttings from the hole and proper cooling of the bit. To minimise the erosive action of the drilling fluid on the core and thereby to improve core recovery, double tube core barrels should be used. The casing and core barrel to be used shall be of designation BX or NX.

During the drilling operation for each bore-hole the contractor shall record the rate of sinking of drill rods, ground water table elevations, if any, nature, type and sequence of rock drilled. From the recovered cores the contractor shall determine nature of fractures and degree of weathering of rock for each bore hole. The contractor shall also note and record any appreciable loss of drilling fluid throughout the entire drilling operations for each bore hole. The contractor shall also determine the percentage recovery ratio and rock quality designation from the recovered cores for each stages of core advance and for all the bore-holes. Rock quality designation is defined as the ratio of cumulative lengths of intact pieces of core greater than 10 cm to the length of core advance.

The contractor shall furnish all the information mentioned above fully verified and signed by the Engineer at site and submit them in triplicate to the Engineer.

The drilling operation shall be terminated when more than 75% of the core recovery is possible. If core recovery is lower and the nature of rock is

weathered, drilling must be continued upto 30m for two bore holes and 20m for the remaining boreholes below the natural ground level.

In addition to the above mentioned points the contractor shall also take into consideration the provisions of the latest revisions of the following Codes of Practice :

a) IS:6926 - Code of practice for diamond core drilling for site investigation for river valley projects (optional).

b) IS:4078 - Code of Practice for indexing and storage of drill cores.

c) IS:4464 - Code of Practice for presentation of drilling information and core description in foundation investigation.

3.05.00 **Adits and Test Shafts**

An exploratory adit is a horizontal or near horizontal excavation made by mining methods in rock. The term "test shaft" is used to refer to a vertical excavation, generally in rock and to very deep test pits. These are used for in-situ examination of the nature of the rock and its structural features such as joints, fractures, faults and shear zones. Adits may also be used for in-situ tests to determine the modulus of deformation of rock.

3.06.00 **Sampling**

Bored spoil shall be collected continuously during boring to note any change of strata. Samples of undisturbed soil shall be obtained preferably at every 1.5 m where a change in strata is indicated by the slurry flowing out. In no case shall the depth between successive sampling be more than 3.0 m and a sample shall be obtained on the average for every 2.0 m depth of boring, since it is intended to ascertain the characteristics of the soil at various depths. If, however, there is fair uniformity in the characteristics of the soil for certain depths the Engineer may limit the number of samples stipulated above.

3.06.01 **Tube Sampling**

For obtaining undisturbed samples in its simplest from, an open drive thin wall tube sampler shall be attached to a rod and shall be lowered to the bottom after completely cleaning the borehole bottom by washing. The samplers to be used should have area ratio less than 13 percent and preferably less than 10 percent. The head should have check valve and ports to permit easy escape of drilling fluid or air from the sample tube as the sample enters it.

Sampling will be accomplished by jacking or driving the tube depending on the type of soil to be sampled. Upon completion of the sampling operation the sampler shall be withdrawn from the borehole and the sample of soil carefully taken out. Approximately on inch length of soil is to be removed from each end for identification. If there is any surface water on the sample, this shall be wiped off with soaking paper, all sludge of cuttings from advancement of borehole removed and the sample immediately packed in an airtight, close fitting container marked with respective test bore numbers, elevation at which

the sample was taken and other relevant information as per IS:1892. The size of soil test samples shall preferably be 65 mm dia x 200 mm high, but not less than 50 mm dia. x 150 mm high.

Representative/disturbed samples shall also be taken in different strata for visual classification, water content, grain size analysis, Atterberg limits, determination of specific gravity and compaction tests.

3.06.02 **Chunk Samples**

In cohesive soils, undisturbed samples of regular shapes shall be collected. The samples shall be cut and trimmed to a suitable size (0.3 x 0.3 x 0.3 m). A square area (0.35 x 0.35 m) shall be marked at the centre of the levelled surface at the bottom of the pit. Without disturbing the soil inside the marked area, the soil around this marking shall be carefully removed upto a depth of 0.35 m. The four vertical faces of the soil block protruding at the centre shall be trimmed slowly so that its size reduced to 0.3 x 0.3 m. Wax paper cut to suitable size shall be wrapped uniformly and covered with two layers of thin cloth over all the 5 exposed surfaces of the soil block and sealed properly using molten wax. A firmly constructed wooden box of size 0.35m x 0.35m (internal dimensions) with the top and bottom open shall be placed around the soil block and held in such a manner that its top edge protrudes just above the surface of the block. The space between the soil block and the box shall be filled uniformly and tightly with moist saw dust. The top surface shall also be covered with saw dust before nailing the wooden lid to cover the box firmly taking care that the soil block is not disturbed. The area of contact between the bottom portion of the block and the ground shall be reduced slowly by removing soil in small quantities using small rods, so that the block can be separated from the ground slowly without disturbance. After inverting the wooden box along with the soil block, the bottom portion shall be trimmed and covered with wax paper, cloth and sealed with molten wax. A wooden lid shall be nailed to the box after providing proper saw dust cushion below it. An arrow mark shall be made on the vertical face of the wooden box to indicate the top surface along with the coordinates and depth of sampling.

3.06.03 **Sampling in rock**

Sampling in rock shall be accomplished during the drilling process by employing double tube core barrels for continuous core recovery. The drilling procedure to be followed should be the one which brings about the highest percent recovery and the exact procedure must be determined in the field.

3.07.00 **Record of Boring**

Detailed chronological record of drilling and sampling operations shall be maintained in the field log and should be submitted to the Owner after completion of boring work at site. The final log showing pertinent subsurface information and results of field and laboratory testing should be submitted with the soil report.

The field log should contain at least the following information :

a) Reference information like project number, title and location, exploration number and location by coordinates, inclination of the boring and if inclined the bearing or azimuth of the dip of the hole, reference level and datum.

b) Personnel information - name of drilling contractor, driller and inspecting Engineer.

c) Equipment data - manufacturer's name and model designation.

d) Sampling and coring information

   i) General : Sample type and number, sampler dimension, depth at start and completion of sampling, length of sample, recovery ratio and complete visual description of each sample in "as retrieved" state.

   ii) Drive samplers : weight and height of drop of hammer and number of blows for each 150 mm penetration.

   iii) Push samplers : hydraulic pressure and rate of penetration.

   iv) Soil or rock coring : average rotational speed, downward hydraulic pressure and rate of penetration.

   v) Rock coring : Rock quality designation (R Q D)

e) Description of material penetrated but not sampled.

f) Casing information - size, depth at which required, length and depth of bottom of casing; weight and height of drop of hammer and number of blows for each 300 mm of penetration for driven casing, and average rotational speed and downward pressure on casing and average rate of penetration for drilled casing.

g) Seepage pressure test information-depth and duration of test.

h) Groundwater information - depth to water surface recorded daily and continued till water level has stabilized.

i) Artesian pressure information - depth at which encountered, measured head and lime at which each measurement is made.

j) Elevation of top and bottom of hole and top of rock

k) Date and time of all operations and delays with reasons.

l) Miscellaneous information to aid interpretation of subsurface conditions.

m) Additional pertinent information.

The final log shall be a condensation of the field log refined on the basis of field and laboratory tests. The final log should present a clear, concise and accurate picture of subsurface conditions to be utilized by the Engineer.

4.00.00 PENETRATION TESTS

Penetration tests using various types of equipment as specified shall be conducted to measure the resistance of soil to penetration.

4.01.00 Standard Penetration Test

Standard penetration test (SPT) shall be carried out in accordance with IS:2131 at every change in strata or at 1.5 m intervals or as directed by the Engineer. The contractor shall record the number of blows for each 150 mm penetration of the standard split spoon sampler over a depth of 450 mm. The number of blows for the first 150 mm of penetration shall not be considered in evaluating the penetration resistance. Rammer used for driving the sampler rod shall be 65 kg and drops of 750 mm shall be maintained. Records of the test including depth at which driving is initiated and the number of blows for each 150 mm penetration shall be shown in the field log, the final log shall indicate the actual SPT value (sum of number of blows for last 300 mm of penetration) at appropriate depths.

4.02.00 Static Cone Penetration Test

The test shall be carried out at locations as shown on the drawing and/or at such other locations as directed by the Engineer. A steel cone with an apex angle of 60 deg. and overall base diameter of 35.7 mm giving a cross-sectional area of 10 Sq.cm shall be pushed through soil strata through a distance in accordance with the design of the equipment and cone resistance is noted. Thereafter the cone and the friction jacket with 36 mm OD are pushed together for a distance depending upon the design of the cone and the friction jacket assembly and combined values of cone and friction resistance noted. The procedure shall be repeated upto the desired depth. Rate of penetration shall be 1 cm/sec. unless otherwise instructed by the Engineer. The test shall be carried out upto a depth of ... m or upto the top of rock layer whichever is earlier.

The driving mechanism shall have a capacity of not less than 10 tonne for the mechanically operated equipment. If approved by the Engineer, manually operated equipment may be used for shallow depths (Not greater than 10 m) in case of soft clay layer.

The contractor shall get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the actual test and produce the test certificates to the Engineer.

The test shall be carried out in accordance with IS:4968 (Part-III), latest edition. Cone resistance and frictional resistance shall be separately provided in the report together with a borehole log.

4.03.00 **Dynamic Cone Penetration Test**

Dynamic cone penetration test shall be conducted to predict stratification, density, bearing capacity etc. of soils. The test shall be conducted by driving a standard size cone attached to the bottom of a string of drill rods. The test shall be conducted upto the specified depth or terminated earlier if the number of blows exceeds 35 for 100 mm penetration when the cone is driven dry and 20 for 100 mm penetration when the cone is penetrated by circulating bentonite, in order to avoid damage to the equipment.

The specification for the equipment and accessories for performing this test, test procedure, field observations and reporting or results shall conform to IS:4968 Part - II. the driving system shall comprise of a 65 kg. drive mass having a free fall of 0.75m. The cone shall be of 62.5mm diameter provided with vents for continuous flow of bentonite slurry through the cane and rods in order to avoid friction between the rods and soil. The use of bentonite slurry may not be necessary when the investigation required is upto a depth of 6m only. On completion of the test, the results shall be presented as a continuous record of the number of blows required for every 300 mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot of blow count for 300 mm penetration vs depth.

5.00.00 **GROUNDWATER INVESTIGATION**

Groundwater investigation shall comprise determination of groundwater levels and pressures and permeability of subsurface materials. The effect of tidal variations (if applicable for the site) on ground water level shall also be observed by noting the water level in boreholes during high and low tide periods.

5.01.00 **Ground Water Level Observation**

The contractor shall make necessary arrangements to prepare the boreholes for ground water observation. Completed boreholes should be capped and a G.I. pipe inserted in order to preserve them for future ground water observation. These observations will be taken by the contractor during the period of investigation. At the end of the site investigation work, these boreholes shall be handed over to the Owner in such a condition that further observations can be taken by the Owner for a period of at least a year.

Piezometers will have to be installed in boreholes as directed by the Owner. A piezometer consisting of either a simple standpipe of PVC tubing with a slotted end and surrounded by granular filter of plastic fabrics shall be used for granular soils or permeable rocks. In impermeable soils, hydraulic piezometer consisting of a porous element connected by twin small-bore plastic tubing to a remote reading station will be used.

5.02.00 **In-Situ Permeability Test**

In-situ permeability test shall be performed in the boreholes specified in Geotechnical Test location plan and/or at such other locations at specified

depths as directed by the Engineer for determination of the permeability co-efficient of the soil. The type of test shall be either pump-in or pump-out test depending on the sub-soil and ground water conditions. Pump-in test shall be conducted whether ground water in the borehole exists or not. Pump-out test with piezometer installations shall be conducted to obtain data for dewatering purposes when ground water is met in the borehole.

The specification for the equipment required for the test and the procedure of testing shall be in accordance with IS:5529, Part-I. The contractor shall provide all necessary equipment (diesel operated). When it is required to carry out the permeability test for a particular section of the soil strata above the ground water table, bentonite slurry shall not be used while boring.

5.02.01 **Pump-in Test**

Pump-in test shall be conducted in the borehole/trial pit by allowing water to percolate into the soil. Choice of the method of testing shall depend on the soil permeability and prevailing ground water level. Only clear water shall be used for conducting the test. Before conducting the test, the bore hole shall be cleaned. Water shall be allowed to percolate through the test section for sufficient period of time to saturate the soil before starting the observation.

a) **Constant Head Method (in borehole)**

This test shall be conducted in boreholes where soils have a high permeability. Water shall be allowed into the bore hole through a metering system ensuring gravity flow at constant head so as to maintain a steady water level in the bore hole. A reference mark shall be made at a convenient level which can be easily seen in the casing pipe to note down the fluctuations of water level. The fluctuations shall be counteracted by varying the quantity of water flowing into the bore hole. The elevation of water shall be observed at every 5 minute interval. When three consecutive readings show constant level of water surface above test depth, diameter of casing pipe, etc. shall be noted and recorded as per the proforma recommended in IS : 5529, Part-I, Appendix-A.

b) **Falling Head Method (in borehole)**

This method shall be adopted for soils of low permeability and which can stand without casing. The test section shall be sealed by the bottom of the boreholes and a packer at the top of test section. If the test has to be conducted at an intermediate section of prebored hole then, double packers shall be used. Access to the test section through the packer shall be by means of a pipe which shall extend to above the ground level. Water shall be filled into the pipe upto the level marked just below the top of the pipe and water allowed to drain into the test section. The water level in the pipe shall be recorded at regular intervals as mentioned in IS : 5529, Part-I, Appendix-B. The test shall be repeated till constant records of water level are achieved.

c) **Percolation test (in trial pit)**

Percolation test shall be conducted in the trial pit in areas where effluent is stored/discharged in ground level tanks. The loss of water due to percolation into the soil shall be estimated by the soil absorption capacity. This test shall be conducted in trial pits as per the procedure given in IS : 2470-Part-I, Appendix-A.

5.02.02 **Pump-Out Test**

This test shall be adopted to determine accurate values of permeability of soil below water table. Observation pipes of 50 mm dia shall be installed at regular intervals along three radial lines extending from the borehole at 120 degrees to each other. Length of these pipes shall depend on the ground level and estimated lowering of the ground water table. The test shall be carried out by pumping out the water to a known depth and recording the water levels in the observation pipes at regular intervals of time till the water level is stabilized. The observations shall be recorded as specified in IS : 5529, Part-I, Appendix-D.

6.00.00 **FIELD TESTS**

In situ tests shall be performed as desired by the Engineer to measure properties of soil during the field investigation work.

6.01.00 **Menard Pressure meter Test**

This test shall be carried out as per clause 3.7 of IS:1892 in the..... bore holes specified in drg. no. ..... and/or at such other locations as directed by the Engineer to the full depth of bore holes, to assess the co-efficient of earth pressure at rest and the stress-strain modulus of soil. The tests shall be carried out at every 3.0 m intervals.

The tenderer shall furnish in his tender the complete details of the equipment and method he proposes to follow.

The contractor will submit, for approval of the Engineer detailed arrangement drawings for the tests including the detail of the equipment he proposes to use and satisfy the Engineer about its adequacy. The contractor shall also check and confirm whether the equipment he proposes to use will be suitable for carrying out this test in bore holes of size specified under clause 3.01.00 of this section. If not, separate bore holes of suitable diameter shall be made at locations approved by Engineer for conducting this test.

6.02.00 **Direct Load Tests on Soils**

The direct load tests on soil shall be carried out in the trial pits specified in Geotechnical test location plan and/or at such other locations as directed by the Engineer. This test is to be carried out at 2.5m/3.5m below the natural ground level as indicated in the above drawing/as directed by the Engineer. The plate sizes to be used shall depend on the nature of the soil, a 45 cm

square plate will be used in clayey soil and in sandy soils, three plates of size varying between 30 cm to 75 cm will be used. The test shall be carried out in a manner as to give dependable assessment of bearing capacities of the soils at particular level. The results of the test shall also be used for arriving at the modulus of subgrade reaction and deformation modulus of soil.

The tenderer shall furnish in his tender the complete detail of the equipment and method he proposes to follow.

The excavation and side protection during the test and back- filling after the test shall be carried out by the contractor. If ground water table is at a depth higher than the specified test depth, the ground water table shall be lowered and maintained at the test depth for the entire duration of the test. The cost of dewatering shall be borne by the contractor.

The contractor will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of its being capable of giving accurate data. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The contractor must get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the direct load tests at the site and produce the certificates of the tests to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The contractor shall bring not less than two dial gauges and one pressure gauge as standby.

In no case settlement observations by means of level & staff shall be accepted.

The tests shall be carried out as described in IS:1888 unless otherwise specifically directed. The application of load may be by gravity or by reaction as detailed out in the above standard.

The test plate shall be preloaded with a load of 700 Kg/ sq.m. retained for a reasonable period and then replaced to take out all slacks of the arrangement. All settlement observations shall start thereafter. Unless the ultimate bearing capacity can be calculated from the available soil data, the contractor shall assess ultimate bearing capacity of the soil under test. Increments of the load shall be of about one fifth of the ultimate bearing capacity. The increments shall continue to an extent that allows locating the 'Yield Value of the Soil' as defined in IS:1888 or upto practicable limit of testing.

While releasing the loads, the rebounds are to be observed in a similar manner as the settlement observations.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to start of releasing the load so that the total settlement can be checked by him.

In addition to carrying out plate load tests, undisturbed/disturbed soil samples shall also be collected at regular intervals during excavation.

The payment shall be lumpsum for each test & shall include all costs inclusive of earthwork in excavation upto 3.5m depth below natural ground level, shoring for side protection, if necessary, and back filling after the test. For the depths over 3.5m extra payments shall be made only for earthwork and shoring, if any. If water table is required to be lowered during the test, necessary diesel operated pumping arrangement will have to be provided by the contractor himself. All expenses in this connection shall be included in his quoted rates.

6.03.00 **Vane shear Tests**

Vane shear test shall be conducted for measuring the strength of soft clay in-situ at all depths from the surface to at least 30m and at locations as specified. The test shall be conducted by pushing into the clay a small four-bladed vane of suitable size (75mm or 100 mm diameter depending upon the soil condition), attached to the end of a rod and then measuring the maximum torque necessary to cause rotation. This torque is a measure of the moment developed by the shear strength of the clay acting over the surface of the cylinder.

The test can be performed at desired depths either inside boreholes or by direct penetration from ground surface. If cuttings at the test depth in the bore hole show any presence of gravel, sand, shells, decomposed wood etc., which are likely to influence the test results, the test at that particular depth may be omitted with the permission of the Engineer.

The specification for the equipment and accessories required for performing this test procedure, field observations and reporting of results shall conform to IS:4434.

6.04.00 **Determination of Dry-Density of Soils**

In place dry density of soil is required for assessment of bearing capacity of soils, analysis for stability of natural slopes and in settlement calculations for estimating overburden pressure at different depths. The following methods depending on the scope of application in different types of soils shall be adopted as directed by the Engineer for determination of in-place dry density of soils.

6.04.01 **Sand Replacement Method**

This method is suitable for fine, medium and coarse grained soils. Small sand pouring cylinder should be used when the soil consists of fine to medium size grains while for soils containing stones where difficulties would be encountered with this method, a large sand pouring cylinder should be used. The sand used for filling shall be clean, uniformly graded natural sand, passing 1.00 mm IS sieve and retained on 600 micron IS sieve. It shall be free from organic matter, oven dried and stored for suitable period to allow its water content to reach equilibrium with atmospheric humidity.

Equipment and accessories, test procedure, observations and reporting of results shall conform to IS:2720 (Part XXVIII)

6.04.02 **Core-cutter Method**

The specification for this test shall be as per IS:2720 (Part XXIX) . The method should be applied for fine grained soil, free from aggregates . Fine grained soils for the purpose of application of this method are defined as soil with not less than 90 percent passing 4.75 mm IS sieve.

6.04.03 **Ring and Water Replacement Method**

The specification for equipment, test procedure, observation and reporting of results for this test shall conform to IS:2720 (Part XXXIII). The test equipment shall consist of a circular ring placed at the surface of the ground and plastic film inserted in the hole to retain the water. The method should be applied in coarse grained soils including gravels, cobbles, boulders and rock. Density can be determined for either the total material or material smaller than specified or given size.

6.04.04 **Rubber balloon Method**

The equipment, testing method, observations and reporting of results shall be as per IS:2720 (Part XXXIV) . This method should be applied for firmly bonded soils, it is unsuitable for very soft soils which will deform under slight pressure or in which the volume of the hole cannot be maintained at a constant value.

6.05.00 **In-situ Block Shear/Wedge Shear Test**

The test shall be carried out in a manner as to give a dependable assessment of shear resistance of rock, when at a shallow depth, rock is encountered.

The tenderer shall furnish in his tender the complete detail of the equipment and the method he proposes to follow.

The test shall be carried out in the trial pits marked in Geotechnical test location plan. and/or at such other locations as directed by the Engineer. The interpretation of test data and report shall be as per the provisions of IS:7746. The set up without an arrangement for direct application of normal load as detailed in the above standard shall be followed.

Regarding the approval of detailed arrangement drawings for the test, adequacy of conducted test, dial gauges to be used for the test and recording of observations for the test the provisions as laid down for direct load tests on soils shall hold good.

The payment terms as indicated for clause 3.02.00 above shall hold good for this test.

6.06.00 **Test for Measurement of soil Resistivity**

For designing the earthing system for the project it is necessary to find out the electric resistivity of the soil at some representative locations of the project site.

Soil resistivity is determined in Ohmmeter by using "WENNER's FOUR ELECTRODE METHOD". The principle of the above method is generally as under :

Four electrodes are driven into the earth along a straight line at equal intervals of 'S'. This distance 'S' can be varied and different readings taken for electrode spacing S = 5, 10, 15, 20 metres etc. to detect the vertical variations of resistivity at a certain location. A current I is passed through the two outer electrodes and the earth. The voltage difference, V, between the two inner electrodes is measured. The current I flowing into the earth produces an electric field proportional to its density and to the resistivity of the soil. The voltage V measured between the inner electrodes is, therefore, proportional to this field. Consequently, the resistivity will be proportional to the ratio of voltage to current.

If the depth of burial of electrodes in the ground is negligible compared to the spacing between the electrodes, then the soil resistivity.

= 2 X 3.14 X S.V / I

Where, Resistivity of soil in Ohm-meter

S = Spacing between electrodes in metre

V = Voltage difference between two inner electrodes in volts.

I = Current flowing through two outer electrodes in amp.

Earth testers normally used for the above purpose comprise the current source and meters in a single instrument and directly read the resistance. Such an instrument is known as four terminal meggar. Using such meggar for measurement, above formula becomes

= 2 X 3.14 X S.R.

where R is meggar reading in Ohms.

Depth of burial of electrodes shall not be more than 1/20 or the spacing between the electrodes.

Correction of the test results should be done, if necessary, using the method outlined in IS:3043.

The location and number of the test points are shown in the plant layout. The number shall be increased if the test results obtained in different locations show a significant difference.

7.00.00 TESTS FOR DYNAMIC PROPERTIES

For evaluation of in-situ dynamic and damping properties of soils, Block Vibration Test, Cyclic Plate Load Test and Wave Propagation Test shall be conducted. The triaxial test method using repeated static loading should also be carried out for arriving at the value of the Young's Modulus.

The Tenderer shall furnish in his tender the complete details of the equipment and method of testing he proposes to follow.

The locations at which such tests are to be carried out are indicated in Geotechnical test location plan and/or at such locations as directed by the Engineer. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall exclude such filled-up soil.
The tests shall be carried out as described in IS:5249 or IS:1888 as applicable. The contractor will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of it being capable of giving accurate data. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to the start of releasing the load so that the total settlement can be checked by him.

The payment shall be lumpsum for each test and shall include all costs inclusive of earthwork in excavation, shoring for side protection (if necessary) construction/curing of plain concrete test block, supply and embedment of foundation bolts etc. and backfilling after the test.

7.01.00 Block Vibration Test

Test pits of size 4.5m x 2.75m at the bottom shall have to be made. Then at the bottom of the pit a Plain Cement Concrete block of grade M15 and of size 1.5m x 0.75m x 0.70m shall be constructed. Suitable foundation bolts shall be embedded in the concrete block during casting for fixing the oscillator assembly. The concrete block shall be cured for a minimum of fifteen days and then the following Block Forced/Free vibration Test shall be carried out as per the recommendations of IS:5249 :

a) Vertical Vibration Test

b) Longitudinal Horizontal Vibration Test

c) Free Vertical Vibration Test

d) Horizontal Free Vibration Test.

7.02.00 **Wave Propagation Test**

The wave propagation test for determination of shear modulus shall be conducted both by exciting the block to steady state vibrations in the vertical direction and by making seismic waves to pass through the ground by impact of hammer and determining the time of travel of these waves between two points at a known distance apart.

7.03.00 **Cyclic Plate Load Test**

The test shall be carried out in a manner as to give a dependable assessment of load-deformation characteristics within the soil mass.

The provisions of IS:1888 shall be followed for conducting the test. The application of load may be by gravity or by reaction as detailed out in the above Standard.

The contractor must get the dial gauges and pressure gauges calibrated by an approved testing laboratory before commencing the test at site and produce the certificates of the test to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The contractor shall bring not less than two dial gauges and one pressure gauge as standby.

The contractor shall provide a layer of cement-sand mortar (1:1 mix) below the bearing plate to level-off any uneven parts and interstices on the rock surface. Also to achieve a uniform distribution of pressure over the loaded surface, the contractor shall provide a flexible layer in the form of rubber pad over the loaded surface.

For conducting the load test the contractor shall apply cyclic loading and unloading, with four or five cycles, increasing in successive of 20% to 25% of full load. While releasing the loads the rebounds to be observed in a similar manner as the settlement observations. The range of cyclic loading shall be decided only after the static net bearing capacity is established by conventional plate load tests.

8.00.00 **FIELD DETERMINATION OF CALIFORNIA BEARING RATIO**

The test shall be carried out at locations as shown on the drawing or at locations as directed by the Engineer. The test shall be carried out at a depth of 500 mm below the finished ground level.

The contractor shall submit, for approval of the Engineer complete detail of the equipment and the method he proposes to use. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The surface area to be tested shall be exposed, cleaned of all loose and dried material, levelled and then soaked till saturation with a surcharge weight of 15 kg. After soaking is complete, the test surface shall be drained of all free

water and allowed to stand for at least 15 minutes before starting further operations.

The test shall be carried out strictly in accordance with the provisions as laid down is IS:2720 (Part XXXI) latest edition. Surcharge weights of 15 kg including that of the annular weight of 5 kg shall be applied before application of load on the penetration piston. Load shall be applied on the penetration piston such that the penetration is approximately 1.25 mm/min. The load readings shall be recorded at penetrations of 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 and 12.5 mm. The maximum load and penetration shall be recorded if it occurs for a penetration of less than 12.5 mm.

After completion of the test, a sample of soil shall be taken from the point of penetration for moisture content determination. In place density shall also be determined.

From the plot of load penetration curve, after necessary correction, the bearing ratios shall be calculated for penetrations of 2.5 mm and 5 mm. If the bearing ratio at 2.5 mm penetration is greater than that at 5 mm penetration the former shall be taken as the bearing ratio. If bearing ratio at 2.5 mm penetration is less than that at 5 mm penetration, the test shall be repeated and if the ratio at 5 mm penetration is consistently greater than that at 2.5 mm penetration, the ratio at 5 mm penetration shall be taken.

9.00.00 LABORATORY TESTS ON SOIL SAMPLES/ROCK CORES

The contractor shall carry out the tests as listed out in the Schedule of Items, and/or as decided by the Engineer, in laboratory. He shall furnish the name/s of laboratories where he proposes to have the tests carried out and have them approved by the Engineer.

The Owner shall have the right of access to contractor's laboratory and/or any other laboratory where tests have been arranged to be carried out during the progress of this investigation.

Adequate volume of test samples of soil/rock cores shall have to be collected from site and stored, labeled and transported carefully to the approved laboratory for carrying out the tests. The method and procedure of testing to be followed shall be as per the relevant Indian Standard Codes of Practice. The results of the tests shall be submitted to the Engineer in sextuplicate duly signed by the laboratory- in-charge. In tests for rock cores L/D = 1.0 of samples must be maintained.

10.00.00 REPORT ON SUB-SOIL INVESTIGATION

10.01.00 General

a) On completion of all the field and laboratory work, the contractor shall submit a formal report containing geological information of the region, procedure adopted for investigation, field observations, summarised test data, conclusion and recommendations. The report shall include

detailed borelogs, subsoil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, the supporting calculation for the conclusions drawn etc. Initially, the contractor shall submit ----- copies of the report in draft form for the Owner's review.

b) The contractor's qualified geotechnical Engineer shall visit the Owner's corporate office for a detailed discussion on the Owner's comments on his draft report. During the discussions, it shall be decided as to the modifications that need to be done in the draft report. Thereafter the contractor shall incorporate in his report the agreed modifications and after getting the amended draft report approved, ----- copies of the detailed final report shall be submitted along with one set of reproducible of the graphs, tables, etc.

c) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundations for different type of structures envisaged in the area under investigations. The contractor shall acquaint himself about the type of structures, foundations loads and other information required from the Engineer.

10.02.00 **Data to be furnished**

The report shall include the enlisted items but not be limited to them.

a) Purpose and scope of investigation

b) Authorization enabling the contractor to carry out the work at the site.

c) Project description including proposed facilities and construction materials required for the works.

d) Description of the site which shall include

i) Location of the site and existing facilities.

ii) Topography of the site

iii) Drainage Characteristics

e) A plot plan showing the locations and reduced levels of all field tests e.g., boreholes, trial pits, static cone penetration tests, dynamic cone penetration tests, plate load tests etc., properly drawn to scale and dimensioned with reference to the established grid lines.

f) A true cross section of all individual bore holes and trial pits with reduced levels and coordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted and samples collected at different depths and the rock stratum, if met with.

g) A set of longitudinal and transverse profiles connecting various boreholes shall be presented in order to give a clear picture of the site, how soil/rock strata is varying vertically and horizontally.

h) **Geological information**

i) Regional geology - geologic province, topographic position of site, processes of formation of subsurface materials at site.

ii) Description of overburden and bedrock at the site (if applicable for the site)

iii) Comments on texture & structure of rock, joints, bedding planes, fissures, weathering condition etc. (of applicable for the site)

iv) Effect of geologic features on design.

i) Past observations and historical data, if available, for the area or for other areas with similar profile or for similar structures in the nearby area.

j) Bore hole & trial pit logs on standard proforma showing the depths, extent of various soil strata etc.

k) Plot of SPT (N) value (both uncorrected and corrected) with depth.

l) Procedure of investigations employed - field tests and laboratory investigation.

m) Results of all laboratory test summarised (i) for each sample as well as (ii) for each layer along with all the relevant charts, tables, graphs, figures, supporting calculations, conclusions and photographs of representative rock cores.

n) For all triaxial shear tests stress vs strain diagrams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the magnitude of the same shall be indicated. The value of modulus of elasticity E shall be furnished for all tests along with relevant calculations.

o) For all consolidation tests, the following curves shall be furnished:

e vs log p

e vs p and

compression vs log t or

Compression vs square root of t (depending upon the shape of the plot for proper determination of co-efficient of consolidation).

The point showing the initial conditions (e, P) of the soil shall be marked on the curves.

p) The procedure adopted for calculating the compression index from the field curve and settlement of soil strata shall be clearly specified. The time required for 50% and 90% primary consolidation along with secondary settlements, if significant, shall also be calculated.

q) For pressure meter tests, the following curves shall be furnished:

Field pressure meter, creep and air calibration curves indicating Po, Pf and P1.

Corrected pressure meter and creep curves indicating P'o, P'f & P'1.

r) From the pressure meter test results the value of cohesion, angle of internal friction, pressure meter modulus, shear modulus and coefficient of subgrade reaction shall be furnished along with sample calculation. Calculation for allowable bearing pressures and corresponding total settlements, for shallow foundations mentioned below and capacity calculation of piles in various modes shall also be included.

10.03.00 **Recommendations**

Recommendations shall be given area wise duly considering the type of soil, structure and foundation in the area. The recommendations shall include but not be limited to the following :

a) Type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total settlements permissible for structures and equipment. Minimum depth and width of foundation shall also be recommended. The provision in relevant IS codes indicated in clause 2.04.00 shall be considered.

b) For shallow foundations, the following shall be indicated with comprehensive supporting calculations :

i) Net safe allowable bearing pressure for isolated square and continuous strip footings of different sizes at different founding depths below ground level considering both shear failure and settlement criteria, giving reasons for type of shear failure adopted in the calculation.

ii) Net safe allowable bearing pressure for mat foundations at different founding depths below ground level considering both shear failure and settlement criteria.

iii) Rate and magnitude of settlement expected of the structure.

iv) Modulus of subgrade reaction, modulus of elasticity, deformation modulus from plate load test results alongwith

time-settlement and load-settlement curves for the various footing sizes at different founding levels indicated above. The recommended values shall include the effect of size, shape and depth of foundation.

c) If piling is envisaged, the following shall be indicated with comprehensive supporting calculations.

i) Type of pile and reasons for recommending the same considering soil characteristics.

ii) Suitable founding strata for pile.

iii) Estimated length and diameter of pile for various values of pile capacities. End bearing and frictional resistance shall be indicated separately.

iv) Magnitude of negative skin friction, if any, to be considered in pile design.

d) Recommendations on foundations for special structures like tanks, transformers, sub-station structures, conveyor trestles, silo/stack like structures, etc.

e) Recommendations regarding bases of roads and pavements.

10.04.00 **Additional Recommendations**

a) Coefficient of permeability of various sub soil and rock strata based on in-situ permeability tests.

b) Cone resistance, frictional resistance, total resistance, relation between cone resistance and SPT(N) value and settlement analysis for different footing sizes based on CPT/SPT.

c) Electricity resistivity of sub-soil based on electrical resistivity tests including electrode spacing vs cumulative resistivity curve.

d) Evaluation of design parameters for design and analysis based on dynamic parameters of soil like Amplitude vs. Frequency curves, co-efficient of elastic uniform compression and elastic uniform shear of soil, co-efficient of elastic non-uniform compression, co-efficient of elastic non-uniform shear, value of damping co-efficient, elastic and shear modulus of soil and Poisson's ratio of soils.

e) Coefficient of earth pressure at rest and stress strain modulus of soil from Menard pressure meter test.

f) Recommendations regarding earth pressure as a function of depth below grade as applied to side walls of underground structures. Values of co-efficient of permeability shall be included in the report.

g) Recommendations regarding method and slope of deep excavations.

h) Recommendations regarding stability of slopes, during excavations, etc.

i) Potential of rock slides and methods of stabilisation of slides for very steep cut.

j) If expansive soil is met with recommendation on removal or retainment of the same under the structures/roads etc. shall be given. In the latter case detailed specification of any special treatment required including specification for materials to be used, construction method, equipment to be deployed etc. shall be furnished.

k) Susceptibility of sub soil strata to liquefaction in the event of earthquake and recommendation on remedial measures, if necessary.

l) Information of special significance like dewatering schemes etc. which may have a bearing on design and construction.

m) Aggressiveness of percolating water through sub-soil/ rock fissures to reinforced concrete foundation/sub-structures and also recommended protective measures, if required.

n) Recommendation for the type of cement to be used and any treatment to the underground concrete structures based on the chemical composition of soil and sub-soil water.

o) Recommendation on suitability of the overburden soil as material of construction of earthen embankments and in back filling of excavated pits/trenches.

p) Recommendation on the use of rock available as construction material.

q) Recommendation on the availability of material for use as aggregates at the site.

r) Recommendation for additional investigation beyond the scope of the present work if the contractor considers it necessary.

s) **Plates**

i) General plan showing location of site, and area geology.
ii) Plan showing existing features, proposed facilities, contours and locations of boring and other investigations.
iii) Geologic sections and soil profiles.

t) **Appendices**

i) Logs of subsurface explorations
ii) Field test results
iii) Laboratory test results.

TECHNICAL SPECIFICATION
FOR
III) AREA GRADING AND SLOPE PROTECTION

CONTENTS

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PART-B	TECHNICAL SPECIFICATION FOR AREA GRADING AND SLOPE PROTECTION

PART-A

TECHNICAL SPECIFICATION - GENERAL

CONTENTS

CLAUSE NO.	DESCRIPTION
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2.00.00	DESCRIPTION & FEATURES OF THE SITE
3.00.00	SOIL CHARACTERISTICS
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8.00.00	TEMPORARY WORK
9.00.00	TENDER DRAWINGS

PART-A

TECHNICAL SPECIFICATION - GENERAL

1.00.00 SCOPE OF WORK

The work to be performed under the scope of this specification consists of design, supply and construction of the following work.

This scope of work is to be considered in addition to the scope of work outlined in clause 2.00.00 of K9213-EPC-SPC-001 Volume IIG/1.

a) Clearing and grubbing areas for Area Grading and land filling, cutting trees, bushes etc. including taking out roots.

b) Area grading work including excavation, dressing and leveling as per grades shown in tender drawing annexed hereto.

c) Land filling with selected earth from excavation and from areas designated by owner and or from borrow pits arranged by the Contractor. The present grade level shall be raised upto RL 72 M (above MSL) filling with selected earth and or suitable granular fill material.

d) Earth work for embankment and temporary roads for construction.

e) Slope protection for embankment and sides of filled-up area within the plot designated for Unit 8 Expansion. This work shall also include design of slope protection work using geo-synthetic lining system and lining the sloped surface for protection against erosion.

The major area of work will be primarily within the plant boundary including areas for Unit 8 Expansion. Nature and extent of the work has been given on the Tender drawing annexed hereto but those are preliminary only and are by no means complete and are subject to change. Design drawing showing complete nature of work will be furnished to the Contractor progressively during execution of the work. Contractor shall develop detail drawings for construction and submit the same for approval.

The supply, design and construction of Geo-synthetic/Geo-textile lining system with protective earth cover and turfing (or precast concrete blocks/Brick tiles) shall be under the scope of Contractor. The design of Geo-synthetic lining system shall be done by approved manufacturer or specialized agencies and to be submitted to owner for approval. Laying of Geo-textile grid and covering the same with soil shall be done by the agencies specialized for this type of work.

All items of work shall be executed in accordance with the relevant specifications annexed hereto and the provisions of the contract.

The work to be performed under this tender specification consists of providing all labour, supervision, materials, scaffoldings, construction equipment, tools

& plants, supplies, transportation, all incidental items not shown or specified, but reasonably implied or necessary for successful completion of the work including Contractor's supervision and in strict accordance with the drawings, specifications.

Tenderers are not generally expected to stipulate any conditions of their own or deviate from the General & Supplementary Conditions of the Contract and Specifications. However, should it become necessary, all such deviations shall be indicated clause wise in a separate schedule. Deviations mentioned or brought out elsewhere in the tender other than in the above schedule, will not be entertained and such offers which do not conform to the above requirements are liable to be summarily rejected.

The requirements and the Conditions of Contract as stated in General and Special Conditions of Contract by GSECL are also applicable.

2.00.00 DESCRIPTION AND FEATURES OF THE SITE

2.01.00 The work specified herein shall be carried out at Wanakbori Power Plant, Gujarat, within the area designated for 1x800 MW Super Critical Thermal Power Plant Extension Unit.

2.02.00 The Power Plant is located at Wanakbori, Kheda District in the State of Gujarat.

2.03.00 **Location of Power Plant**

i) At Wanakbori TPS, Kheda District, Gujarat.

ii)	Nearest Town	:	Balasinor (13 Km from Site), Sevalia (10 Km from Site)
iii)	Nearest Highway	:	NH-08 (10 Km from Site)
iv)	Nearest Railway Station	:	Sevalia (8 Km from Site)
v)	Nearest Airports	:	Ahmedabad (110 Km from Site)
			Vadodara (85 Km from Site)

2.04.00 **Meteorological Data**

Weather data for the site :

a)	Dry bulb temperature (max. & min.)	:	40.8^{o}C & 10.8^{o}C
b)	Humidity (min. & max.)	:	42.5% to 81.5%
c)	Average Annual Rainfall	:	750 mm
d)	Wind speed	:	Basic wind speed of 39 m/sec as per IS-875 (Part-3).
e)	Seismic zone	:	Zone-III as per IS-1893

3.00.00 SOIL CHARACTERISTICS

Boring and subsurface data regarding nature of soil, subsoil water etc. are not available now. The tenderer shall satisfy himself of the character and volume of work under the items and expected surface and/or subsoil water to be encountered. He must satisfy himself about general conditions of the site and ascertain the existing and future obstructions likely to come up during the execution of the contract to carry out work under this scope.

[Geo-technical investigation work for preparatory work is being done by other agencies. The report will be available with GSECL after completion of work]

4.00.00 SPECIFICATIONS

The following Technical Specifications are to be referred for various items of work:

A) Technical Specification for Area Grading and Slope Protection

B) Technical Specification for Geo-textile Fabric.

The above specifications are intended for the General description of quality, workmanship etc. desired for various items of work under the Contract. The Specifications are not, however, intended to cover minutest details and all work shall be executed according to the spirit of the specifications and in absence thereof, according to the relevant latest Indian Standard Specification. In absence of the latter, the work shall be executed according to the best prevailing local Public Works Department Practice or to the recommendations of the American or British Standard Specifications at the discretion of the Engineer.

5.00.00 DRAWINGS

The following tender drawings are to be referred in relation to Area grading and Slope Protection work.

Sl. No.	Drawing No.	Description
1.	K9213R-DWG-S-0002 REV 8	Area Grading Plan & Sections
2.	K9213R-DWG-S-0008 REV 0	Paving Pattern For Slope Protection
3.	-	Contour Plan dtd MAY 2010.
4.	K9213R-DWG-M-002, Rev 4	Plot Plan – Unit # 8

Aforesaid drawings are preliminary for Tender purposes only and are by no means complete and final and do not show the full range of the work under the scope of the Contract. Work shall be carried out only on the basis of

design drawings marked "Released for Construction" with additions, alterations and modifications made to aforesaid drawings from time to time and also according to detail construction drawings that will be prepared by the Contractor progressively during the execution of the work.

The Contractor shall refer to the Engineer any discrepancy which may exist between the drawings and the specification for clarification. Engineer's decision as to the clarification of the point raised shall be final and binding to the Contractor.

6.00.00 LAYOUT

The layout and levels of all the work shall be made by the Contractor at his own cost from the general grid of the plot and bench marks given by the Engineer. He shall give all help with instruments, materials and men to the Engineer for checking the detailed layout and correctness of the layout and levels. The approval of the Engineer shall not be deemed to imply any warranty and shall not relieve the Contractor of his sole responsibility in connection with carrying out the work correctly.

Making bench mark pillars and reference line pillars etc. and maintaining them upto the completion of the work shall be responsibility of the Contractor. No extra payment shall be made on this account.

7.00.00 WORKMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. In addition to the requirement specified above, if the bye-laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

8.00.00 TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such temporary work shall have the prior approval of the Engineer, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and

re-erection, if required, shall be carried out by the Contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor.

Owner is not bound to supply materials (cement, reinforcing steel & structural steel) for such temporary work. However, depending on merit of the situation and also discretion of the Engineer, the material may be issued to the Contractor, subject to the availability of the same. The materials issued for this purpose shall be treated as bonafide consumption and will be recovered at issue price as stipulated in Special Condition of Contract.

9.00.00 **TENDER DRAWINGS (Refer Volume IIL of Specification)**

PART-B

TECHNICAL SPECIFICATION
FOR
III) AREA GRADING AND SLOPE PROTECTION

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA
5.00.00	INFORMATION TO BE SUBMITTED

SECTION-II

TECHNICAL SPECIFICATION FOR A) AREA GRADING AND SLOPE PROTECTION

1.00.00 SCOPE

This specification shall govern all clearing, grubbing, excavating, area filling, grading and compacting soils for areas designated on the drawings. The work shall include clearing and grubbing, stripping and storage of top soil, excavation, blasting (if required), hauling, dumping and spreading of soil, undercutting to remove unstable soil areas, compacting existing soil surfaces and bottom of excavated areas to receive fills, compacting excavated areas for subgrade, placing and compacting soils in fills, dealing with surface water, pumping to keep excavated areas and areas to be filled dry, final grading of designated areas, disposing of unsuitable and excess excavated materials and incidentals thereof. For hauling of earth from approved borrow areas to site, agency shall get timely approval from all statutory authorities for right of way. GSECL will give recommendation letter to obtain the permission from appropriate authority for excavation from borrow area.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, earth-moving machineries and equipment, compaction plant and equipment, tools and plants, survey instruments, transportation etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, sumps for dewatering, space for temporary stacking of spoils, disposal area, borrow pits, fencing, slope protection work etc. and all other details as may be required by the Engineer.

c) To carry out and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

d) If blasting is resorted to, necessary licenses to be procured from the proper authorities.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

However, the Owner reserves the right to award the whole work to one Contractor or to split up the work for awarding to two or more Contractors.

2.03.00 **Codes and Standards**

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed :

IS : 1200	:	Method of Measurement of Building and Civil Engineering work, Part-I Earthwork
IS : 2720 (Part-II)	:	Determination of Moisture Content
IS : 2720 (Part-IV)	:	Grain Size Analysis
IS : 2720 (Part-VII)	:	Determination of Moisture Content/Dry Relation using Light compaction
IS : 2720 (Part-VIII)	:	Determination of Moisture Content/Dry Relation using Heavy Compaction
IS : 2720 (Part-XIV)	:	Determination of Density Index (Relative Density) of cohesion less soils
IS : 2720 (Part-XXIV)	:	Determination of Dry Density, in place, by core cutter method
IS : 2720 (Part-XXVIII)	:	Determination of Dry Density of Soils, in place, by sand replacement methods
IS : 3764	:	Safety Code for Excavation Work
IS : 4081	:	Blasting and related drilling operations
IRC : SP-11	:	Hand book of quality control for construction of roads and runways
IRC : 36	:	Construction of Earth Embankments for Road Work.

2.04.00 **Conformity with Designs**

The Contractor shall carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be used**

2.05.01 General

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.05.02 Borrow Material

Borrow material required for area filling shall be excavated from approved locations and levels and shall consist of selected material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material.

When specific borrow area can not be designated by the Engineer, necessary arrangement shall be done by the Contractor at his own cost for locating and using the borrow areas as the source of supply of filling material.

The depth of borrow pits should be so regulated that the borrow pits do not cut an imaginary line having a slope of 1 vertical in 4 horizontal projected from the edge of final section of the adjacent embankment of stack of excavated soil.

2.06.00 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

a) Lines, Levels and Grades :

i) Periodic Surveys

ii) Establishment of markers, Boards etc.

iii) Checking levels and slopes of the graded surface.

b) Area filling :

i) Checking the quality of fill material

ii) Checking moisture content of the fill

iii) Checking the degree of compaction.

2.06.01 Any work which fails to conform to the specifications will be subject to the issue of a Non-conformance Report in line with the Quality Control Procedure to be implemented at site. Corrective or remedial action, design modifications or product rejection will be reviewed in accordance with the site Quality Plan.

2.07.00 **Information regarding Site Conditions**

Boring and sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawings or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the Contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and/or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the Contract so that he may evolve a realistic programme of execution.

3.00.00 **EXECUTION**

3.01.00 **General**

The work shall be undertaken in accordance with the lines, levels, grades and details shown on the drawings, specification and the approved method of work.

The works shall be carried out in a workman like manner without endangering the safety of nearby structures, roads, railway tracks, cable, pipelines, etc. and without causing hindrance to construction activities.

Suitable approaches, fencing, area lighting and temporary works required for the works shall be provided by the contractor. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where damping from a high bench is in progress, if directed by the Engineer. Adequate area lighting shall be provided by the contractor, if night work is undertaken.

The Contractor shall submit a proposal covering the proposed excavation and placement of fill material for approval of the Engineer. The proposal shall include but not be limited to the following:

a) Mobilisation and demobilisation of plant

b) Proposed plant and equipment, labour resources & supervision.

c) Details of proposed method of clearing and grubbing for each area of cut and fill.

d) Drawings showing the areas for placement of material.

e) Management of excavation and filling works i.e., control of setting out, testing procedures, handling, temporary stockpiles, etc.

f) Temporary works proposals

g) Excavation, filling and compaction by mechanical plant

h) Dealing with surface water

i) Dewatering

j) Disposal of materials

k) Safety precautions, fencing and lighting

l) Calculations as appropriate to support work proposal.

3.02.00 **Setting Out**

Within 15 days of award of Contract, the Contractor will prepare and submit to the Engineer, detailed drawings of the excavation and filling work necessary, as proposed to be executed by him, showing the dimensions as per drawings and specification, adding his proposals for slopes, approaches, dewatering sumps, berms etc. On receiving the approval from the Engineer with modifications and corrections if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instruments for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if any. In case any errors are noticed in the Contractor's work at any stage, the same shall be remedied by the Contractor at his own cost.

3.03.00 **Initial Levels**

Initial levels either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. These initial levels and cross-sections shall be jointly signed by the Contractor and the Engineer before commencement of work and they shall form the basis of all payment in future.

3.04.00 **Clearing and Grubbing etc.**

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and leveled up. Trees upto 300 mm girth shall be uprooted. Trees of all sizes are required to be cut and transported to owner’s store. Also all serviceable materials to be credited at owner’s store. Trees above 300mm girth which are required to be cut, shall be got identified by the Engineer and then marked.

Felling of trees shall include taking out roots upto 600 mm below ground level. After the tree is cut and roots taken out, the pot-holes formed shall be filled with good earth in 250 mm layers and compacted to acceptable degree unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer and then shall be transported to the Owner's store or any other space as directed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed as directed by the Engineer. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.05.00 **Classification**

Materials involved in earthwork shall be classified under the following categories. No distinction will be made whether the material is dry or wet. The Engineer's decision in regard to such classification shall be final and binding on the Contractor :

a) Ordinary and hard soil

This shall include clay, silt, sand, moorum, shingle, kankar, gravel, loam, peat, ash and other similar materials in soft, hard or dense state which can generally be excavated with ordinary spade, pick axe, shovel etc. and does not require the use of wedges, pneumatic breaking equipment and/or blasting for removal. It shall also include loose rock boulders present in the soil, with dimensions not exceeding 500 mm in any direction. Breaking of consolidated brick ballast and mud concrete shall be considered equivalent to excavation work under this type of soil.

b) Soft and Decomposed Rock

This shall include rocks like chalk, slate, mica schist, laterite and other similar materials which in the opinion of the Engineer is rock, but does not require blasting for removal and could be removed with picks, hammers, crow bars, wedges, pneumatic breaking equipment etc. It shall also include boulders with dimensions greater than 500 mm but not exceeding 1000 mm in any direction.

The mere fact that the contractor resorts to blasting for his own convenience shall not mean that the rock will be classified as hard rock. Excavation in macadam and tarred roads and pathways, brick work etc. shall be considered at the same rate as excavation of this type of soil.

c) Hard Rock

This shall include rocks occurring in large masses which cannot be removed except by blasting. Harder varieties of rock such as trap, with or without veins and secondary mineral which in the opinion of the Engineer require blasting for removal shall also be considered as hard rock. It shall also include boulders bigger than 1000 mm in any direction. Construction in concrete, both reinforced and unreinforced, which is required to be dismantled during earthwork, shall be measured under this item, unless a separate provision is made in the schedule of Quantities for the same.

3.06.00 Earthwork in Excavation

3.06.01 General

Before commencement of excavation the existing ground surface shall be cleared in accordance with Clause no. 3.04.00.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavation including dimension, side slopes, dewatering, disposal, etc.

This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer and the Contractor shall be paid for the extra excavation and the filling at the appropriate item rates.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost with selected earth and compacted in accordance with the specification as specified in Clause No. 3.07.01.

3.06.02 Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock

The excavation in ordinary soil, hard soil and soft and decomposed rock shall be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures or roads, railway tracks, cables, pipelines etc. if any, and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly & the balance work will be carried out carefully to avoid any over-excavation.

On completion, the work will be finally checked and approved by the Engineer. In case where excavation in soil, soft and decomposed rock and/or hard rock are involved, the soil or soft and decomposed rock layers, shall be removed by turn and levels of the underlying rock surfaces observed to enable measurements. Further work shall be resumed after getting clearance from the Engineer.

3.06.03 Excavation in Hard Rock

Overburden, if any, consisting of top soil, ordinary and hard soil, soft and decomposed rock as per classification of soil, which do not require blasting shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurement. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiseling, wedging or any other approved method. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rate for excavation in hard rock shall include the cost of all these operations.

3.06.04 Blasting

3.06.04.01 General

Excavation shall be continued in hard rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines for the excavation, in the soundest possible condition. The quantity and strength of explosive used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Engineer at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Unless otherwise stated herein, I.S. Specification IS:4081 "Safety Code for Blasting & Related Drilling Operation" shall be followed.

Specific permission of Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting license from the authorities concerned.

Contractor shall obtain necessary license for storage of explosives, fuses and detonators issued to him from owner's stores or from supplier arranged by him, from the authorities dealing with explosives.

The fees, if any, required for obtaining such license, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Govt. authorities and statutory bodies / regulations.

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

Contractor shall employ a competent experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Contractor shall intimate Engineer and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

The blasting of rock near any existing buildings, equipments or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges and where directed by Engineer, a trench shall have to be cut by chiseling prior to the blasting operation separating the area under blasting from the existing structures.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an over break limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M 10. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stepping in rock excavation shall be done by hand trimming.

Contractor shall be responsible for any accident to workmen, public or Owner's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other authority duly constituted under the State and/or Union Government.

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.06.04.02 Material

All materials such as explosives, detonators, fuses tamping materials etc. are proposed to be used in the blasting operations shall have the prior approval of the Engineer.

Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used.

The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for thirty minutes. The rate of burning of the fuse shall be uniform and not less than 4 seconds or inch of length with 10% tolerance on either side.

Before use, the fuse shall be inspected and moist damaged or broken ones discarded. The rate of burning of fuses or when they have been in stock for long shall be tested before use.

The detonators used shall be capable of giving an effective blasting of the explosives, moist; and damaged detonators shall be discarded.

3.06.04.03 Storage of Explosive

Storage of explosives shall be governed by the current Explosive Rules. Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Persons entering the magazine, must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful :

- Not to put their feet on the clean floor unless they have the magazine shoes on.

- Not to allow the magazine shoes to touch the ground outside the clean floor.

- Not to allow any dirty or grit to fall on the clean floor.

Persons with bare feet, shall before entering the magazine dip their feet in water and then step direct from the tub over the barrier (if there be one) on to the clean floor.

A brush broom shall be kept in the lobby of the magazine for cleaning out the magazine, on each occasion if it is opened for the receipt, delivery or inspection of explosives.

No matches or inflammable materials shall be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100 m of a magazine.

No person having article of steel or iron on him shall be allowed to enter the magazine.

Oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Workmen shall be examined before they enter the magazine to see that they have none of the prohibited articles on their person.

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dust storm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.06.04.04 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.06.04.05 Use of Explosives

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shotholes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shot holes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shot firer himself. The shot firing cable shall not be dragged along the ground to avoid possible damage to the insulation. The shot firing cable shall be tested for continuity and possible short circuiting before it is used each time.

The shot firer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shot firer shall return to the blast area and inspect carefully and shall compare the number of blasts planted/fired to the actual number of shorts heard and satisfy himself that all blast have exploded. Withdrawal unexploded charges shall not be permitted. The unexploded charges shall be flooded with water and the hole shall be marked in a distinguishable manner. Another hole shall be made by drilling a parallel fresh hole not less than 450 mm from misfired hole and fired in the usual way. The process shall be continued till the original blast is exploded. The engineer shall also be informed by the Contractor of all the cases of misfired/unexploded charges, their causes and steps taken. The authorised shot firer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until atleast half an hour after firing.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.06.05 Disposal

The excavated spoils will be disposed off within the specified lead in any or a combination of some of the following manners, as directed by the Engineer :

a) By stacking separately the materials suitable for area filling and materials not suitable.

b) By stacking it temporarily for use in backfilling at a later date.

c) i) By either spreading

or

ii) Spreading and compacting at designated filling areas and/or disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in back-filling or other purposes by some other agency.

e) Disposal of debris, earth, mill rejects, (if not useful) excavated spoils will be disposed off outside plant area by bidder. Disposal area shall be identified by the bidders.

The rate for excavation in soil should include the cost of filling and compaction in case (c) (ii). The rate for excavation in rock should include the cost of disposal as per (d).

3.06.06 Dewatering

All areas shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer, any water inclusive of rain water and subsoil water accumulated in the area without any extra cost. Method of dewatering shall be got approved by the Engineer.

3.06.07 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

Working surfaces shall be formed to such falls to shed water and prevent ponding.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems at his own cost to drain surface water from working areas.

3.07.00 **Treatment of Slips**

The Contractor will take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and backfilled later by him at his own expenses.

3.08.00 **Earthwork in Filling**

3.08.01 Area Filling for Grading

The material to be used for area filling shall be selected material capable of being compacted to the requirements stated herein below and approved by the Engineer, obtained directly from excavation for area grading, from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits in selected areas designated/approved by the Engineer. The quality of the material shall conform to that mentioned in clause 2.5.2 of this specification.

Where excavated material is mostly rock, the boulders shall be broken into pieces not longer than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill up the voids and the mixtures used for filling.

If any material is rejected by the Engineer, Contractor shall remove the same forthwith from the site at no extra cost of the owner. Surplus fill material shall be deposited/disposed of as directed by the Engineer after the fill work is completed.

No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

Before commencement of area filling the existing top soil shall be removed upto a minimum depth of 200 mm, or more, as directed by the Engineer in order to clear the surface of undesirable materials. After this the filling operation shall be performed with earth in layers not exceeding 250 mm, loose thickness. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as given below and got approved by the Engineer.

a) Each layer of earth of cohesive nature shall be compacted to 90% of proctors dry density unless otherwise permitted/directed by the Engineer.

b) Each layer of earth of non-cohesive nature shall be compacted to minimum 75% relative density unless otherwise permitted/directed by the Engineer.

Each shall be compacted with approved machine (mechanical plant) and usually manual compaction shall not be allowed unless specifically permitted by the Engineer. The original ground formation and each fill layer shall be compacted by rollers as described below with a maximum of six passes of 8/10 tonne roller.

i) When the optimum moisture content of soil is relatively high, a pneumatic tyred roller (type pressure 3.0 - 3.5 kg/sq.cm) shall be considered to give better performance for mechanical compaction.

ii) When the optimum moisture content of soil is relatively low, a vibrating roller shall be considered to give better performance for mechanical compaction.

Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on this aspect and corrections done to optimise the moisture content. The adequacy of the compaction and moisture content of the soil shall be determined by performing field density tests and other tests as and when directed by the Engineer and shall conform to the stipulations laid down in IS:4701.

The cohesionless soil to be used for area filling, should be placed in fully saturated condition to obtain the maximum possible density. The saturation

moisture content shall be determined by laboratory tests prior to commencement of work.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed.

When density measurements reveal soft areas in the construction, further compaction shall be undertaken at the contractor's cost as directed by the Engineer. If the required compaction is then not achieved the material in the soft area shall be removed and replaced by approved material and compacted in accordance with this specification all to the contractor's account.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than 12 passes of the roller shall be accepted before subsequent similar operations are taken up.

3.08.02 Filling in Disposal Areas

Excavated materials if not used in area filling, will be disposed of in designated disposal areas as directed or as indicated in the drawings. The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 500 mm in thickness and nominal compaction done to the satisfaction of the Engineer. All clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers and trucks shall be allowed to ply over the fill to permit compaction to take place.

In wide areas rollers may be employed and nominal compaction done to the satisfaction of the Engineer. No payment for compaction shall be made for such nominal compaction.

3.09.00 **Compaction Control**

The density of each layer of compacted soil shall be ascertained by testing a number of samples. For this purpose the necessary arrangements for soil testing at the site shall be made by the Contractor in accordance with these specifications at the Contractor's expense and as directed by the Engineer.

The Contractor shall arrange the provision of the field laboratory including the testing equipment and a suitable motor vehicle. He shall also supply all

consumable materials such as kerosene, spirit, gas and sample bags as required.

All soil testing is to be carried out by a competent and suitable qualified engineering testing firm. The Contractor is to obtain the Engineer's approval for the firm to be used. The Contractor may undertake this work with the Engineer's approval.

All density testing shall be carried out on a lot by lot basis. A lot shall be considered to be a portion of work which is essentially homogeneous with respect to material type general appearance response during compaction, moisture condition during compaction, compaction process and state of underlying material.

All fill testing shall be carried out in accordance with the recent editions of relevant Indian Standards. The chainage and the off-set from the centre line of the fill of each test sample shall be recorded and presented along with the test results.

Each test lot shall be classified as cohesionless or cohesive. The classification shall be determined by the Engineer based upon particle size distribution. Cohesionless fill shall have 10% or less by mass of particles finer than 0.075 mm. Otherwise fill shall be treated cohesive.

For cohesionless fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum and minimum dry density. These reference values of dry density shall be used to compute the density index (relative density) of each of the field density test samples taken from the test lot.

For cohesive fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum dry density and optimum moisture content (OMC). These reference values of dry density and moisture content shall be used to compute the dry density ratio of each of the field density test samples taken from that test lot.

The degree of compaction shall be determined by considering the mean density of the samples in each test lot. The mean dry density shall be equal to or exceed the minimum specified density. In no individual case shall density be less than the minimum value specified by more than 2 percent, otherwise further rolling shall be done at the appropriate locations.

The contractor shall lay a further layer or fill only after compaction or a particular layer has been found and approved by the Engineer.

3.10.00 Protection of Side Slopes

The side slopes of the embankment shall be protected against slippage caused by rain cuts, erosion by wind etc. The surface treatment to be adopted will be by turfing, by lining, or by other means as shown in the drawings and also as directed by the Engineer.

3.10.01 Turfing

3.10.01.01 General

The provision of turfing involves the plantation of grass on the top and/or side slopes of the embankment as shown on the drawing or as directed by the Engineer. The work of turfing shall be taken up immediately after the construction of embankment, provided the season is favourable for the establishment of sod, preferably well before monsoon, but not during the monsoon.

The sod shall consist of dense, well-rooted growth of permanent and desirable grasses, indigenous to the locality. Thickness of sod shall be between 5cm & 8cm, so that all the dense root system is retained in the sod strip. The sods shall be of rectangular strips of uniform width, not less than about 25cm x 30cm in size but not so large that it is inconvenient to handle. During wet weather, the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather shall be watered before lifting to ensure its vitality.

3.10.01.02 Preparation of Bed

After the embankment has been constructed to shape and well compacted, the surface earth shall be loosened to a depth of 75 mm for receiving the sod. If the soil is not suitable for grass growth, suitable top soil shall be spread over the slopes and worked into the already loosened soil. Where required, fertilizer shall be spread and incorporated in the soil.

3.10.01.03 Placing of Sod

The prepared sod bed shall be moistened to the loosened depth and the sod shall be placed within 24 hours after the same has been cut. Each sod strip shall be placed edge to edge and such that the joints caused by abutting ends are staggered. The sod shall be lightly tamped with wooden or metal tampers to press it into the underlying soil. The strips are to be placed on the prepared embankment surfaces starting at the bottom. When the top is reached, the edge of the sod shall be turned into the surface and a thin layer of earth placed over the edge and compacted so as to divert water above the edge onto the top of the sod.

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2 metres, the sod shall be staked with pegs or nails spaced approximately 50 to 100 cm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods to be almost flush with them.

The sods shall be watered until the seeds or roots have sprouted. The preferable system of watering is by spraying rather than by flowing.

3.10.02 Geo-textile Membrane

Refer Volume IIG/3 Section XXXII for Technical Specification.

3.10.03 Earth/Soil

The excavated soil, selectively taken from the stacks of the same Contractor and/or stacks left by other agencies shall be used for covering geo-textile membrane and shall be free from pebbles, stones, vegetation and sieved to segregate stones, etc. present in it, if directed by the Engineer. The minimum clay-content of this soil shall be 25%. No fine sand layer excavated shall be used as cover over films.

3.10.04 Pre-cast Concrete

Ingredients used in pre-cast concrete blocks (to be used for covering geo-synthetic/geo-textile membrane) shall conform to the relevant provisions in IS:456, latest revision.

All precast work shall be carried out in a yard made for the purpose. This yard shall be dry properly levelled and having a hard and even surface. If the ground is to be used as a soffit form of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:3 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after installation.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials and men to the Engineer for checking the proper installation of the precast units. All minor defects shall be touched up with a paste of 1 part cement and 3 parts sand.

3.10.05 Bricks and Brick Tiles

Bricks and brick tiles shall be of first class (class A) quality, well burnt, of uniform size, shape and colour, free from cracks, flaws or nodules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, holes etc. compressive strengths shall be 50 Kg/sq.cm minimum for common bricks. Water absorption after 24 hours immersion shall not exceed 15% by weight for common bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for common bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

If the Tenderer can not arrange for such quality bricks during execution, he should clearly indicate it in his offer. Samples of bricks/brick tiles have to be got approved by the Engineer. Any brick or consignment of bricks not found upto the specification shall be outright rejected and shall be removed immediately from site at the Contractor's own cost.

3.10.06 Execution of Slope Protection

The Work shall be strictly executed according to the provisions of this specification, final drawings to be issued, instructions of the Engineer at site, and/or catalogues of the approved manufacturer of Geo-textile membrane films.

3.10.06.01 Preparation of Sub-grade

The side slope shall be well compacted and free from undulations. All sharp objects such as rock pieces, boulders, stones, pebbles, roots and weeds shall be cleared to prevent puncturing of the membrane, and holes are to be filled up with proper material and compacted as directed by the Engineer. If the sides of excavation is a rock-cut terrain, sharp protrusions shall be levelled off. It is important that the sloping sides are well compacted to the satisfaction of the Engineer.

3.10.06.02 Treatment of Weed- Infested Areas

For safe guarding Geo-textile membrane against the growth of weeds, weedicides (such as Biodex-C, Grammaxene, Fernoxene or equivalent products) should be mixed with water in accordance with the manufacturer's instructions (3 litres of weedicide mixed with 200 litres of water is a standard practice) and this solution should be spread over the earth with a chemical spraying pump on side slopes.

The anti-weed treatment should be given only after moisture content of the soil is brought below 29%. After completion of the spraying of anti-weed chemicals and before taking up the next activity, a period of 24 hours should be allowed for penetration of the chemical into the soil.

3.10.06.03 Anti-Termite Treatment

The danger of termites at the side slope is rather remote. However in the case of infested areas, suitable insecticide slurries with insecticides such as BHC may be used over the side slope and before laying the film to prevent termite attack.

The tenderer, in his offer, shall quote separately for spraying suitable insecticide slurries in each square metre of treated area, and shall clearly indicate the type of insecticide, he proposes to use, manufacturer's name, proportion of ingredients in the slurry, and method of application, etc.

3.10.06.04 Not used.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Soil Testing

The following tests shall be undertaken by the Contractor and results and reports shall be submitted to the Engineer for approval. Test failures are to be immediately notified to the Engineer, otherwise results to be submitted within 24 hours of testing. Each layer of material shall be tested for compaction. Each layer is to be tested in a manner that is representative of its full depth. The Engineer may at his discretion instruct the Contractor to increase or decrease the frequency of testing.

a) Minimum one test per 500 cu.m of soil coming out of the borrow pits for determination of natural moisture contents in order to evaluate how far the natural moisture content tallies with the optimum value and whether further addition or reduction of water content would be necessary. Test to be done in accordance with IS : 2720 (Part-II).

b) Minimum two sets of laboratory tests per 8000 cu.m of soil coming out of the borrow pits for determination of dry density at optimum moisture content. Test to be done in accordance with IS : 2720 (Part-VII, XIV, XXVIII, XXIV) as applicable.

c) Minimum two sets of test per 500 cu.m of loose fill for determination of moisture content just prior to compaction of area filling. Test to be done in accordance with IS : 2720 (Part-II).

d) For each compacted layer, minimum one test per 2000 sq.m of compacted area for determination of moisture content and dry density.

e) Minimum two tests per 8000 cu.m of soil for determination of soil classification. Test to be done in accordance with IS : 2720 (Part-IV).

f) Minimum 10 (ten) density measurements shall be plotted to establish moisture content-dry density relationship.

4.02.00 Acceptance Criteria

4.02.01 Excavation

On completion of excavation, the dimensions of the area will be checked as per the drawings after the area is completely dewatered.

The work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by compacted earth, at the Contractor's cost.

Over excavation of the sides will be made good free of cost by the Contractor. The excavation work will be accepted after the above requirements are fulfilled & all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.02 Area-filling

The degree of compaction required will be as per the stipulations laid down in appropriate sections of this specification. The actual method for measuring the compaction achieved will be as decided by the Engineer. The work of area filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

Following details of Machineries, transport vehicles, equipment proposed to be used for excavation, area-filling and compaction have to be submitted along with the tender :

i) Equipment, machinery & earthmoving vehicles, available with the Contractor and proposed to be used for excavation and haulage giving details regarding make, model, capacity, year of manufacture, numbers available for this contract and general condition.

ii) Equipment proposed to be used for area filling and compaction giving similar details as in item 5.01.00 (i) above.

iii) Method of transportation.

5.02.00 After Award

After award of contract the successful tenderer shall submit the following for approval and adoption :

a) Within 15 days of Award of the contract, the Contractor shall submit a detailed programme of work as proposed to be executed giving completion dates of excavation of the various areas and the time required for area-filling and compaction. The programme should also show how the excavation and area- filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with overall construction schedule without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, approaches, sump pits, dewatering lines, borrow pits, if any, fencing etc. for approval of the Engineer for adoption.

TECHNICAL SPECIFICATION
FOR
IV) EARTHWORK IN EXCAVATION AND BACKFILLING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA
5.00.00	INFORMATION TO BE SUBMITTED

IV) EARTHWORK IN EXCAVATION AND BACKFILLING

1.00.00 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing, etc. and all other details as may be required by the Engineer.

c) To carry out sampling and testing and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

d) Construction, maintenance and removal after completion of Magazine of proper capacity as well as design for storing of explosives required for blasting work to be carried out under the scope of this tender including procurement of necessary licenses from proper authorities.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All works under this specification, unless specified otherwise, shall conform to the latest revision and/or replacement of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed:

IS:1200 : Method of Measurement of Building and Civil (Part-I) Engineering work; Part-I Earthwork.

IS:2720	:	Determination of Moisture Content (Part-II).
IS:2720	:	Determination of Moisture content/Dry Relation (Part-VII) using Light Compaction.
IS:2720	:	Determination of Density Index (Relative Density) (Part-xiv) of cohesionless soils.
IS:2720	:	Determination of Dry Density, in place, by core (Part-xxix) cutter method.
IS:2720 (xxviii)	:	Determination of Dry Density of soils, in place, (Part-by sand replacement methods.
IS:3764	:	Safety code for Excavation work.
IS:4081	:	Blasting and Related Drilling Operations
IS:4701	:	Earthwork on canals

2.04.00 **Conformity with Designs**

The Contractor is to carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and approved by the Engineer.

2.05.02 **Borrow Material**

Borrow material required for back-filling shall be excavated from approved locations & levels and shall consist of material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries shall be used as fill material.

2.06.00 **Quality Control**

The Contractor shall submit the Quality Assurance Plan (QAP) for total work to the Owner/Engineer for approval and follow the approved plan during work execution.

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

a) Lines, Levels and Grades :

i) Periodic surveys

ii) Establishment of markers, boards etc.

b) Back-filling :

i) Checking the quality of fill material

ii) Checking moisture content of the backfill

iii) Checking the degree of compaction.

2.07.00 **Information regarding site conditions**

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation there from shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, Sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.00.00 **EXECUTION**

3.01.00 **Setting Out**

Within 7 days of releasing of construction drawing, the Contractor will prepare and submit to the Engineer, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his proposals of slopes, shorings, approaches, dewatering sumps, berms, etc. On receiving the approval from the Engineer with modifications and corrections, if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be fixed at intervals prescribed by the Engineer and checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instructions for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, free of cost to the Owner in case any errors are noticed in the Contractor's work at any stage.

3.02.00 **Initial Levels**

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements.

All records of levels, measurements etc. and also any drawing, cross section etc. made there from, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.03.00 **Clearing and Grubbing, etc.**

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and leveled up. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600mm below ground level or 150mm below formation level whichever is lower. After the tree is cut and roots taken out the pot-holes formed shall be filled with good earth in 250mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burned or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.04.00 **Classification**

All earthwork shall be classified under the following categories :
No distinction will be made whether the material is dry or wet.

a) **Ordinary Soil**

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) **Hard Soil**

This shall include :

i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;

ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;

iii) soling of roads, paths, etc., and hard core ;

iv) macadam surfaces such as water bound, and bitumen/tar bound;

v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;

vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and

vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) **Soft and Decomposed Rock**

This shall include :

i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;

ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;

iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin; and

iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (requiring blasting)**

This shall include :

i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;

ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and

iii) boulders requiring blasting.

iv) Rock cutting and blasting, if required.

e) **Hard Rock (blasting prohibited)**

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.05.00 **Excavation for Foundations and Trenches**

3.05.01 **General**

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal, etc. This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Engineer they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Engineer and the Contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works.

The Contractor shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Contractor shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment of the work, etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which, in the opinion of the Engineer, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even

below the final level. The extra excavation shall be filled up as instructed by the Engineer and the Contractor shall be paid for the extra excavation and the filling at the appropriate item rates.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost (with cement concrete not leaner than 1:4:8 ordinary concrete or richer) as directed by the Engineer in each individual case.

In formation of rock requiring blasting, those over cuts which are unavoidable will be made up by ordinary cement concrete 1:2:4 which will be paid for under appropriate rate, provided this over cut is not due to negligence of the Contractor. The decision of the Engineer as to the admissibility of such over cut for payment will be final. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked separately as directed by the Engineer and shall be the property of the Owner.

3.05.02 **Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock**

The excavation in ordinary soil, hard soil, soft and decomposed rock will be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work will be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation. On completion, the work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Engineer may order to suspend the work at any stage and instruct the Contractor to carry out the balance work just before the foundation work of the structure can be started. No extra will be paid to the Contractor for such unavoidable temporary suspension of work.

3.05.03 **Excavation in Hard Rock**

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc. which can be excavated without blasting, shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurements. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 meters, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiseling, wedging or any other approved method and payment appropriate to blasting shall be made, unless otherwise mentioned in the Schedule.

3.05.04 **Blasting**

3.05.04.1 **General**

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.05.04.2 **Storage of Explosive**

Storage of explosives shall be governed by the current Explosive Rules, Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in- charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 m of a magazine.

Magazine shoes without nails shall be used while entering the magazine.

The mallets, levers, wedge etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dust storm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.05.04.3 **Carriage of Explosives**

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.05.04.4 **Use of Explosives**

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shot holes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shot holes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shot firer himself. The shot firing cable shall not be dragged along the ground to avoid possible damage to the insulation. The shot firing cable shall be tested for continuity and possible short circuiting before it is used each time.

The shot firer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the Engineer.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole not less than 600 mm from the misfired hole and by exploding a new charge. The authorised shot firer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until atleast half an hour after firing.

When blasting is conducted in the neighborhood of roads, structures, buildings etc. controlled blasting has to be carried out by drilling shallow shot holes and filling the same with light charge of explosives.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.05.05 **Disposal**

The excavated spoils will be disposed of in any or all the following manners :

a) By using it for backfilling straightway.

b) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.

c) i) By either spreading, Or
ii) spreading and compacting at designated filling areas and / or disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in backfilling by some other agency.

The rate for excavation in soil should include the cost of filling and compaction in case (c) (ii). The rate for excavation in rock should include the cost of disposal as per (d).

3.05.06 **Disposal of Surplus**

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner and if the Contractor wants to use it, he shall have to obtain it from the Engineer at a mutually agreed rate for the same.

All sound rock and other assorted materials like excavated bricks, etc. shall be stacked separately and shall be measured in stacks deducting 30% volumetric measure for voids.

3.05.07 **Protection**

The Engineer shall be notified by the Contractor as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Engineer, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval and measurement by the Engineer. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Engineer.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.

The Contractor shall protect all under-ground services exposed by excavation. The Contractor shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean.

All the above works shall be carried out by the Contractor without any commercial implication to the Owner.

3.05.08 **Dealing with Surface Water**

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems at his own cost to drain surface water from working areas.

3.05.09 **Dewatering**

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rain water & subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. (except where such de-watering would need installation of well points or deep wells for which separate payment will be made) Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

If necessary, the Engineer may direct the Contractor to continue dewatering beyond his original or extended contract period in which case he will be paid separately for dewatering as per terms mentioned elsewhere under payment & measurement, provided the Contractor has completed all the work satisfactorily.

3.05.10 **Timber Shoring**

Timber Shoring made out of approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Engineer. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.05.10.1 **Close Timbering**

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 250x40 mm sections as directed by the Engineer. The boards shall generally be placed in position vertically in pairs, one board on each side of cutting, and shall be kept apart by horizontal

walers of strong wood at maximum 1.2 metres spacings, cross strutted with bellies or as directed by the Engineer. The length of the bally struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and preceded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.05.10.2 **Open Timbering**

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Engineer. In all other respects, specification for close timbering shall apply to open timbering.

3.06.00 **Treatment of Slips**

The Contractor will take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and back-filled later by him at his own expenses.

3.07.00 **Back-filling**

3.07.01 **General**

The material used for backfilling shall consist of material, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, the Engineer may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete.

3.07.02 **Filling and Compaction in Pits and Trenches around Structures**

As soon as the work in foundations has been accepted and measured, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to achieve a dry density of not less that 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) where backfilling with cohesive soil and sandy silt containing high percentage of Silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS-2720 part XIV. Earth shall be rammed with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and leveled to proper profile as shown in the drawing and as desired by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimise the moisture content.

3.07.03 **Plinth Filling**

The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted as stated under clause no. 3.7.2 with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.07.04 **Filling in Trenches for Water Pipes and Drains**

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. The types of bedding & pipe surround material shall be as specified in the drawings.

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of excavation of trenches in rock, the filling upto a depth of 300 mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel

shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and compacted.

3.07.05 **Filling in Disposal Area**

Surplus material from excavation which is not required for backfilling will be disposed of in designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas rollers will be employed and compaction done to the satisfaction of the Engineer at the optimum moisture content which shall be checked and controlled by the Contractor.

In certain cases the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

3.08.00 **Approaches and Fencing**

The Contractor should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.09.00 **Lighting**

Full scale area lighting is to be provided if night work is permitted or directed by the Engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.00.00 **TESTING AND ACCEPTANCE CRITERIA**

4.01.00 **Excavation**

On completion of excavation, the dimensions of the pits will be checked as per the drawings after the pits are completely dewatered the work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of 1:4:8 proportion and/or richer and/or by compacted earth, as directed by the Engineer, at the Contractor's cost. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer. Over excavation of the sides will be made good free of cost by the Contractor while carrying out the back-filling. The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.00 **Back-filling**

The degree of compaction shall be sufficient to achieve a dry density of not less than 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part-vii) or a relative density of 75% as per IS-2720 (Part-xiv) as applicable depending on the nature of back filling material as stated in clause no. 3.7.2 of this specification. The work of back-filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted along with the tender.

5.02.00 **After Award**

After award of the Contract the successful tenderer shall submit the following for approval and adoption :

a) Within 30 days of Award of the Contract, the Contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures. In case the Earthwork Contractor is also the agency for the foundation work, the Earthwork programme is to be connected with the foundation programme. The programme should also show how the excavation and back-filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Engineer for adoption.

TECHNICAL SPECIFICATION
FOR
V) CEMENT CONCRETE – PLAIN AND REINFORCED

CONTENTS

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V) CEMENT CONCRETE - PLAIN AND REINFORCED

1.00.00 **SCOPE**

1.01.00 **General**

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

1.02.00 This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in SCOPE of IS:456.

1.03.00 IS:456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate IS Code, specifications and/or replacement by any International Code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference.

2.00.00 **GENERAL**

2.01.00 **Work to be provided for by the Contractor**

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following :

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Except where it is excluded from the Scope of Contract, Contractor shall prepare progressively and submit for approval detailed drawings and Bar Bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval.

d) Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Submit for approval detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

f) Submit for approval detailed schemes of all operations required for executing the work, e.g. Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and submit for approval concrete mix designs required to be adopted on the job.

h) Furnish samples and submit for approval results of tests of various properties of the following :

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

I) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings, specifications and Schedule of Items.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 **Work by Others**

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 **Information to be submitted by the Tenderer**

2.03.01 **With Tender**

The following technical information are required with the tender :

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms, if any, with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 **After Award**

The following information and data including samples where necessary, shall be submitted by the Contractor progressively during the execution of the contract.

a) Programme of Execution and Requirement of Materials

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work giving monthwise requirements of materials, particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms and conditions of the Contract. In case the Contractor proposes to take on hire any machineries or tools and plants from the Owner, the detailed phased out programme of such hire is also to be submitted.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Approval of such programme shall bind the Contractor to adherence and assurance of their duties and responsibilities according to agreed schedule.

Detailed day to day programme of every month is to be submitted by the Contractor before the end of the previous month.

Contractor shall furnish daily/weekly progress of work and details as may be required by Owner so as to enable him to monitor the progress of work. The Contractor shall submit the progress photograph in three (3) copies every month relating to the progress of work in sequence for major activities.

b) Samples

Samples of the following materials and any other materials proposed to be used, shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities :

i) Coarse and fine aggregates.
ii) Admixtures.
iii) Plywood for Formwork.
iv) Embedded and anchorage materials as may be desired by the Engineer.
v) Joint sealing strips and other waterproofing materials.
vi) Joint filling compounds.
vii) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per Clauses 2.1 (g) & 3.4 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works. Before submission to the Engineer, the design mix needs to be approved from recognized institution.

d) Detail Drawings and Bar Bending Schedules

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.01(b) and 3.16.1 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01 (c).

f) Detailed Drawings for Templates & Temporary Supports for Embedments

As per Clause 2.01 (e).

g) Mill Test Reports for Cement & Reinforcing Steel

Mill Test Reports for Cement and Reinforcing Steel in case these materials are supplied by the Contractor.

h) Inspection Reports

Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Engineer in accordance with Clause 2.04 of this specification.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0 : SAMPLING & TESTING of this specification.

j) Any other data which may be required as per this specification.

2.04.00 **Conformity with Design**

The Contractor will prepare check lists in approved proforma which will be called 'Pour Cards'. These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the Engineer will give written permission on the same 'Pour Card' allowing the Contractor to commence placement of concrete. Details of

all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', will be prepared by the Contractor on approved proforma. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 **Materials to be used**

2.05.01 **General Requirement**

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

2.05.02 **Cement**

Generally cement shall be 43 grade / 53 grade ordinary Portland Cement conforming to IS-8112 / IS 12269. In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Engineer :

a) 33 Grade ordinary Portland Cement conforming to IS-269

b) Rapid hardening Portland Cement conforming to IS-8041

c) Portland slag cement conforming to IS-455

d) Portland Pozzolona Cement (fly ash based) Conforming to IS-1489 (Part-1)

e) Portland pozzolona Cement (calcined clay based) conforming to IS-1489 (Part-2)

f) Hydrophobic Cement conforming to IS-8043

g) Low heat Portland Cement conforming to IS : 12600

h) Sulphate Resisting Portland Cement conforming to IS-12330

2.05.03 **Aggregates**

Aggregates shall be natural or crushed gravel or crushed rock and free from deleterious material. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Engineer.

a) Coarse Aggregate

Aggregate of sizes ranging between 4.75mm & 150mm will be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS:383 will be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary.

The grading of coarse aggregates by sieve analysis shall be as per IS:383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Engineer may ask the contractor to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

b) Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS:383 is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used on works.

In certain cases there may be two types of sand, one very fine and the other very coarse. In such cases, the two types shall be combined to meet the requirements of a particular zone of IS:383. In all cases, the preferred zone is Zone-II.

In certain cases crushed stone sand may be added to natural sand in order to achieve the required grading.

Crushed stone sand alone may be used only with the approval of the Engineer.

2.05.04 **Water**

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS:3550 will be followed for routine tests. Acceptance test for water shall be as per IS:3025, and Table-I of IS:456.

In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time tests as per method of tests in accordance with the requirements of IS-516 & IS-4031 respectively. The PH value of water shall generally be not less than 6.

2.05.05 **Admixture**

Only admixture of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards :

IS : 2645 - Integral cement water proofing compound

IS : 9103 - Indian standard specification for Admixtures for Concrete

or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075, Part 1 to 3) and may be one of the following :

a) Accelerating admixtures :

Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10" or approved equivalent.

b) Retarding admixtures :

Modified ligno sulphonate based set retarding concrete admixture like, "Plastiment R" or approved equivalent.

c) Water reducing admixtures :

Modified sulphonated melamine formaldehyde based water reducing concrete admixture like, "Sikament" or approved equivalent.

d) Air entraining admixtures :

Modified ligno sulphonate based air entraining concrete admixture like "FLOMO AEP" or surface - active agents like "Sika AER" or approved equivalent.

e) Water proofing admixtures :

Modified lingo-sulphonate based waterproofing admixture like "Plastocrete Super" or approved equivalent.

However, the Contractor shall furnish following technical information about the admixtures (alongwith the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Engineer :

i) Type of admixture

ii) Mix proportion & mode of application in concrete/mortar

iii) Manufacturer's specification & necessary quality assurance certificates (mainly on chloride & sulphate content, PH value, infra red analysis & solid content).

2.05.06 **Reinforcement**

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stackwise) of all materials. Storage of materials shall conform to IS:4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated ware-houses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

Different types of cement shall be clearly marked with the type & different types of cement shall not be intermixed.

2.06.03 Aggregates

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

Grading of aggregate shall be checked by the Engineer in conformity with respective IS Code and the design requirement and if the same is found not meeting the above requirement the material will be replaced by the Contractor at his own cost.

2.06.04 **Reinforcement**

Reinforcing steel shall be stored consignment-wise and sizewise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease and distortions. If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 **Quality Control**

The Contractor shall submit the Quality Assurance Plan (QAP) for total work to the Owner/Engineer for approval and follow the approved plan during work execution. Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work :

a)	Admixture	:	Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits
b)	Aggregate	:	Physical, chemical & mineralogical qualities, Grading, moisture content and impurities.
c)	Water	:	Impurities tests.
d)	Cement	:	Tests to satisfy relevant IS Specifications (only association with Owner's tests, if the supply is made by Owner).
e)	Formwork	:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f)	Reinforcement	:	Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices. Material tests or certificates to satisfy relevant IS Spec. (If Contractor's supply).
g)	Grades of concrete	:	Usage & mix design, testing of all properties.
h)	Batching & Mixing	:	Types and capacity of plant, concrete mixers and transportation equipment.

i)	Joints	:	Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.
j)	Embedded and Anchorage Items	:	Material, shape, location, setting.
k)	Placing	:	Preparation, rate of pouring, the limitations, time intervals between mixing & placing and between two successive lifts, covering over dry or wet surfaces, cleaning & preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
l)	Compaction	:	Number of vibrators, their prime mover, frequency & amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
m)	Setting of base & Beaming plates	:	Lines, elevations and bedding mortar.
n)	Concrete Finishes	:	Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
o)	Curing	:	Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirts or other deleterious materials.

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.

However, all washing & screening of aggregates shall be carried out by approved means to ensure compliance with the aggregate specification.

3.02.00 **Admixture**

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures may be permitted to be used in accordance with IS:456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 **Grades of Concrete**

Concrete shall be in any of the grades designated in IS:456. Grade of concrete to be used in different parts of work shall be as shown on the drawing or as per the Engineer's instructions. In case of liquid retaining structures, IS:3370 will be followed.

3.04.00 **Proportioning and Works Control**

3.04.01 **General**

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Engineer.

a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.

b) Without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS:456, may be used if shown on drawings or approved by the Engineer. In all cases the proportioning of ingredients and works control shall be in accordance with IS:456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 **Mix Design Criteria**

Concrete mixes will be designed by the Contractor to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations :

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) Chemical admixtures may be used to modify the rate of hardening, to improve workability (maintaining low water - cement ratio) or as an aid to control concrete quality.

e) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Engineer. The Contractor will strictly abide by the same in his design of concrete mix installation.

Notwithstanding anything mentioned in various tables given in IS:456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, the following tables in the specification are included. For identical condition if values given in the tables shown herein below are different from those mentioned in IS:456, the values as indicated in the table shown herein below shall prevail.

Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

TABLE-I

STRENGTH REQUIREMENT OF CONCRETE

	Specified Characteristic Compressive Grade of concrete strength of 15 cm Cubes at 28 days conducted in accordance with IS:516 (All values in N/Sq.mm)
M-10	10
M-15	15
M-20	20
M-25	25
M-30	30
M-35	35
M-40	40

Note-1 : Nominal mix concrete of proportions 1:4:8 or 1:3:6 may be used as lean concrete for simple foundations for masonry walls, below the reinforced concrete foundations and mass filling. These mixes need not be designed.

Note-2 : Grades of concrete lower than M-20 shall not be used in reinforced concrete.

TABLE-II

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO

(FOR GUIDANCE)
CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/ CEMENT RATIO	RATIO BY WEIGHT OF CEMENT TO GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT TO CRUSHED STONE AGGREGATE	
		20 mm size	**38 mm size**	**20 mm size**	**38 mm size**
Very low Slump 0-25 mm	0.4	1:4.8	1:5.3	1:4.5	1:5.0
	0.5	1:7.2	1:7.7	1:6.5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low Slump 25-50 mm	0.4	1:3.9	1:4.5	1:3.5	1:4.0
	0.5	1:5.5	1:6.7	1:5.0	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7.0
	0.7	1:8.0	1:8.5	1:7.4	1:8.0
Medium Slump 50-100 mm	0.4	1:3.5	1:3.8	1:3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5.0
	0.6	1:6.0	1:7.3	1:5.2	1:6.2
High Slump 100-175 mm	0.4	1:3.2	1:3.5	1:2.9	1:3.3
	0.5	1:4.4	1:5.2	1:3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

NOTE-1 : Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

NOTE-2 : It should be noted that such high aggregate cement ratios will be required or concretes of very low slump and high water-cement ratios which may be required to be used in mass concrete work only.

NOTE-3 : The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.05.00 **Strength Requirements**

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland slag cement is used, shall be as per Table-2 of IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 **Minimum Cement Content**

The minimum cement content for each grade of concrete shall be as per strength and durability requirement conforming to IS 456 : 2000 and design mix criteria.

3.07.00 **Water-Cement Ratio**

The choice of water-cement ratio in designing a concrete mix will depend on

a) The requirement of strength.

b) The requirement of durability.

3.07.01 **Strength Requirement**

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give acceptable test results as per IS:456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS:456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS:456.

3.07.02 **Durability Requirement**

Tables 3,4 & 5 of IS:456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

However, water-cement ratio, from the point of view of durability as well as from strength consideration, should meet the requirement given in Table No. IV.

In general the water cement ratio between 0.4 & 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer.

However the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It will be preferable to use Melamine based plasticizer.

TABLE-IV

MAXIMUM PERMISSIBLE WATER/CEMENT RATIOS FROM DURABILITY CONSIDERATIONS FOR DIFFERENT TYPES OF STRUCTURES AND DEGREES OF EXPOSURE USING ORDINARY PORTLAND CEMENT

	Exposure Conditions			
Type of Structure	Severe wide range of temperature. Frequent alterations of freezing & thawing (use Airor arid Entrained concrete only)		Mild Temperature rarely below freezing or rainy	
	At the water line or within the range of fluctuating water level or spray		At the water line or within the range of fluctuating water level or spray.	
	In Air		**In Air**	
	In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)	In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)
Thin sections such as railings kerbs, sills ledges, ornamental or Architectural concrete reinforced concrete piles, pipes and all sections with less than 25mm concrete cover to reinforcement.	0.49 0.44	0.40	0.53 0.49	0.40
Moderate sections such as Retaining Walls, abutments, piers, girders, beams	0.53 0.49	0.40	* 0.53	0.44
Exterior portions of heavy mass sections.	0.58 0.49	0.44	* 0.53	0.44
Concrete deposited by Tremie under water	- 0.44	0.44	- 0.44	0.44

	Exposure Conditions			
	Severe wide range of temperature. Frequent alterations of freezing & thawing (use Airor arid Entrained concrete only)		Mild Temperature rarely below freezing or rainy	
Type of Structure	At the water line or within the range of fluctuating water level or spray		At the water line or within the range of fluctuating water level or spray.	
	In Air		**In Air**	
	In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)	In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)
Concrete slabs laid on ground	0.53 -	-	* -	-
Concrete which will later be protected by enclosure or backfill but which may be exposed to freezing & thawing for several years before such protection is offered.	0.53 -	-	*	
Concrete protected from the water, interiors of buildings, concrete below ground which is free from sulphate attacks.	*		*	

Note: * Water/Cement ratios should be selected on basis of strength & workability requirements.

3.08.00 **Workability**

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below :

TABLE-V

LIMITS OF CONSISTENCY

Degree of Workability	Slump in mm with Standard Cone as per IS:1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads and like
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion or reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note : Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS:1199 and Clause 7 of IS 456:2000 shall be carried out.

3.09.00 **Size of Coarse Aggregates**

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer :

Very narrow space	-	12 mm
Reinforced concrete except foundation	-	20/12 mm
Ordinary Plain concrete and Reinforced concrete foundations	-	40/20 mm
Mass concrete	-	80/40 mm
Mass concrete in very large structure	-	150/80 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles :

150 mm to 80 mm, 80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10.00 **Mixing of Concrete**

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Engineer for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS:4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS:1791 will be allowed to be employed.

Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Batchers conforming to IS:2722 may be used.

Batching plant conforming to IS:4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within ± 2% of the quantity of Cement, water or total aggregates being measured and within ± 5% of the quantity of any admixture being used. The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical/electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Engineer. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Engineer, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the Owner.

3.11.00 **Conveying Concrete**

Concrete shall be handled and conveyed from the place of mixing to the place of laying with required consistency and plasticity without loss of slump and as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, inspite of all precautions, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 **Placing and Compacting Concrete**

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces :

a) Earth foundation

b) Rock foundation

c) Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. All excavated areas for foundations, ring beams, plinths, pile caps etc. shall be rammed & consolidated properly before blinding with nominal mix plain concrete, as per drawing and / or direction of the Engineer and shall be allowed to cure prior to setting out steel fixing, shuttering and concrete pouring for the main structural element.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry will be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar will be deemed to be included in the unit rate of concrete.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS:4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS:2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The size of the concrete pours must be carefully considered prior to commencement to ensure the structural elements are poured in on continuous shift to avoid cold joints.

Slabs, beams and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Moulding, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation therefrom shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods & equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction. Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12. For water retaining structures and leak-proof buildings suitable approved water bars will be installed at the construction joints.

Where the location of the joints are not specified, it will be in accordance with the following :

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span.

c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it :

a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, the joint will be left to harden for at least 12-24 hrs. It will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under Cl. 3.12.

3.14.00 **Repairs, Finishes and Treatment of Concrete surfaces**

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner. All concrete work shall be inspected by the Contractor immediately after the forms are removed and he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations :

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth and shape.

c) Cleaning of reinforcement and embedments. It may be necessary to provide an anti-corrosive coating on the enforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out defective concrete.

i) Grouting with a cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortar.

k) Polymer modified patching and adhesive repair mortar for beams & columns.

3.14.02 **Finishing Unformed Surface**

The Contractor is to include in his quoted rate for concrete, the provision of normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc., as and where required by the Engineer without any extra cost to the Owner. A few typical and common cases of treatment of concrete surface are cited below :

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No overtrowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked without any extra cost to the Owner to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling by hand or by rotary power float is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the

approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 **Protection and Curing of Concrete**

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet , hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor.

If permitted by the Engineer, curing compound like "ANTISOLE (WP)" or approved equivalent may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost to the owner.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case any lapse on the part of the Contractor is noticed by the Engineer, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or pay for the part where adequate curing was noticed at a reduced rate, entirely at the discretion of the Engineer.

3.16.00 **Reinforcement**

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc., will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS:9077 , as shown on the drawing or as directed by the Engineer.

3.16.01 **Bar Bending Schedules**

The Contractor shall submit to the Engineer for approval Bar Bending Schedules with working drawings in triplicate, showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Contractor shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

3.16.02 **Cleaning**

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 **Cutting & Bending of Reinforcement**

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS:2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845 Deg.C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Engineer at exceptional cases.

3.16.04 **Placing in Position**

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire. Tack welding of bars should not be done unless permitted by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 **Welding**

Normal bond laps in reinforcement may be placed by lap or butt welding reinforcement bars, if asked by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS:2751 and IS:456. Welded mesh fabrics conforming to IS:1566 may also be used if specified in the Schedule of Items and Drawings.

3.16.06 **Control**

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS:456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 **Cold Weather Concreting**

When conditions are such that any operation of concreting may be expected to be done at 5 Deg.C atmospheric temperature or below the work shall conform to the requirement of Clause 14 of IS:456 and IS:7861. (Part. II).

3.18.00 **Hot Weather Concreting**

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS:7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40 Deg.C while placing. Positive temperature control by pre-cooling, post-cooling or any other method, if required, will be specified and paid for separately.

3.19.00 **Concreting under Water**

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14 of IS:456.

3.20.00 **Form Work**

3.20.01 **General**

Formwork shall conform to the shape, grade, lines, levels and dimension as shown on the drawings. The contractor shall prepare design & working drawings for formwork & temporary support system for important structures and get them approved by the Engineer prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load, in case the Contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits will be filled with expanding mortar to seal the void. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified free of charge as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, beveled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges without any extra charge. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 **Cleaning and Treatment of Forms**

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil based shutter release agent like "Separol/Sika form oil/ Separol Concentrate" or approved equivalent before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 **Design**

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

The design of formwork shall take into account all vertical and lateral loads that the forms will carry or be subjected to during the construction process. Besides weight and pressures of reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete; impact from dumping of concrete; movement of men and construction equipment; wind action and any other imposed load during construction. The contractor shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pourer of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sq.m excluding weight of concrete.

30.20.04 **Inspection of Forms**

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 **Removal of Forms**

Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if he so desires.

The Contractor shall record on the drawing or in any other approved Banner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed therefrom and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner. The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

Forms for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Engineer in each case.

TABLE-VI

SCHEDULE OF REMOVAL OF FORM

Part of Structure	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement Concrete			
	Temperature Deg.C				Temperature Deg.C			
	Above 40 Deg.	40 Deg.- 20 Deg.	20 Deg.-Below 5 Deg.		Above 40 Deg.	40 Deg.- 20 Deg.	20 Deg.- Below 5 Deg.	
	Days	Days	Days	Days	Days	Days	Days	Days
a) Columns & Walls	2	1	1	Do not remove	1	1	1	Do not remove
b) Beam sides	3	2	3	forms until site cured	2	1	1	forms until
c) Slabs, 125 mm	10	7	8	test speci-	7	4	5	site
d) Slabs over 125mm thick and sof-				men develop at least 50% of the speci-				cured test specimen develop
fit of minor beams	18	14	16	fied 28 days strength	12	8	9	at least 50% of the speci-
e) Soffit of main beams	24	21	22		14	10	12	fied 28 days strength

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40 Deg.C can be reduced to those of the temperature range of 20 Deg.C to 40 Deg.C subject to approval of the Engineer.

Construction joints in beams, if required to be provided, will be located within the middle third of span according to clause 3.13.1(b) of this specification. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Engineer.

If any type of cement other than ordinary Portland cement and Rapid hardening Portland cement is used the time of removal or forms shall be revised as approved by the Engineer such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form as mentioned above. This has to be supported by regular tests.

3.20.06 **Tolerance**

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Engineer :

For :	a)	Sectional dimension	-	$\pm$ 5 mm
	b)	Plumb	-	1 in 1000 of height
	c)	Levels	-	$\pm$ 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 **Re-use of Forms**

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified herein before. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 **Classification**

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Engineer :

a) Ordinary

These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) Plywood

These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-se may only be permitted after special inspection and approval by the Engineer. He may also permit utilisation of used plywood for the 'ordinary' class, if it is still in good condition.

c) Ornamental

These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 **Opening, Chases, Grooves, Rebates, Blockouts etc.**

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 **Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and Other misc. Embedded Fixtures**

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to be painted with one coat of approved anti-corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer, free of cost to the Owner.

Items to be embedded

a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be left embedded for future extension, special connection etc.

d) Lugs or plugs for door and window frames occurring in concrete work.

e) Flashing and jointing in concrete work.

f) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibre board of approved manufacturer as per IS:1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint Sealing Strips

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

Non-metallic sealing strips will be normally in Rubber or PVC Rubber or PVC joint seals can be of shape having any combination of the following features :

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer :

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75 Deg.C
Ultimate Elongation	:	Not less than 350%

b) P.V.C. Sealing Strips

The minimum thickness of P.V.C sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly :

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to 80A
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 **Joint Sealing Compound**

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS:1834.

Alternatively, when directed, the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

3.23.05 **Isolation Joints**

Strong and tough alkathene or PVC sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 **Rubber Pad**

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 **Grouting under Machinery or Structural Steel Bases**

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stonechips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If desired by the Engineer, admixtures like Aluminium powder, 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Engineer. Admixture, if directed to be added, will be measured and paid separately.

Alternatively non-shink, free flow, cementitious grout like "Sikagrout 214 / Ankor NSG" or approved equivalent specifically selected for the type of equipment to be located (vibrating, static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Engineer.

3.25.00 **Precast Concrete**

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly leveled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting & curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapour or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

All members shall be indelibly marked with a unique identification mark on a surface which will not be permanently exposed to show on which production line they were manufactured, their type, the class of concrete, the data of casting and if they are of a symmetrical section the face which will be uppermost when the member is in its correct position after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Engineer. If centerings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement : sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Waterproofing of concrete structures shall be done by either suitable extraneous treatments like applying waterproofing paints like "Sikatop Seal" or approved equivalent, fixing bitumen felts etc. or internally by suitable design of the concrete mix, addition of suitable admixtures conforming to IS:2645 and equivalent American or British codes in the concrete or mortar at the time of mixing and/or installing water bars at the joints.

The design, material and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be rubber or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint should be provided as per clause 3.13.1 with or without water bar / Seal as shown on the drawing. In case of water bars being used at the construction Joint, fixing of the same has to be done carefully so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods :

Method 1 : A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent will be mixed with water which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days :

Compressive strength	-	55 to 60 N/Sq. mm
Flexural Strength	-	25 to 30 N/Sq. mm.
Tensile strength	-	15 N/Sq. mm (approx.)
Bonding strength to concrete	-	3 N/Sq. mm (approx.)
Bonding strength to steel	-	20 N/Sq. mm (approx.)

The whole operation shall be done as per manufacturer's specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

Method 2 : One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 Kg/Sq cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%.

The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement but a lower dosage will always be preferred.

The product shall be stored in strong moisture proof packings.

However, in case of important structures where M25 or higher grade concrete is specified, a melamine based super plasiticizer will be preferable.

a) In concrete : The admixture shall be procured from reliable and reputed manufacturers and approved by the engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to the Owner to supervise the work, if desired by the Engineer.

b) In Plaster : The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost to the Owner. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Bituminous or Tar Coating on External Surface

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS:216 (not heated above 375 Deg.F) using not less than 2 Kg. per Sq.M or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400 Deg.F) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Engineer, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely. In place of hot application by coal tar / asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous emulsion/rubber protective coating of approved manufacturer.

3.26.05 Protective Coating on Inside Surface

Two coats or cement based to components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt : Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS:1322, and the workmanship to IS:1609. The bitumen felt shall be Hessian base and/or fibre base as specified in Drawing/Schedule of Items. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well known specialised firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. shall be included in the rate for this item. If any protective brickwork on/against concrete sub-bases or walls are required, these will be paid extra under suitable items in the contract. A 20 (twenty) years' guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this item of work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 **Polyethylene Films : Application in Walls or base of Structures**

Waterproof treatment shall be applied as outlined and as per sequence given hereunder :

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.

ii) apply hot bitumen 80/100 grade (IS:73-1961) at the rate of 1.0 Kg/Sq.m minimum.

iii) lay black polyethylene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.

v) Lay hot bitumen 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250 micron polyethylene film as second layer similar to (iii) above.

vii) Lay second layer of 100 gm brown craft paper laminated similar to (iv) above.

viii) Apply hot bitumen (straight run grade) to IS:73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

ix) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 **Protective coating on Concrete Surface**

3.27.01 **On Foundation**

The outside faces of foundation of important structures will be protected from adverse effect of soil/ underground water, if shown on drawing or instructed by the Engineer, by using rubber/bitumen emulsion protective coating of approved manufacturer.

3.28.00 **Waterproofing by Pressure / Chemical Grouting**

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non-shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. The pressure during injection shall not be less than 2.5 kg/Sq.cum and the thickness of epoxy resinous emulsion waterproof paint (to be applied on the external surface of walls/slabs) shall not be less than 700 microns.

4.00.00 **SAMPLING AND TESTING**

4.01.00 **General**

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 **Cement**

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Engineer. The tests shall be carried out free of charge by the Owner if cement is supplied by him. In case the Contractor is directed to arrange for the supply of cement as per the terms and conditions of the Contract the tests shall be carried out by him without any expense to the owner. In case due to any circumstances, the

agency of supply is changed in the middle of the Contract, the party who bore the original contractual obligation will carry on with the test, free of charge to the other, till the end of the job. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Owner, Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the Owner or the Contractor. These tests are of great importance as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 **Aggregates**

The Contractor shall carry out any or all the tests aggregates as may be required by the Engineer in accordance with IS:2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 **Water**

Sampling and Testing of water being used for concrete works as per IS:3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt will be as per IS:3025 & IS:456.

4.05.00 **Admixture**

4.05.01 **Air Entraining Agents (A.E.A)**

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor free of charge by carrying out sufficiently large number of tests. After than, at regular intervals and whenever directed by the Engineer, the Contractor will check up free of charge, the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 **Other Admixtures**

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Contractor free of charge to the Owner.

4.06.00 **Concrete**

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS:516 and IS:1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS:516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 15 of IS:456.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS:1199 and as mentioned in Clause 3.6 of this Specification shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 16 of IS:456.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to Clause 9.2.4 of IS:456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to Clause 16 of IS:456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 17 of IS:456.

5.04.00 Load Test

Load tests of structural members may be required by the Engineer, when the strength of test specimen results fall below the required strength, as per 'Load Test on Parts of Structures', Clause 17.6 of IS:456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Contractor free of cost to the Owner. Alternatively, if permitted under Statutory Regulations and at the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS:456.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 LIST OF IS : CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed :

IS : 73 - Indian Standard Specification for Paving Bitumen.

IS : 216 - Indian Standard Specification for Coal Tar Pitch.

IS : 269 - Indian Standard Specification for 33 grade Ordinary Portland Cement.

IS : 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.

IS : 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement - Part-1 & 2.

IS : 455 - Indian Standard Specification for Portland Slag Cement

IS : 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.

IS : 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures.

IS : 516 - Indian Standard Specification for Methods of Test for Strength of Concrete.

IS : 737 - Indian standard specification for wrought Aluminium and Aluminium Alloy sheet and strip for general Engineering purpose.

IS : 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete

IS : 1200 - Indian Standard Specification for Method of (Part-II) Measurement Cement Concrete Works.

IS : 1200 - Indian Standard Specification for Method of (Part-V) Measurement of Formwork.

IS : 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing.

IS : 1489 - Indian Standard Specification for Portland - Pozzolona Cement - Part 1 & 2.

IS : 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.

IS : 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts.

IS : 1786 - Indian Standard Specification for high strength deformed Bars & wires for Concrete Reinforcement.

IS : 1791 - Indian Standard Specification for Batch Type Concrete Mixers.

IS :1834 - Indian standard specification for hot applied sealing compound for joint in concrete.

IS : 2062 - Steel for general structural purpose.

IS : 2185 - Indian Standard Specification for Hollow and solid/ solid light wt. Cement Concrete Blocks - Part-1 & 2.

IS : 2210 - Indian Standard Specification for Design of Reinforced Concrete Shell Structures and Folded Plates.

IS : 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII.

IS : 2430 - Indian standard specification for method of sampling of Aggregate for concrete.

IS : 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement.

IS : 2505 - Indian Standard Specification for Concrete Vibrators Immersion Type.

IS : 2506 - Indian Standard Specification for Screed Board Concrete Vibrators.

IS : 2514	-	Indian Standard Specification for Concrete Vibrating tables.
IS : 2645	-	Integral Cement water proofing compound.
IS : 2722	-	Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type).
IS :2751	-	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.
IS : 2770	-	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete. Part-1 : Pull out Test.
IS : 3025	-	Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water & Waste Water - part-1 to 37.
IS : 3201	-	Indian Standard Specification for Design and Construction of Precast Concrete Trusses and purlins.
IS : 3370	-	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4.
IS : 3384	-	Indian standard specification for / Bitumen primer for use in waterproofing and Damp proofing.
IS : 3414	-	Code of practice for Design and Installation of joints in Buildings.
IS : 3550	-	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry.
IS : 3558	-	Code of Practice for use of Immersion Vibrators for Consolidating Concrete.
IS : 3696	-	Safety Code for Part-1 : Scaffolding and Part 2: Ladders.
IS : 3812	-	Indian Standard Specification for Fly Ash for Use as Pozzolone & Admixture.
IS : 4031	-	Indian Standard Specification for Method of Tests for Hydraulic Cement - Part-1 to 14.
IS : 4082	-	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site.
IS : 4090	-	Indian Standard Specification for Design of Reinforced Concrete Arches.
IS : 4634	-	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers.

IS : 4656	-	Indian Standard Specification for Form Vibrators for Concrete.
IS : 4925	-	Indian Standard Specification for Concrete Batching and Mixing Plant.
IS : 4926	-	Indian Standard Specification for Ready Mixed Concrete.
IS : 4990	-	Indian Standard Specification for Plywood for Concrete Shuttering work.
IS : 4991	-	Indian Standard Specification for Blast Resistant Design of Structure for Explosion above ground.
IS : 4995 (Part-I&II)	-	Indian Standard Specification for Design of Reinforced Concrete Bins for the Storage of Granular and Powdery Materials.
IS : 4998 (Part-I)	-	Indian Standard Specification for Design of Reinforced Concrete Chimneys.
IS : 5512	-	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials.
IS : 5513	-	Indian Standard Specification for Vicat Apparatus.
IS : 5515	-	Indian Standard Specification for Compaction Factor Apparatus.
IS : 5751	-	Indian Standard Specification for Precast Concrete Coping Blocks.
IS : 5816	-	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders.
IS : 5891	-	Indian Standard Specification for Hand Operated Concrete Mixers.
IS : 6452	-	Indian Standard Specification for High Alumina Cement for Structural Use.
IS : 6909	-	Indian Standard Specification for Supersulphated Cement.
IS : 6923	-	Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators.
IS : 6925	-	Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.
IS : 7242	-	Indian Standard Specification for Concrete Spreaders.

IS : 7246	-	Indian Standard Specification for Table Vibrators for Consolidating Concrete.
IS : 7251	-	Indian Standard Specification for Concrete Finishers.
IS : 7320	-	Indian Standard Specification for Concrete Slump Test Apparatus.
IS : 7861 (Part-I&II)	-	Indian Standard Specification for Recommended Practice for hot and cold Weather Concreting.
IS : 7969	-	Safety Code for Storage and Handling of Building Materials.
IS : 8041	-	Indian Standard Specification for Rapid Hardening Portland cement.
IS : 8043	-	Indian standard specification for hydrophobic cement.
IS : 8112	-	Indian Standard Specification for 43 grade ordinary Portland Cement.
IS : 8142	-	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance.
IS : 8989	-	Safety Code for Erection of Concrete Framed Structures.
IS:9013	-	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens.
IS : 9077	-	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction.
IS : 9103	-	Indian Standard Specification for Admixtures for Concrete.
IS: 9417	-	Recommendation for welding cold worked bars for reinforced concrete construction.
IS : 10262	-	Recommended Guideline for concrete Mix Design.
IS : 12269	-	Indian standard specification for 53 grade ordinary portland cement.
IS : 12330	-	Indian standard specification for sulphate resting portland cement.
IS : 12600	-	Indian standard specification for low heat portland cement.

TECHNICAL SPECIFICATION
FOR
VI) DRIVEN PRECAST CONCRETE PILES

CONTENTS

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VI) DRIVEN PRECAST CONCRETE PILE

1.00.00 SCOPE

This Specification deals with the requirements regarding materials, workmanship, casting, curing, handling, transportation and driving of precast concrete piles (both vertical and raker) and all related items of work like surveying, layout of piles, sand filling in holes (considering driving of precast piles into the ground using follower) after driving of the piles, lengthening of the piles, redriving of the piles, jetting, and load testing of the piles, etc.

IS:2911 (Part I/Sec.3) shall form a part of this Specification and shall be complied with unless they are at variance with the Specification where the latter will prevail.

2.00.00 GENERAL

2.01.00 Work to be Provided by the Contractor

Work to be provided for by the Contractor, unless otherwise specified, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, forms, templates, supports, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Prepare and submit for approval detailed drawings and bar bending schedules for reinforcement bars showing the positions and details of spacers, supports, etc.

c) Submit for approval detailed scheme of all operations required for executing the work e.g. Material handling, casting, curing, handling, transporting, driving, testing, services, approaches, sand filling of holes etc.

d) Design and submit for approval concrete mix designs required to be adopted for the job.

e) Furnish samples and submit for approval results of tests for various properties e.g. various ingredients of concrete, concrete cubes etc.

f) Supply and install the pile shoes made of chilled cast iron of approved design.

g) Supply and paint Bitumen coating, if required, on the outer surfaces of the piles prior to their driving, as per schedule of items.

h) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings, specifications and schedule of items.

2.02.00 **Work to be Provided by Others**

No work under this specification shall be provided by any agency other than the Contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 **Codes and Standards**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practices.

IS-269	:	I.S. Specification for ordinary, and Low Heat Portland Cement.
IS-383	:	I.S. Specification for Coarse and Fine Aggregates from Natural Source for concrete.
IS-432	:	I.S. Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for Concrete Reinforcement.
IS-456	:	I.S. Code of Practice for Plain and Reinforced Concrete.
IS-516	:	I.S. Specification for Methods of Test for Strength of Concrete.
IS-1199	:	I.S. Specification for Methods of Sampling and Analysis of Concrete
IS-1786	:	I.S. Specification for Cold-twisted Steel Bars for Concrete reinforcement.
IS-2386	:	I.S. Specification for Methods of Test for Aggregates for Concrete - Part - I to VIII.
IS-2502	:	Codes of Practice for Bending and Fixing of Bars for concrete Reinforcement.
IS-2751	:	Code of practice for welding of mild steel bars used for Reinforced concrete construction.
IS-2911 (Part-I/ Sec.3)	:	Code of practice for Design and Construction of Pile Foundations. Driven Precast Concrete Piles.
IS:2911 (Part-IV)	:	Code of Practice for Design and Construction of Pile Foundations - Load Test of Piles.
IS:3558	:	Code of Practice for use of immersion Vibrators for Consolidating Concrete.

IS-6999	:	I.S. Specifications for super-sulphated cement.
IS-8112	:	I.S. Specification for high strength Ordinary Portland Cement.
IS : 12269	:	Indian standard specification for 53 grade ordinary portland cement

2.04.00 **Conformity with Design**

The Contractor will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the Engineer, the work will be checked and approved by the Engineer for Correctness and conformity with the design, Specifications and drawings, before allowing the next phase of the work to commence. The intermediate checks and approval by the Engineer will not, however, absolve the Contractor from his total responsibility to execute the work as per the specification and drawings and remove and/or rectify all work which is defective or inaccurate.

2.05.00 **Materials**

2.05.01 **Cement**

Cement used shall conform to IS:8112 or IS 12269.

2.05.02 **Aggregates**

Aggregates both fine and coarse shall comply with requirements of IS:383. Size of coarse aggregates shall be selected considering the size of section. Generally 20 mm down coarse aggregate shall be used.

2.05.33 **Steel**

Reinforcement Steel shall conform to IS:432 (Part-I) and IS:1786.

2.05.04 **Concrete**

Controlled concrete grade M25 (minimum) shall be used for the piles, unless specified otherwise in the schedule of items. Water/cement ratio including water contained in aggregates shall not be more than 0.45. However, minimum cement content and corresponding W/c ratio shall be determined by trial mix design and as approved by the Engineer. Materials and methods of manufacture of concrete shall be in accordance with IS:456. In addition, the materials shall have special resistance against sulphate attack where subsoil conditions warrant it.

2.05.05 **Water**

Clear water, free from acids and other impurities, shall be used for the manufacture of concrete. Normally potable water is found to be suitable.

2.06.00 **Storage of Materials**

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer shall not be used, failing which, the Engineer shall be at liberty to get the materials removed and the cost increased thereof shall be realised from the Contractor's dues.

2.07.00 **Quality Control**

The Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The requirements will include but not be limited to the following :

a) Casting of piles

b) Inspections of piles

c) Location and Plumb : Control survey for accuracy in plan and check for verticality.

d) Driving : Correlation of weight of hammer, length of stroke, number of strokes per minute and rate of penetrations.

e) Load tests.

3.00.00 **INSTALLATION**

All installation requirements shall be in accordance with IS:2911 (Part-I/ Sec. 3) latest edition and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all this aspects to the full satisfaction of the Engineer.

3.01.00 **General**

The tenderer shall furnish complete information about the type of piles offered, method of driving of piles, details and availabilities of driving equipment, formula or data curve on which the tenderer bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient `founding' of individual piles and any other relevant details.

The Contractor shall acquaint himself fully about the nature of the soil encountered from bore hole logs or any other data as available with the owner. All piles will have to be driven to the required set and/or based on load tests, as decided by the Engineer. In case the Contractor is required to drive piles to greater or shallower depths than that is envisaged the rates will be adjusted as per relevant items in Schedule of Items and no other extra claims

will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bore holes if he feels it necessary to assess the type of equipment to be used and the depths to which the piles may have to be driven finally.

3.02.00 **Casting and Curing**

Precast concrete piles shall be square with chamfered edges. (25mm x 25mm) and conical bottom. The top edges of all piles shall also be chamfered (25mm x 25mm).

Before placing in moulds, the steel skeletons shall be accurately fabricated and assembled away from the moulds, complete with metal shoe if specified, accurately fitted so that the point is truly on the axis of the pile.

Care shall be taken to ensure that the binders are perfectly tight and main reinforcements straight and true. Spacer fork of approved design are to be inserted throughout and spacing shall not be more than 1.5 m apart.

Longitudinal bars shall be in one length. In cases where laps in reinforcement bars cannot be avoided, the bars shall be staggered. Welded joints in reinforcement may be used with prior approval of the Engineer. Welding of reinforcements shall be done in accordance with the recommendations of relevant IS Code of practice. The cages shall be rigidly fixed straight and parallel to the moulds and held correctly as to maintain cover by spacer blocks. Care shall be taken to ensure correct and uniform cover throughout.

Formwork to be used for casting of the piles must be strong and level so that the outer faces of the piles are smooth and free from undulations. The prefabricated steel formwork with proper fasteners shall be used. Deformed and out of alignment formwork will be rejected.

The Casting Yard shall be so located that the piles can be lifted directly from their beds and transported to the piling frame with a minimum of handling. The casting yard should have a well drained surface to prevent excessive uneven settlement due to softening of soil during manufacturing and curing. The contractor shall submit layout drawing of the casting yard to the Engineer for approval prior to its construction.

Each pile shall be cast in continuous operation from end to end. The concrete shall be thoroughly compacted against the forms and around the reinforcement by means of immersion and/or shutter vibrators. Care shall be taken to ensure that the heads of the piles are formed plane and square to the axis. Particular attention must be paid to compaction at head and toe having regard to the more closely spaced reinforcement and the need for the densest possible concrete.

Immediately on completion of the casting the top surface shall be finished level without excess trowelling. Care shall be taken to ensure that vibration from adjacent work does not affect the previously placed concrete for piles during the setting period.

Side shutters shall be stripped off only after 24 hours of concreting. The piles shall be kept continuously wet for at least 7 days and protected from rapid drying by sheltering them from the wind and direct sunlight by covering the stacks.

3.03.00 **Storing and Handling**

Storage area shall be of firm ground free from liability to unequal subsidence or settlement under weight of the stack of piles. The piles shall be placed on timber supports which are truly level and spaced so as to avoid undue bending in the piles. The supports shall be vertically one above the other. Space shall be left round the piles to enable them to be lifted without difficulty. The order of stacking shall be such that the older piles can be withdrawn for driving without disturbing the new piles.

Great care shall be taken at all stages of transporting, lifting and handling of the piles that they are not damaged and cracked. Piles shall be lifted only by means of bolts or shackles inserted through the lifting holes provided and in no other way. Any pile damaged in handling shall be replaced free of charge by the Contractor.

All lifting and toggle holes shall be formed by casting in pieces of steel pipe for the full length of the concrete section. In places where lifting holes have not been provided in the piles, the points of lifting shall be clearly marked on the surface of the pile over at least half the perimeter. If the piles are put down temporarily after being lifted, they shall be placed on trestles or blocks located at lifting points. Lifting shall be by two points i.e. at 1/5th length of pile from either end so as to keep the handling stress minimum. Single point lifting is not permitted.

Piles must not be taken for driving before 28 days have passed after casting.

3.04.00 **Driving**

The proposed arrangement for driving, the equipment and accessories shall be to the approval of the Engineer.

The equipment and accessories are to be selected considering the hardness of driving, the capacity suitable for the size and weight of the pile to be handled. Piles may be driven with any type of hammer provided they penetrate to the prescribed depth or attain the specific resistance without being damaged. A hammer may be 'single acting' or 'double acting'. The hammer, dolly, helmet and the pile should be co-axial and sit squarely one upon the other. For a single acting or drop hammer, the fall should be limited to 1.2m, preferably 1m.

The head of precast concrete piles shall be protected with packing of resilient material, evenly spread and held securely in place. A helmet should be placed over the packing and provided with dolly of hardwood or equivalent not thicker than the width of pile.

Any sudden change in rate of penetration which cannot be explained due to normal change of nature of the ground should be noted and the cause ascertained before driving is continued.

Jetting may be used in case of sand, gravel and fine grained soils provided percentage of clay is small, after approval of the Engineer, as a means of minimizing the to resistance and skin resistance along the pile shaft. Jetting shall not be used in case of clay soils. The pressure of jetting should be from 6 Kg./Sq.cm. to 10 Kg./Sq.cm. Proper arrangement shall be made for taking away water that emerge at the ground so that the stability of the piling equipment is not endangered by softening of the ground. Special care should be taken to ensure that pile penetrates vertically.

Jetting shall be stopped prior to completing the driving which should always be made by ordinary methods. Jetting shall also be stopped if there is any tendency of the pile tip to be drawn towards the piles already driven owing to disturbance of the ground.

Piles should be installed as accurately as possible as per the drawings. As a guide, for vertical piles a deviation 1.5% and for raker piles a deviation of 4% shall not be exceeded. Piles shall not deviate more than 75 mm from their designed position. Spacing of the piles shall be as per the drawings.

In case of piles deviating beyond these limits, the piles shall be replaced or, supplemented by one or more piles as instructed by the Engineer at no extra cost to the owner.

In a group the sequence of installation shall be from the centre to the periphery of the group or from one side to the other, such that the carrying capacity of previously installed pile is not reduced. The driving shall not cause appreciable upheaval of the ground or cause unusual soil resistance to rest of the pile driving. It shall be ensured that soil is not flowing out literally during driving operation.

Set criteria shall be same as those used when the sets of test piles were obtained under identical driving conditions.

3.05.00 **Stripping of Pile Heads**

If specified in the schedule of items the concrete shall be stripped to the cut-off levels shown on the drawings. Reinforcements shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap. All concrete and cement shall be removed from the bars which shall also be wire brushed to remove any loose rust, dirt and scale. Any cracked or defective concrete shall be cut away and made good with new concrete properly bonded to the old concrete.

3.06.00 **Lengthening of Piles**

Length of individual piece of precast pile is generally restricted from handling point of view. Considering the required total length of pile and the length of individual piece as mentioned above, the contractor shall develop standard

splicing detail using studs, dowels, keys etc. at the spliced end of the piles and get it approved by the Engineer. The splice shall be as strong as the pile segments.

If due to unforeseen site conditions over and above the preplanned splicing mentioned above, further lengthening of pile is required during driving the longitudinal reinforcement shall be exposed by stripping of head and jointed properly either by welding or lapping as directed by the Engineer. The exposed surface of the concrete shall be hacked to form a key, brushed to remove loose material and covered with 25 mm thick cement mortar (1:2 mix) immediately before the new concrete is placed.

3.07.00 **Risen Piles**

In places where the piles may rise due to ground heaving, levels of the tops of the piles should be measured at interval while nearby piles are being installed. Piles which have risen as a result of driving adjacent piles should be redriven to the original depth as per the direction of the Engineer.

3.08.00 **Defective Piles**

Defective piles shall be removed or left in place without affecting performance of the adjacent piles as per direction of the Engineer. Additional piles shall be provided by the Contractor free of charge.

3.09.00 **Idle Period**

The phasing of construction and movement of plant shall be done as desired by the Engineer. The phasing may involve some extra movement of the plant or some idle period, but the Contractor will not be entitled for any claim due to this reason.

During the actual testing of the piles, the Contractor's plant and personnel may remain temporarily idle. Again, during the period of redesign, if any, (based on the pile test results), the plant personnel of the contractor may remain idle for any reason whatsoever.

For such idle periods mentioned above, the Contractor will not be entitled to any claim and rates quoted by him shall include the same. However, during the testing of piles and other hold ups, pile driving operation may be allowed on other piles wherever possible, if decided by the engineer with a view to minimise idle times.

If due to change in loading, elevations or any other alteration, some amendments become necessary in the design of foundations, the Contractor shall not be entitled to any claim whatsoever for such amendments in the pile layout during the progress of work including claims for any idle labour or tools and plant on this account.

3.10.00 **Test Pile**

The Contractor may have to construct test piles, if desired by the Engineer, before he starts systematic piling operation at locations indicated. For this

purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Load test on such piles shall be as per the provisions under "Procedure for Initial Load Test" in IS:2911.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

The Contractor shall carry out all sampling and testing for the components of reinforced concrete in accordance with the relevant Indian Standards at his own cost unless otherwise specified in the Contract. Whenever directed, the Contractor shall get the specimens tested in a laboratory approved by the engineer and submit to the Engineer the test results in triplicate within three (3) days of completion of the test.

Initial tests and/or routine tests as indicated in the Schedule of Items or as directed by the Engineer shall be carried out on single pile or pile groups to ascertain the capacities of the piles and their behaviour.

Any or all of the following tests shall be carried out as indicated in the Schedule of Items and as directed by the Engineer.

a) Vertical load test on pile (Compression)

b) Lateral load test on pile

c) Pull out test on pile

All the above tests are to be performed as per requirements of IS:2911 (Part-IV) - latest revision and as supplemented herein.

4.02.00 Static Load Test on Working Piles

In order to determine the carrying capacity of piles, static load tests shall be undertaken by the Contractor on single pile or pile groups, as indicated on drawings. Before any load test is made, the proposed arrangement of the structure, dead load to be used in making the load test, and method of application of load to the pile shall have to be approved by the Engineer. All load tests shall be made under the supervision of the Engineer. All responsibilities for conducting the test safely and properly lie with the Contractor.

The test load to be applied on pile or piles shall be one and a half times the proposed load value of the pile or piles as claimed by the Contractor. The test load shall be applied in 6 increments equal to one fourth, half, three fourth, one, one and one fourth and one and one half times the proposed working load. Readings of settlements and rebounds shall be referred to a constant elevation bench mark and shall be recorded with the help of three dial gauges of 0.02 mm sensitivity each positioned at equal distance around the pile. Each stage of loading, except the final test load of one and one half times the working load, shall be maintained till the rate of movement of the pile top is not more than 0.02 mm per hour. The final test load shall be maintained for

24 hours and hourly readings of settlements are to be recorded. The total test load shall be removed in decrements not exceeding 1/5 of the total test load with intervals of not less than one hour. The rebounds shall be recorded after each decrement is effected and the final rebound shall be recorded 24 hours after the entire test load has been removed. A complete record in triplicate shall be filed with the Engineer on the loads and readings obtained duly verified and countersigned by the Engineer.

The tested piles shall be used as usual foundation piles if they satisfy the acceptance criteria and no extra payment shall be made except for load tests on the piles.

If so desired by the Engineer, special test caps may have to be cast and subsequently dismantled at no extra cost.

4.03.00 **Acceptance Criteria**

The piles shall be accepted as satisfactory only when the work has been executed in order with this Specification to the satisfaction of the engineer and satisfy the following requirements :

a) Deviations shall be within the prescribed limit of tolerance specified in this specification.

b) Results of the load tests satisfy the specification and IS Code requirements.

4.04.00 **Recording Data**

The Contractor shall maintain a separate register, signed jointly by him and the Engineer, giving the following information during installation of the piles:

a) The sequence of installation of piles in each group with dates of starting and completion

b) The dimensions of the pile including the reinforcement details of the piles

c) The depth driven

d) The final set for the last ten blows or as may be specified by the Engineer

e) Cut-off levels

f) The type and size of hammer and its stroke, or with double acting hammers, the number of blows per minute

g) The type and condition of the packing on the pile head and the dolly in the helmet; and

h) Any other important observation

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The tenderer shall submit the following information along with his tender.

5.01.01 Programme of Construction

The tenderer will submit the details of the method of construction and the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and possible delays due to modifications of design should be drawn up and submitted along with the tender, keeping in view the completion dates stipulated in the tender.

5.02.00 After Award

After award of the contract, the successful tenderer is to submit the following details.

5.02.01 Execution Plan

Within 15 days of the receiving the Letter of Intent the Contractor will submit 6 (six) copies of drawings showing the sequence of driving. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the Engineer.

5.02.02 Detailed Construction Programme

Within 30 (thirty) days of the award of contract, a detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the Engineer, incorporating the various factors which have caused or are likely to cause changes in the programme.

5.02.03 Requirement of Materials, Tools and Plants and Equipment

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the Owner is to supply or is to help in procurement as per the terms and conditions of the Contract, is to be submitted within 30 (thirty) days of the contract.

5.02.04 Test Results

The test data and result for the various ingredients of R.C.C., concrete cubes and cylinders, driving of the pile, static load test on single piles and group will be submitted regularly and as and when directed by the Engineer.

TECHNICAL SPECIFICATION
FOR
VII) DRIVEN CAST IN SITU CONCRETE PILES

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VII) DRIVEN CAST-IN-SITU CONCRETE PILES

1.00.00 SCOPE

This specification covers driven reinforced cement concrete cast in situ piles including movement of pile driving equipment as per drawings as made available from time to time, and all related items of work like sand filling in the holes left after casting the piles, testing the load bearing capacity of individual piles and group of piles, etc. The relevant clauses of the "Technical Specification for Cement Concrete (Plain or Reinforced)" appearing in this document elsewhere, fall within the Scope of this Specification.

IS : 2911 (Part-I/Sec-2) shall form a part of this specification and shall be complied with unless they are at variance with the specification where the latter will prevail.

Other items of work like, excavation, casting pile caps, beams etc. which in most cases, will be required to be executed in connection with piling, will fall under the Scope of other relevant sections of the Technical Specifications which appear separately in this document.

2.00.00 GENERAL

2.01.00 Work to be provided by the Contractor

The work to be provided for by the Contractor, unless otherwise specified, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment, tools, plants, transportation etc. required for the supply and installation of piles of desired capacity.

b) Mark the proposed sequence of driving on six (6) copies of identification plan. The identification plan will be prepared by the Contractor as per the basic plan furnished by the Engineer, if so desired by him.

c) Furnish detailed drawings in six (6) copies of the pile driving equipment giving all salient dimensions and loads.

d) Submit detailed daily report of pile driving incorporating information as required by the Engineer.

e) Carry out load tests to the satisfaction of the Engineer including casting and dismantling of test caps if necessary and submit the test results in approved proforma.

f) Make necessary earthwork and approaches for movement of the pile driving rig.

g) Provide all necessary work mentioned under the "Technical Specification for Cement Concrete (Plain or Reinforced)", as may be applicable.

2.02.00 **Work to be provided by others**

No work under this Specification will be provided by any agency other than the Contractor unless specifically mentioned otherwise elsewhere in the Contract.

2.03.00 **Codes and Standard**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standards Specifications and codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other Standard Practice as may be specified by the Engineer shall be followed :

IS : 269 Indian standard Specifications for 33 Grade ordinary Portland Cement.

IS : 383 Indian Standard Specifications for Coarse and fine Aggregates from Natural sources for concrete.

IS : 432 I.S. specification for Mild Steel and Medium (Part-I) Tensile Steel Bars and Hard Drawn Steel Wire for Concrete Reinforcement : Part I Mild Steel and Medium Tensile Steel Bars.

IS : 455 Indian Standard Specification for Portland Slag Cement.

IS : 456 Code of Practice for Plain and Reinforced concrete.

IS : 516 Indian Standard Specification for Methods of test for Strength of concrete.

IS:1199 Indian Standard Specification for Method of sampling and Analysis of Concrete.

IS:1786 Indian standard Specification for Cold worked steel High strength Deformed Steel Bars and Wires for Concrete Reinforcement.

IS : 2502 Code of practice for bending & Fixing of Bars for Concrete Reinforcement.

IS: 2722 Indian Standard Specification for Portable Swing Weight Batches for Concrete (Single and Double Bucket Type).

IS : 2751 Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.

IS :2911 Code of Practice for Design and (Part-I/Construction of Pile Foundations - Driven Sec-2)Cast-in-situ Concrete Piles.

IS : 2911 Code of Practice for Design and Construction (Part-IV) of Pile Foundations - Load Test on Piles.

IS : 4926 Indian Standards Specification for Ready Mixed Concrete.

IS : 5121 Safety Code for Piling and other Deep Foundations.

IS : 8112 I.S. Specification for 43 grade Ordinary Portland Cement.

IS : 12269 I. S. Specification for 53 grade ordinary portland cement

2.04.00 **Conformity with Design**

The Contractor will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the Engineer, the work will be checked and approved by the Engineer for correctness and conformity with the design, specifications and drawings, before allowing the next phase of the work to commence. The intermediate checks and approvals by the Engineer will not, however, absolve the Contractor from his total responsibility to execute the work as per the specification and drawings and to remove and/or rectify all work which is defective or inaccurate.

2.05.00 **Materials**

2.05.01 **General**

All materials whether incorporated in the works or used temporarily as aids or for executing enabling works will be of best approved quality conforming to the latest Indian Standard Specification.

2.05.02 **Pile Shoes and Shells**

Piles shoes, where used, should be manufactured out of best quality cast Iron or Steel with proper treatment, the composition and thickness of the materials being of special importance where they are likely to be in contact with harmful chemicals and organic materials causing deterioration in service. The shell tubes which are to be left in place should also receive similar consideration in selection.

2.05.03 **Cement**

Cement used shall conform to IS : 8112 or IS : 12269 (Portland Cement.

2.05.04 **Aggregates**

Aggregates both fine and coarse shall comply with the requirements of IS : 383. Size of coarse aggregates shall be selected considering the size of the section. Generally, 20 mm down coarse aggregates shall be used.

2.05.05 **Steel**

Reinforcement steel shall conform to IS : 432 (Part - I) (Mild Steel plain bars) or IS : 1786 (High yield strength deformed bars).

2.06.00 **Storage of Materials**

2.06.01 **General**

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer shall not be used, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The relevant clauses pertaining to storage of material under "Technical Specification for Cement Concrete (Plain & Reinforced)" will apply.

2.06.02 **Cast Iron or Steel Shoes and Shells**

All cast iron or steel shoes and shells will be painted with two coats of anticorrosive paint or smeared with protective layer of grease and kept stored in weatherproof sheds, off the ground, on sturdy racks in such a manner as to enable quick and easy inspection.

2.07.00 **Quality Control**

The Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The Quality Control requirements stipulated under the "Technical Specifications for Cement Concrete (Plain and Reinforced)" will apply wherever relevant. In addition, the requirements will include but not be limited to the following :

a) Location and Plumb : Control survey for accuracy in planned check for verticality.

b) Driving : Correlation of wt. of hammer, length of stroke, number of strokes per minute and rate of penetration.

c) Casting of Piles : Check inside casing, reinforcement cage, concrete mix, placing, consolidation and curing.

d) Inspection of Pile

e) Load Tests

2.07.01 **Non-conformance**

Any work which fails to conform to the specification will be subject to the issue of a non-conformance report in line with the quality control procedures to be implemented at site. Corrective or remedial action, design modification or product rejection will be reviewed in accordance with site quality plan.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:2911 (Part I) and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all the aspects to the full satisfaction of the Engineer.

3.01.00 General

The Tenderer shall furnish complete information about the type of piles offered with sketches of pile sections showing reinforcement, method of driving the piles, details and availability of driving equipment, formula or data curve on which the Tenderer bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient 'founding' of individual piles and any other relevant details.

The Tenderer will be supplied with bore hole logs or any other data indicating the nature of the soil expected to be encountered. The information furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the Contract. All piles will have to be driven to the required set and/or based on load tests, as decided by the Engineer. In case the Contractor is required to drive piles to greater or shallower depths than that is envisaged the rates will be adjusted as per relevant items in the Schedule of Items and no other extra claims will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bore holes if he feels it necessary to assess the type of equipment to be used and the depths to which the piles may have to be driven finally.

3.02.00 Type of Pile

All piles shall be adequately reinforced cast in situ concrete piles driven as specified on the drawing/s. The reinforcement and diameters of piles should be exactly as indicated in the drawing and specification. Only cast in situ piles with complete reinforcement for the total length and casing driven to total depth required for pouring controlled concrete mixture shall be accepted.

3.03.00 Identification of Piles

A plan, in triplicate, showing clearly the designation of all piles by an identifying system shall be filed with the Engineer before installation of piles is started if so desired by the Engineer.

3.04.00 Sequence of Construction

The piles shall be installed in such a sequence that the carrying capacity of previously installed pile is not reduced. The driving shall not cause appreciable upheaval of the ground or cause unusual soil resistance to rest of the pile driving. It shall be ensured that the soil is not flowing out laterally during driving operation. The Engineer shall decide on the sequence of the groups of piles and the Contractor shall have to follow this sequence.

3.05.00 **Driving of Piles**

Piles shall be installed with due consideration to the adjacent structures and by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance. Equipment and the method of driving the pile shall be such that the pile is installed in its proper position and alignment. The pile shall not be out of plumb by more than 2% of the pile length. If any pile goes out of plumb by more than 2% of the pile length, the design of the foundation shall have to be modified in a manner approved by the Engineer to support the resulting vertical and lateral forces properly. The cost of modification, however, has to be borne by the Contractor at no extra cost to the Owner. A maximum positional deviation of 7.5 cm at the cut off level from the designed location of pile may be permitted, beyond which modification in the design shall become necessary.

Jetting shall not be done except when permitted in writing by the Engineer. The driving shall start from the existing ground level. After completion of driving, concrete shall be placed and compacted to fill up the hole left by the driving up to 300 mm above the cut of level. The balance depth between the G.L. and the top of concrete shall be filled up with sand so that the next pile does not move out of place during construction. To construct the pile cap, the ground will be excavated to expose the top portion of the piles, which will be dismantled neatly upto the cut off level removing all cracked, loose and unsound concrete. the top surface of the piles will be kept rough to ensure bond with the pile cap in which they will be ultimately embedded. The reinforcement rods of the pile should project out of the top by at least the value of bond length for the bar depending on its diameter and grade of concrete in pile cap. This length of bar will be later on bent and embedded in the pile cap concrete.

During the process of driving, should an obstruction be encountered, through which piling tube can not penetrate, the Contractor shall be compensated for the cost of removal of such obstruction at actual cost plus 20%.

Liquefaction of soil or localised compaction of soil due to driving of piles, if occurring, may create conditions when determination of load bearing capacity by the usual method of 'set' sometimes gives erroneous results. The pile, in such cases, shall be driven to the set desired or the desired strata based on the experience gained on the various load tests as desired by the Engineer.

The Contractor shall ensure that any green concrete in the nearby piles or any pile loaded in testing operation is not disturbed by driving the tube adjacent to it.

3.06.00 **Concrete in Pile**

This shall conform to the requirements of "Technical Specification for Cement Concrete (plain and reinforced)" enclosed herewith, to the extent it has been referred to or as applicable to this Specification. The concrete shall be of controlled grade and approved quality M 25 (minimum). The stipulation laid down in IS:2911 (Part I), regarding selection of mix shall be generally followed unless otherwise specified by the Engineer.

Concreting shall start as soon as possible after the hole is completed. Concrete shall be so placed as to fill the entire volume of the hole without segregate and formation of voids caused by faulty consolidation or entrapped air. The volume of concrete placed shall be observed in the initially cast piles and the average figure obtained shall be used to check whether there is undue deviation in concrete consumption for the subsequent piles.

Where the concrete is cast in place in a tube, its consistency shall be suitable to the method of compaction employed in the formation of piles. If necessary, concrete shall be as dry as possible to minimise shrinkage and to minimise the possibility of cement being washed down by flow of subsoil water while casing is withdrawn. Care shall be taken against segregation of concrete while passing the reinforcement cage, and against inflow of soil and water during withdrawal of the tube by maintaining sufficient head of concrete inside the tube. The extraction of casing shall not cause any shearing or necking of the poured concrete thereby reducing the capacity of piles.

The method of concreting shall strictly conform to the above specification and no deviation shall be allowed.

As mentioned in Section 3.5, concreting of the pile shall have to be done at least 300 mm above the cut off level of the pile. The remaining part of the hollow formed by the withdrawal of driving tube from ground down to the top of the concreted pile shall be filled up with sand.

3.06.01 Trimming of Pile Heads

Completed piles shall be trimmed to the cut-off levels shown on the drawings or until sound concrete is found. In the event of trimming being carried below the cut-off level, the pile shall be made up to the correct cut-off level, with concrete of the same quality as used in the piles at the contractor's expense. A 'non-conformance' will be raised in such circumstances. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap as per drawing. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose rust, dirt and scale.

3.06.02 Lengthening of Piles

Where it is necessary to increase the length of any pile after it has been installed, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be chiselled to form a key brushed to remove loose material and covered with 25 mm thick cement mortar (1 : 2 mix) immediately before the new concrete is placed.

3.07.00 Reinforcement in Piles

Steel Reinforcement conforming to IS:432, IS:1139 or IS:1786 grade suitable for reinforced cement concrete for general building work shall be applicable for the specification to the extent it has been referred to or applicable.

Pile has to be reinforced throughout its length. In spite of different methods of driving, concreting, etc. of different types of cast-in-situ driven piles, the minimum area of longitudinal reinforcement within the pile shaft shall be 0.4 percent of the sectional area calculated on the basis of outside diameter of the casing of the shaft when mild steel plain bars conforming to IS : 432 Grade I are used. For other grades of steel noted above, the area of reinforcement may be adjusted suitably, but in no case shall the number of vertical reinforcing bars be less than six and the bar diameter less than 16 mm. The minimum diameter of the links or spirals shall be 6 mm and their spacing shall not be less than 150mm. In addition to the binders/links, spacer bars of 8 mm diameter shall be welded at the inside face of the cage of suitable intervals.

Reinforcement used in cast in situ piles shall be made up into cages sufficiently well wired or spot welded to withstand handling without damage. The bars shall be so spaced as not to impede the placing of the concrete. Care shall be taken to preserve correct cover and alignment of reinforcement throughout the whole operation of placing the concrete by means of concrete rollers or by any other means approved by the Engineer. Any distortion or displacement of reinforcement, during the compaction of concrete or while extracting the tube, shall be avoided. The reinforcement in the pile shall be exposed for a minimum length of the anchor length in tension above cut off level to permit it to be adequately bonded into the pile cap. All reinforcement in piles including the dowels projecting above the piles, shall be measured and paid separately.

3.08.00 **Dowels**

The Contractor shall provide necessary dowels as directed by the Engineer. In case of inadequate length of dowels, the same shall be extended by welding or by mechanical devices, if necessary as per direction of the Engineer. The expenditure on this account shall be borne by the Contractor. The extra reinforcement thus required shall be taken into consideration during reconciliation if the same is supplied by the Owner.

3.09.00 **Inspection**

Before placing the reinforcement and concrete in the driven pile, the same shall be inspected by lowering a battery or flash lamp or by any other method approved by the Engineer to ensure water tightness of the tube. In case of water in any bore or damage to any cast iron shoe, the tube shall be extracted and redriven after earthfilling of the hole, with a fresh shoe at the cost of the Contractor.

3.10.00 **Record for driving of Piles**

A joint record of the entire penetration shall be maintained by the Contractor in a proforma approved by the Engineer for every pile for the behaviour of such pile during its entire process of construction. Such records shall be submitted to the Engineer regularly as the job progresses. Any sudden change in the rate of penetration which can not be ascribed to the nature of the ground or any deviation from the designed location, alignment or load

carrying capacity of any pile or any upheaval or subsidence noticed on any pile driven under this Contract shall be promptly reported to the Engineer and adequate corrective measures shall be taken free of any charge as decided by the Engineer.

Upon completion of the pile driving, all records together with the records of such additional borings or other subsurface information that were obtained during the process of driving shall also be filled with the Engineer in triplicate.

3.11.00 **Defective Piles**

Piles that are defective or piles with deviation in alignment of the tube or position of the base more than that permissible under this specification shall be pulled out or left in place as per the direction of the engineer. Additional piles shall be driven to replace them and/or the pile cap shall be redesigned in consultation with the engineer. All the additional costs associated with the corrective action shall be borne by the Contractor. However, the extra reinforcement and cement that will be required for such work shall be taken into consideration during reconciliation of Owner's material, if the same are supplied by the Owner.

3.12.00 **Idle Period**

The phasing of construction and movement of plant shall be done as desired by the Engineer. The phasing may involve some extra movement of the plant or some idle period, but the Contractor will not be entitled for any claim due to this reason.

During the actual testing of the piles, the contractor's plant and personnel may remain temporarily idle. Again, during the period of redesign, if any, (based on the pile test results), the plant personnel of the contractor may remain idle for any reason whatsoever.

For such idle periods mentioned above, the Contractor will not be entitled to any claim and rates quoted by him shall include the same. However, during the testing of piles and other hold ups, pile driving operation may be allowed on other piles wherever possible, if decided by the engineer with a view to minimise idle times.

If due to change in loading, elevations or any other alteration, some amendments become necessary in the design of foundations, the Contractor shall not be entitled to any claim whatsoever for such amendments in the pile layout during the progress of work including claims for any idle labour or tools and plant on this account.

In case of extra rolling of rig arising out of a decision taken by the Engineer due to non-availability of drawings or site, or priority consideration, the same shall be paid under the relevant item in the schedule of items.

3.13.00 **Test Pile**

The Contractor may have to construct test piles, if desired by the Engineer, before he starts systematic piling operation at locations indicated. For this

purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Initial test shall be carried out on such piles as per the relevant provision in IS : 2911 (Part-IV).

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in the Contract. Whenever directed, the Contractor shall get the specimens tested in a laboratory approved by the engineer and submit to the Engineer the test results in triplicate within three (3) days of completion of the test.

4.02.00 Components of R.C.C

The testing and acceptance criteria for the components of Reinforced Cement concrete shall be as stipulated in the relevant clauses of the Technical Specification for Cement concrete (Plain and Reinforced) appearing in the document elsewhere.

4.03.00 Static Load Test on Working Piles

In order to determine the carrying capacity of piles, static load tests shall be undertaken by the Contractor on single pile or pile groups, as indicated on drawings. Piles to be tested shall be cast at least 30 days before loading unless otherwise directed by the Engineer. Before any load test is made, the proposed arrangement of the structure, dead load to be used in making the load test, and method of application of load to the pile shall have to be approved by the Engineer. All load tests shall be made under the supervision of the Engineer. All responsibilities for conducting the test safely and properly lie with the Contractor.

The test load to be applied on pile or piles shall be one and a half times the proposed load value of the pile or piles as claimed by the Contractor. The test load shall be applied in 6 increments equal to one fourth, half, three fourth, one, one and one fourth and one and one half times the proposed working load. Readings of settlements and rebounds shall be referred to a constant elevation bench mark and shall be recorded with the help of minimum two dial gauges of 0.02 mm sensitivity and resting on diametrically opposite sides. Each stage of loading, except the final test load of one and one half times the working load, shall be maintained till the rate of movement of the pile top is not more than 0.02 mm per hour. The final test load shall be maintained for 24 hours and hourly readings of settlements are to be recorded. The total test load shall be removed in decrements not exceeding 1/5 of the total test load with intervals of not less than one hour. The rebounds shall be recorded after each decrement is effected and the final rebound shall be recorded 24 hours after the entire test load has been removed. A complete record in triplicate shall be filed with the Engineer on the loads and readings obtained duly verified and countersigned by the Engineer.

The tested piles shall be used as usual foundation piles if they satisfy the acceptance criteria, and no extra payment shall be made except for load tests on the piles.

If so desired by the Engineer, special test caps may have to be cast and subsequently dismantled at no extra cost.

4.03.01 **Acceptance Criteria**

The pile or piles tested shall be accepted to carry the proposed working load provided that the total settlement of the pile top under the load does not exceed 12 mm.

4.04.00 **Lateral Load Tests/Pull out Tests**

If desired by the Engineer lateral load tests on piles will be carried out by the Contractor as per IS:2911. Pull out tests will be carried out in special cases if required by either cantilever or fulcrum loading as may be approved by the Engineer. The quantum and nature of test loading will be as approved by the Engineer.

4.05.00 **Non-destructive Dynamic Testing on Working Piles**

In addition to the above load tests, the Contractor may also have to carry out testing of piles by non-destructive dynamic testing methods before or during piling work as desired by the engineer.

4.05.01 **"Low Strain" Method for Integrity Investigation of Concrete Piles**

The method of testing shall conform to ASTM D4945. All equipment including small impact device, 16 lbs nylon tipped hand held hammer accelerometer pile integrity tester and pile driving analyser shall be arranged by the Contractor. Analysis shall be carried out by exponential amplification of the signal with line and the average velocity curve obtained by numerically integrating the acceleration record to be submitted. From analysis of the results any defect like necking, honey-combing, segregation or weakness in concrete, when detected shall be reported in detail.

4.05.02 **"High Strain" Method for Determination of Pile Capacity**

The method of testing shall conform to ASTM D 4945. All equipment including piezoelectric transducers, strain gauges, pile driving analyser, two track oscilloscope for displaying data and contractor for every hammer below the analyser shall determined the following data :

a) Pile bearing capacity

b) Transferred energy

c) Maximum compression force

d) Maximum tension force

e) Maximum impact velocity

f) Maximum acceleration

g) Maximum displacement

which are to be properly recorded and analysed and submitted in detailed report form.

4.06.00 **Lateral Dynamic Load Test on Piles**

Two types of tests, namely, free and forced vibration lateral tests shall be carried out to observe response of soil-pile system under horizontal dynamic loads and for the evaluation of soil pile stiffness, soil modulus, natural frequency, time period and damping characteristics of soil- pile system.

A minimum of three representative piles of same type in almost similar soil conditions shall be tested. Two adjacent piles shall be subjected first to free vibrations and then to forced vibrations, the third pile shall only be tested under forced vibrations.

The equipment and accessories for the test, setting up and test procedure and recording of observations shall be as described in relevant sections IS : 9716 (Guide for Lateral Dynamic Load Test on Piles).

The tests shall normally be carried out without sustained vertical load other than that of the oscillator assembly. However, sustained weight can be used to increase dynamic force to obtain resonance or nearly resonance condition.

From analysis of test data, the following parameters shall be determined:

i) Frequency of vibrations

ii) Amplitude of vibrations

iii) Imparted dynamic force

iv) Natural frequency

v) Damping coefficient

vi) Soil-pile stiffness

vii) Coefficient of horizontal soil modulus variation

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

The Tenderer should submit the following information alongwith his tender :

5.01.01 **Design Data**

The Contractor will submit full details of method of construction, design data and drawings for the type of piles he wishes to adopt.

5.01.02 **Programme of Construction**

The Contractor will also submit the details of the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and possible delays due to modifications of design should be drawn up and submitted along with the tender, keeping in view the completion dates stipulated in the tender.

5.02.00 **After Award**

After award of the contract, the successful tenderer is to submit the following details.

5.02.01 **Execution Plan**

Within 15 days of receiving the letter of Intent the Contractor will submit 6 (six) copies of drawings showing the sequence of driving. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the Engineer.

5.02.02 **Detailed Construction Programme**

Within 30 (thirty) days of the award of contract, a detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the Engineer, incorporating the various factors which have caused or are likely to cause changes in the programme.

5.02.03 **Requirement of Materials, Tools and Plants and Equipment**

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the Owner is to supply or is to help in procurement as per the terms and conditions of the Contract, is to be submitted within 30 (thirty) days of the contract.

5.02.04 **Test Results**

The test data and result for the various ingredients of R.C.C., concrete cubes and cylinders, driving of the shell, static load test on single piles and group and non-destructive dynamic test on working piles will be submitted regularly and as and when directed by the Engineer. For testing the ingredients of R.C.C. the relevant clauses of the "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply.

TECHNICAL SPECIFICATION
FOR
VIII) BORED CAST IN SITU CONCRETE PILES

CONTENTS

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VIII) BORED CAST IN SITU CONCRETE PILE

1.00.00 SCOPE

This specification deals with the requirements regarding materials, workmanship and installation of bored cast-in-situ reinforced concrete piles and all related items of work like sand filling in the holes after casting the piles, testing the load bearing capacity of individual piles and group of piles, etc. The relevant clauses of the "Technical Specification for Concrete Work", appearing elsewhere in this document, fall within the scope of this specification.

IS:2911 (Part-I/Sec-2) shall form a part of this specification and shall be complied with unless they are at variance with the specification where the latter shall prevail.

2.00.00 GENERAL

2.01.00 Work to be provided by the Contractor

The work to be provided for by the contractor, unless otherwise specified, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment and accessories, tools, plants transportation including consumables and temporary works required for the supply and installation of piles of desired capacity.

b) Mark the proposed sequence of installation on six (6) copies of identification plan. The identification plan will be prepared by the contractor as per the basic plan furnished by the Engineer, if so desired by him.

c) Furnish full details of the proposed piling equipment, accessories, temporary works and method of pile construction for approval of the engineer.

d) Submit detailed daily report of boring and pile casting incorporating information as required by the Engineer.

e) Carryout load tests to the satisfaction of the engineer including casting and dismantling of test caps if necessary and submit the test results in approved proforma.

f) Make necessary earthwork and approaches for movement of pile installation equipment.

g) Provide all necessary work mentioned under "Technical Specification for Cement Concrete (Plain and Reinforced)", as may be applicable.

2.02.00 **Work to be provided by others**

No work under this specification will be provided by any agency other than the contractor unless specified elsewhere in the Contract.

2.03.00 **Codes and Standards**

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements/amendments of the following or any other Indian Standard Specifications and Code of Practice.

IS : 269 Indian Standard Specifications for 33 Grade Ordinary Portland Cement.

IS : 383 Indian Standard Specifications for Natural Sources for Concrete.

IS : 432 Indian Standard Specification for (Part - I)Mild Steel & Medium Tensile Steel Bars and Hard drawn Steel Wire for Concrete Reinforcement : Part I Mild Steel and Medium Tensile Steel Bars.

IS : 455 Indian Standard Specifications for Portland Slag Cement.

IS : 456 Indian Standard Code of Practice for Plain and Reinforced Concrete.

IS : 516 Indian Standard Specifications for Methods of Test for Strength of Concrete.

IS : 1199 Indian Standard Specifications for Methods of Sampling and Analysis of Concrete.

IS : 1786 Indian Standard Specifications for high strength deformed steel bars and wires for concrete reinforcement.

IS : 2062 Steel for General Structural Purposes

IS : 2386 Indian Standard Specification for Methods of Test for Aggregates for Concrete Part - I to VIII.

IS : 2502 Code of Practice for Bending & Fixing of Bars for Concrete Reinforcement.

IS : 2722 Indian Standard Specifications for Portable Swing Weight Batches for Concrete (Single and Double Bucket Type).

IS : 2751 Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.

IS : 2911 Code of Practice for Design and Construction of Pile Foundations - Bored Cast-in-situ piles.

IS : 2911	Code of Practice for Design and (Part - IV)Construction of Pile Foundations - Load Test on Piles.
IS : 4926	Indian Standard Specifications for Ready Mixed Concrete.
IS : 8112	I.S. Specification for 43 grade Ordinary Portland Cement.
IS : 9716	Guide for Lateral Dynamic Load Test on Piles.
IS : 12269	I. S. Specification for 53 grade ordinary portland cement

2.04.00 **Conformity with Design**

The contractor will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the engineer, the work will be checked and approved by the engineer for correctness and conformity with the design, specification and drawings, before allowing the next phase of work to commence. The intermediate checks and approvals by the engineer will not, however, absolve the contractor from his total responsibility to execute the work as per the specification and drawings and to remove and/or rectify all work which is defective or inaccurate.

2.05.00 **Materials**

2.05.01 **General**

All materials whether incorporated in the works or used temporarily as aids or for executing enabling works will be of best approved quality conforming to the latest Indian Standard specification.

2.05.02 **Casing**

Casing in boreholes where used, should be manufactured out of best quality mild steel with proper treatment, the composition and thickness of the materials being of special importance where they are likely to be in contact with harmful chemicals and organic materials causing deterioration in service. Casing to be left in place like in offshore piling should also receive similar consideration in selection. They shall have sufficient strength and rigidity to permit their being driven and not to be distorted by soil pressure or driving of adjacent tubes. They shall be sufficiently water-tight to exclude water during placing of concrete.

2.05.03 **Concrete**

Concrete type M-25 (minimum) grade shall be used for piles as indicated in drawings. Materials and method of manufacture for cement concrete shall in general be in accordance with IS : 456. The concrete cube strength on 15 cm. cubes at 28 days shall satisfy the acceptance criteria as per IS : 456. Concrete cubes will be cast as per instruction of the Engineer. These will be cast and cured by the Contractor at site for testing. The concrete shall be of such consistency as to give a slump of 100 to 150 mm. Cement used for the concrete shall be 43 / 53 Grade ordinary Portland cement conforming to IS:8112 & IS:12269 respectively.

2.05.04 **Reinforcement**

Reinforcement shall be mild steel bars conforming to IS: 432. If instead of mild steel, Tor steel bars are used, they shall conform to IS : 1786.

2.06.00 **Storage of Materials**

2.06.01 **General**

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the engineer shall not be used, failing which, the engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the contractor's dues. The relevant clauses pertaining to storage of material under "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply.

2.06.02 **Casing**

Mild steel casing will be painted outside with two coats of anticorrosive paint or smeared with protective layer of grease and kept stored in weather proof sheds, off the ground, on sturdy racks in such a manner as to enable quick and easy in spectrum. Epoxy painting on outside surface shall be provided if so specified in the drawing.

2.07.00 **Quality Control**

The contractor shall establish and maintain quality control for different items of work and materials as may be directed by the engineer to assure compliance with contract requirements and maintain and submit to the engineer records of the same. The quality control requirements stipulated under the "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply wherever relevant. In addition, the requirement will include but not be limited to the following.

a) Location and plumb : Control survey for accuracy in plan and check for verticality.

b) Driving of casing : Correction of weight of hammer, length of fall, number of strokes per minute and rate of penetration.

c) Boring : Boring method to suit soil profile.

d) Casting of piles : Check inside casing, reinforcement cage, concrete mix, placing, consolidation and curing.

e) Inspection of pile

f) Load tests

2.07.01 Any work which fails to conform to the specification will be subject to the issue of a `non-conformance report' in line with the quality control procedures to be implemented at site. Corrective or remedial action, design modification or product rejection will be reviewed in accordance with site quality plan.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:2911 (Part-I/ Sec.2) and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all the aspects to the full satisfaction of the engineer.

3.01.00 General

The tenderer shall furnish complete information about the type of piles offered with sketches of pile sections showing reinforcement, method of boring, details and availability of equipment and accessories formula or data curve on which the tenderer bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient founding of individual piles and any other relevant details.

The tenderer will be supplied with bore hole logs or any other data indicating the nature of the soil expected to be encountered. The information furnished to the contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. Piles should be founded on suitable continuous hard strata. In case the contractor is required to drive piles to greater or shallower depths than that is envisaged, the rates will be adjusted as per relevant items in the schedule of items and no other extra claims will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bores if he feels it necessary to assess the type of boring equipment to be used and the depth to suitable founding strata.

3.02.00 Design of Pile

The contractor shall satisfy the engineer as to the boring procedure and equipment which he proposes to use for the particular conditions of the site. If the engineer desires, sufficient test piles shall be installed to prove the adequacy of the pile, at the places indicated by the engineer and a load test shall be performed on each pile.

The Contractor shall satisfy the Engineer as to the boring procedure and equipment which he proposes to use for the particular conditions of the site. If the Engineer desires, sufficient test piles shall be driven to prove the adequacy of the pile, at the places indicated by the Engineer, and a load test shall be performed on each pile.

Piles have to be reinforced throughout their length. Main longitudinal reinforcement in the length of the piles as well as links or spirals shall be provided as shown in the drawings. Longitudinal bars shall preferably be in one length. Reinforced cage shall be handled and installed carefully without damaging its shape. All other requirements of reinforcement bars i.e., quality,

workmanship, etc. shall be as specified for reinforced concrete work in Technical Specification for Concrete work.

The average basic length of the piles shown in the drawing/schedule of items is tentative and is to be assumed from cut-off level to the tip of the pile, but the final length will be decided by the Contractor with approval of the Engineer on the basis of boring resistance actually observed at site at the particular location. It will be the responsibility of the Contractor to prove by subsequent load tests/pull-out tests that the adopted length of the pile shall carry the safe loads, in compression and tension with the resulting deflections being within permissible limits. To ensure this, the length of the pile actually installed will be subject to change if considered necessary from the above mentioned basic length and payment shall be made to the Contractor on the basis of the actual lengths of pile installed at the rates quoted by the Contractor for deviation in length above or below the stipulated basic length.

If the load test is satisfactory and the Engineer accepts the type of the pile as suitable, payment shall be made for the pile. If the piles by reasons of defective workmanship or failure of one or more load tests, are found to be unsatisfactory, the cost of the test piles shall be borne by the Contractor.

3.03.00 **Identification of Piles**

A plan in triplicate, showing clearly the designation of all piles by an identifying system shall be filed with the engineer before installation of piles is started if so desired by the engineer.

3.04.00 **Sequence of Piling**

Individual piles and pile groups shall be constructed in such a sequence that the adjacent piles already installed are not disturbed, nor their carrying capacity reduced by subsequent boring/driving operation. The Contractor shall submit the sequence order and programme chart to the Engineer and get his confirmation before starting the work.

3.05.00 **Boring**

3.05.01 **With Casing**

Boring equipment and accessories shall generally conform to IS:2911 - relevant section. Boring may be done by either rotary or percussion equipment or grabbing equipment using reversed or direct mud circulation method. In case of unstable soils the boring tools used should be such that suction effects are minimised. Stabilisation of the sides of bore hole shall be done by use of casing. The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm.

The casing should be used from the ground level and shall be kept ahead of boring in case where there is danger of caving-in due to subsoil water entering into the bore hole or where the soil is loose. While boring below subsoil water level, precaution shall be taken so that no boiling of the bottom of the hole occurs due to difference in hydrostatic head.

Boring shall proceed by alternatively driving the casing and extracting the bored material with the boring tools. While boring in soft material liable to cavitation boring tools shall not be operated at a level below the toe of the casing. Care shall be taken to ensure that the volume of water added to the bore shall be not more than the minimum necessary for the operation of the boring tools. The casing shall be driven down through the soft material to penetrate a hard stratum not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter the boring shall be continued by means of the boring tools until the approved bearing layer is reached.

Criteria for approval of the bearing layer will be agreed between the Engineer and the Contractor based on visual inspection of recognisable samples, recovered from the pile bore in the upper levels of the compact layer. The approved samples shall consist of sound material shall be consistent in quality for a depth of 300 mm in the pile bore. A sample of this material shall be supplied by the Contractor to the Engineer duly labelled for maintaining records of the founding strata.

The piles shall be installed with due consideration for safety of adjacent structures by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance.

Where the soil is such that driving of a pile causes previously installed piles to heave, load test shall be conducted at the expense of the Contractor on such proportion of the heaved piles which shall be ordered by the Engineer.

3.05.02 **With Drilling Fluid**

Alternate to the boring with casing, stabilisation of the sides of bore hole can be effected by the use of drilling fluids.

In such cases the drilling fluid must be used at least from the level of subsoil water, as the hole, should then be always kept almost full with the fluid. The density and composition of the fluid shall be such as to suit the requirements of ground conditions and to maintain the fine materials from the boring in suspension. At the last stage of boring or in intermediate hard layers chisel or a chopper may be used. The rate for piling work should be inclusive of any chiselling, chopping of hard strata, clearing of bottom of pile borehole etc. complete as per specifications and necessary penetration test as may be required to prove the soundness of the founding strata. A five per cent bentonite suspension would be generally suitable and its quality shall conform to specification given in Appendix 'A' of IS : 2911 (Part-I/Sec.2).

3.06.00 **Spacing of Piles**

In general, all piles shall have a minimum spacing on centres of 3 d (where 'd' is the diameter of the pile) unless shown otherwise in the drawings.

3.07.00 **Placing of Reinforcement**

Reinforcement as required shall be made into stiff cages sufficiently wired or welded to withstand handling without any damage or distortion. Reinforcement shall be placed immediately after cleaning and inspection of

the bottom of bore holes. The reinforcement should be supported away from the sides of the shaft by means of suitable space block to ensure concentric alignment in the shaft. Steps shall be taken to ensure correct positioning during concreting of reinforcement in the piles without any distortion.

Nominal lap between reinforcement cages shall be 60 cm and the main reinforcing steel shall project for a length sufficient to develop bond (45 times the diameter of reinforcing bar) above the level of the underside of the pile cap.

The concrete cover to main reinforcement shall not be less than 5 cm and suitable spacer blocks shall be provided at intervals not exceeding 2 metres and wired to the main reinforcement.

3.08.00 **Concreting**

Immediately before concreting the bottom of the hole shall be cleaned very carefully. The cleaning of the hole shall be ensured by careful operation by air lifting process unless otherwise allowed by the Engineer. To lift the spoil at founding level before concreting, borehole shall be agitated by jetting with fresh drilling mud with relatively higher pressure than that used during boring or air through tremie pipe. While boring by use of drilling mud, the specific gravity of the mud suspension in the vicinity of the bottom of the borehole shall be determined by suitable slurry sampler in a first few piles and at suitable interval of the piles and recorded. Consistency of the drilled mud suspension shall be controlled throughout the boring as well as concreting operation in order to keep the hole stabilised and to avoid concrete mixed up with the thicker suspension of the mud.

Concreting of boreholes shall start as soon as possible after the completion of boring. If a borehole, be left unconcreted for more than two hours, it shall be cleaned thoroughly as directed by the Engineer before concreting. Concrete shall be so placed as to fill the entire volume of the tube or bore without the formation of voids caused by faulty consolidation or entrapped air. Great care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete. Concreting under water shall be done in one operation. Concrete shall be placed by means of a tremie pipe. It shall, however, be ensured that concrete entering the tremie pipe does not get mixed up with the slurry and 1/4 kg of granulated vermiculite shall be poured in the tremie pipe before pouring concrete as directed by the Engineer.

3.08.01 **Tremie Method of Concreting**

The tremie pipes and funnel shall be filled and lifted just 15 cm above bottom before releasing the concrete column to facilitate flushing out the bottom. The concrete levels in the tremie shall be checked every few centimeters in order to note the difference, if any, between the theoretical quantity that should have been placed and actual quantity that has gone in. This is to locate the position of over cut during boring.

In addition to the normal precautions to be taken in tremie concreting as per relevant section of IS:2911 the following specifications shall be particularly applicable for the use of tremie concrete in pipes :

a) The concrete shall be coherent, rich in cement (not less than 400 kg/m3) and of slump not less than 100 mm.

b) The hopper and tremie shall be closed system embedded in the placed concrete, through which water cannot pass.

c) The tremie shall be large enough with due regard to the size of the aggregate. For 20 mm aggregate the tremie pipe shall be of diameter not less than 200 mm, aggregates more than 20 mm shall not be used.

d) The first charge of concrete shall be placed with a sliding plug pushed down the tube ahead of it or with a steel plate of adequate charge to prevent mixing to concrete and water. However, the plug shall not be left in the concrete as a lump.

e) The tremie pipe shall always penetrate well into the concrete with an adequate margin if safety against withdrawal of the pipe is required while discharging the concrete.

f) The pile shall be concreted wholly by tremie and the method of deposition shall not be changed part way up the pile, to prevent the laittance from being entrapped within the pile.

g) All tremie tubes shall be scrupulously cleaned after use.

Normally concreting of the piles shall be uninterrupted. In exceptional cases interruption of concreting may be allowed but it will be resumed within 1 or 2 hours. The tremie shall not be taken out of the concrete, instead it shall be raised and lowered slowly, from time to time to prevent the concrete around the tremie from setting. Concreting should be resumed by introducing a little richer concrete with a higher slump for taking care of the partly set concrete in the bore.

If the concreting cannot be resumed before final setting of concrete already placed, the pile so cast may be rejected.

In case of withdrawal of tremie out of the concrete, either accidentally or to remove a choke in the tremie, the tremie may be reintroduced in the following manner to prevent impregnation of laittance or scum lying on the top of the concrete already deposited in the bore.

The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug shall be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm shall be filled in the tremie which will push the plug forward and will emerge out of the tremie displacing laitance/scum. The tremie will be pushed further in steps making fresh concrete sweep away laitance/scum in its way. When tremie is buried by about 60 to 100 cm, concreting may be resumed.

3.08.02 **Concreting in Cased Holes**

In case of cased holes, after the required founding level is encountered, the bottom shall be sealed with concrete and the reinforcement cage shall be lowered. If the borehole is dry, concrete shall be deposited by direct pour from the top followed by gradual withdrawal of casings. If water is present in the borehole, it shall be bailed out by bailer.

If it is difficult to dewater by the bailer, concrete shall be placed under water by means of a placer. After the head of water has been neutralised by the head of the concrete, excess water shall be bailed out and concrete shall then be deposited by direct pouring from the top, as is done, if the borehole is dry.

Extraction of casing shall be done in such a way that no necking or shearing of the concrete in the shaft takes place.

During the extraction of casing, slumping of concrete shall be observed and when required, additional quantity of concrete shall be poured so that the pile is formed above the cut-off level as per the requirements indicated below.

3.08.03 **Cut-off Level**

The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap.

Where cut-off level is less than 1.5 m below the working level concrete shall be cast to a minimum of 500 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level additional coverage of 50 mm minimum shall be allowed. Higher allowance may be necessary depending on the length of the pile as directed by the Engineer. When concrete is placed by tremie method, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of one metre above cut-off level. In the circumstances where cut-off level is below ground water level, the need to maintain a pressure on the unset concrete equal to or greater than water pressure shall be observed and accordingly length of extra concrete above cut-off level shall be determined and allowed in Works.

3.09.00 **Steel Pipe or Casing Tube**

This item shall be fabricated with mild steel plates conforming to IS : 2062 and/or steel tubes for structural purpose conforming to IS : 1161 & IS : 1239 as shown on drawings and/or described in the schedule of items.

Fabrication work and welding of steel shall be done in accordance with IS : 800 and IS : 9595. Welding of pipes shall be done by experienced and good welder who have been qualified by tests in accordance with IS : 817.

3.10.00 **Trimming of Pile Heads**

Completed piles shall be trimmed to the cut-off levels shown on the drawings or until sound concrete is found to the satisfaction of the Engineer. In the event of trimming being carried below the cut-off level, the pile shall be made upto the correct cut-off level, with concrete of the same quality as used in the piles at the Contractor's expense. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap. The minimum distance of keying of pile into pile cap shall be 75 mm unless noted otherwise. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose, rust, dirt and scale.

Manual chipping shall be permitted after three (3) days of pile casting. Pneumatic chipping, if permitted by the Engineer, shall not be started before seven (7) days. In case Portland Pozzolana cement is used, chipping shall only be started as directed by the Engineer.

3.11.00 **Lengthening of Piles**

Where it is necessary to increase the length of any pile after it has been driven, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be hacked to form a key, brushed to remove loose material and covered with 25 mm thick cement mortar (1:2 mix) immediately before the new concrete is placed.

3.12.00 **Removal of Spoil**

The Contractor shall be responsible for the prompt removal from the site of all spoil due to the boring to places indicated by the Engineer. The cost of such disposal shall be deemed to have been included in the cost of piling.

3.13.00 **Back-Filling of Abandoned Borings**

The Contractor shall backfill all the abandoned borings between the concrete pile and the surface level after setting of concrete of the piles, by sand or by other materials as directed by the Engineer.

All permanently abandoned boreholes generally shall be backfilled with selected materials and for a depth of 5 M below cut-off level with plain concrete of mix 1:4:8 so that resistance to lateral forces on neighboring piles are developed.

3.14.00 **Record for Installation of Piles**

The Engineer and the Contractor shall maintain separate registers, signed jointly by both the parties, giving the following information for each pile or any other proforma as agreed between Engineer and Contractor. These data shall be submitted to the Engineer, in triplicate, on completion of installation of each pile.

a) Date of completion, pile number & sequence of installation of piles in a group.

b) Bored depth, concreted depth, empty boring and nature of stratum at founding level.

c) Pile diameter, details of reinforcement and details of mild steel liner where provided along with stiffener.

d) Volume of concrete poured, time taken, cement bag consumption, slump of concrete and RL of top of concrete.

e) Time taken for penetration of every 15 cm during last 2 M depth before founding level.

f) Method of cleaning bottom of hole at founding level before concreting.

g) Records of additional borings or other subsurface information obtained during the process of boring.

h) Any other relevant important information.

Any sudden change in the rate of boring which cannot be ascribed to the nature of the ground or any deviation from the designed location, alignment or load carrying capacity of any pile or any upheaval or subsidence noticed on any pile shall be promptly reported to the engineer and adequate corrective measures shall be taken free of any charge as decided by the engineer.

The data for pile load test (load, displacement, time, etc.) are to be recorded sequentially for the test under consideration in a suitable proforma as agreed between Engineer and Contractor. These data along with the load displacement curve shall be submitted to the Engineer, in triplicate, on completion of each load test.

3.15.00 **Defective Piles**

Any pile which is shown to be defective under load test shall not be accepted and the Engineer will relate such failure to the acceptance of other piles in the area.

If an individual pile should fail to meet the requirements specified in Clause 16.00.00 above such piles may be deemed to be defective and the Engineer may order such investigation to be made as he considers appropriate.

When any pile is found defective, the Contractor shall perform at his own expense one or more of the following remedial measures as directed by the Engineer.

i) Replacement of defective piles.

ii) Providing additional piles.

iii) Alteration in design of pile caps.

3.16.00 **Idle Period**

The phasing of construction and movement of plant shall be done as desired by the engineer. The phasing may involve some extra movement of the plant or some idle period, but the contractor will not be entitled to any claim due to this reason.

3.17.00 **Test Pile**

The contractor may have to construct test piles, if desired by the engineer, before he starts systematic piling operation at locations indicated. For this purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Load test on such piles shall be as per the provisions under "Procedure for Initial Load Test" in IS : 2911 (Part-IV) or as directed by the engineer.

3.18.00 **Offshore Piles**

Offshore piles, subjected to high horizontal forces and having large unsupported height above the bed level are to be installed under structures to be constructed on river/sea bed. Installation shall be done with the help of floating rig/crane from the river or by cantilever method from land using moving gantry or similar other equipment. Temporary filling of the area for movement of the piling rig will, however, be allowed to the extent that such filling does not encroach on the flow of the river and also no hindrance is caused to adjoining work. The cost of building such temporary gangway/ filling, embedment and removal of the same shall be included in the cost for relevant items related to installation of offshore Piles in the schedule of items.

The piles adopted are in general large diameter bored piles with mild steel liner retained for a height as indicated in the related drawings. The liner shall be of 6 mm mild steel plates fabricated to true shape and be provided with protective surface treatment. The concreting shall be done by tremie method as described earlier and according to the other stipulation as described in the Technical Specification.

4.00.00 **TESTING AND ACCEPTANCE CRITERIA**

4.01.00 **General**

The contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in the contract. Whenever directed, the contractor shall get the specimens tested in a laboratory approved by the engineer and submit to the engineer test results in triplicate within three (3) days of completion of the test.

4.02.00 **Components of RCC**

The testing and acceptance criteria for components of reinforced cement concrete shall be as stipulated in the relevant clauses of the Technical Specification for Cement Concrete (Plain and Reinforced).

4.03.00 **Components of Steel**

Testing and acceptance criteria for the component of steel pipe material and fabrication work shall be as stipulated in relevant clauses of IS : 800 and IS : 9595.

4.04.00 **Load Tests**

4.04.01 **General**

Initial tests and/or routine tests as indicated in the schedule of items or as directed by the engineer shall be carried out on single pile or pile groups to ascertain the capacities of the piles and their behaviour.

Minimum three (3) nos of test piles are to be provided for each test – Vertical, lateral and pull out test. Minimum load for initial test shall be 2.5 (Two and half) times of design load. Safe load shall be derived from IS code and Technical specification guideline.

Any or all of the tests described below shall be carried out as indicated in the schedule of items and as directed by the engineer. The tests shall be performed as per requirements of the relevant Indian Standards and as supplemented herein.

4.04.02 **Vertical Load Test [as per IS : 2911 (Part-IV)]**

Load tests shall be carried out on single piles to check the bearing capacity or the quality of piles in the manner specified below :

From among the completed piles the Engineer at his discretion shall select piles for the purpose of testing.

At least 1% of the piles driven shall be tested to an overload of 50% above the working load of the pile and 0.1% of the piles driven shall be tested to an over load of 100% above the working load of the pile.

Load shall be applied in increments of about one-fifth of the design load till the design load is reached and thereafter in increment of 10 tonnes till the test load is reached.

Each increment of load shall be maintained for minimum of half an hour upto design load and thereafter for one hour till the test load is reached. Test load shall be maintained for 24 hours.

For each increment of load, readings of settlement at every ten minutes shall be taken. The next increment of load shall be applied only when the difference in settlement of readings between the last two readings does not exceed 0.02 mm. On application of test load, readings shall be taken at every hour.

Unloading will be done in following decrements of load :

i) Test load to design load

ii) Design load to 50% of design load

iii) 50% of design load to 25% of design load

iv) 25% of design load to complete unloading

Each decreased load shall be kept for a minimum of half an hour and readings of rebound taken every ten minutes. The next decrement shall be applied only when the difference in readings between the last two readings is less than 0.02 mm.

The observation and recording of settlement and rebound shall be done simultaneously by the Contractor and the Engineer's representative. Three copies of all the readings for the test shall be supplied by the Contractor to the Engineer-in-charge. Actual proforma for recording the results shall be proposed by the Contractor and approved by the Engineer-in-charge before the start of the load test.

The pile shall be deemed to be acceptable if the gross settlement at the test load of one and a half times the designed load does not exceed 0.01" per tonne of test load or 1/2" (12 mm) whichever is less.

In case a pile fails under or during the load test, the Engineer shall select two additional piles in lieu of each of such piles failed and the Contractor shall carry out load tests on these piles in the same way as the load tests on the original piles at his own cost. This procedure will be repeated in the case of each failure of pile under/during load test.

The Contractor shall arrange at his own expense sufficient amount of knowledge for loading well in advance of the commencement of the load test.

Detailed proposal together with a sketch for the load test arrangement shall be furnished by the Contractor to the Engineer-in-charge for checking and approval.

The pile head shall be chipped off to natural horizontal plane till sound concrete is met. The projecting reinforcement shall be cut-off or bent suitably and the top finished smooth and level. A bearing plate with a hole at the centre shall be placed on the head of the pile for the jacks to rest.

Jacks used in any particular load test should be of the same capacity and their number shall be limited to two only. They should preferably be connected and operated by one pump. The Contractor shall submit certificates certifying the correctness of the calibrations of the pressure gauges and jacks before use. All jacks should be fitted with locking devices. Settlement and rebound shall be recorded by minimum two (2) deflectometers of 0.01 mm sensitivity and also by other independent means of direct measurement. Deflectometers shall be supported independently and in such a way as to be not affected by the settlement of the piles.

4.04.03 **Lateral Load Test**

The test shall be carried out by introducing hydraulic jack with gauge between two piles under test or the reaction shall be suitably obtained otherwise. When the test is conducted by jack located between two piles, the full load imposed by the jack shall be taken as the lateral resistance of each pile.

Load shall be applied in increments of about one-fifth of the design load. The next increment shall be applied after the rate of displacement is nearer to 0.1 mm per 30 minutes. Displacement shall be read by using at least two (2) deflectometer of 0.01 mm sensitivity spaced by 30 cm and kept horizontally one above the other or by any means as per IS-2911 (Part-4) or as approved by the Engineer. The safe lateral load on pile shall be taken as the least of the followings :

a) Fifty percent (50%) of the final load at which displacement increases to 12 mm.

b) Final load at which the total displacement corresponds to 5 mm.

4.04.04 **Pull-out Test**

The test shall be carried out to an overload of fifty percent (50%) of the estimated safe load or a displacement of 12mm total whichever is earlier.

Uplift force may preferably be applied by means of hydraulic jack(s) with gauge using a suitable pull-out set up as per IS-2911 (Part-4) or as approved by the Engineer.

The pull-out load increments and consequent displacement readings shall be same as in the case of Vertical Load Test.

The safe load shall be taken as the least of the followings :

a) Two-thirds of the total load at which the displacement is 12mm.

b) Half the load at which the load-displacement curve shows a clear break (downward trend).

4.05.00 **Non-destructive Dynamic Test on Working Piles**

4.05.01 **"Low Strain" Method for Integrity Investigation of Concrete Piles**

The method of testing shall conform to ASTM D 4945.

All equipments e.g., small impact device 16 lbs. nylon tipped hand held hammer, accelerometer, pile integrity tester & pile driving analyser shall be arranged by the Contractor. Analysis shall be carried out by exponential amplification of the signal with time and the average velocity curve obtained by numerically integrating the acceleration record to be submitted. From analysis of the results any defect like necking, honey-combing, segregation or weakness in concrete, when detected shall be reported in detail.

4.05.02 **"High Strain" Method for Determining of Pile Capacity**

The method of testing shall conform to ASTM D 4945. All equipment including piezoelectric transducers, strain gauges, pile driving analyser, two track oscilloscope for displaying data and analog tape recorders for recording data shall be arranged by the contractor. For every hammer below, the analyser shall determine the following data :

i) Pile bearing capacity

ii) Transferred energy

iii) Maximum compression force

iv) Maximum tension force

v) Maximum impact velocity

vi) Maximum acceleration

vii) Maximum displacement

which are to be properly recorded and analysed and submitted in a detailed report form.

4.06.00 **Acceptance Criteria**

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification to the satisfaction of the Engineer and the standards stated hereinafter.

a) The head of the pile shall be within 75 mm of the specified position on the drawings.

b) The pile shall not be out of plumb by more than two percent.

c) The toe of the pile shall be at the approved bearing level in each case.

d) The total volume of concrete shall not be less than 20% and not more than 50% greater than the calculated volume. The calculated volume for this purpose shall be the cross-sectional area inside the casing multiplied by the length of the shaft. The concrete shall show the specified strength as indicated by the cube test results.

e) The results of the load tests including non destructive dynamic test carried out in accordance with the contract and with the specifications shall be satisfactory.

f) In case of single pile the positional tolerance shall not be more than 50mm.

4.07.00 **Lateral Dynamic Load Test on Piles**

Two types of tests, namely, free and forced vibration lateral tests shall be carried out to observe response of soil-pile system under horizontal dynamic loads and for the evaluation of soil-pile stiffness, soil modulus, natural frequency, time period and damping characteristics of soil-pile system.

A minimum of three representative piles of same type in almost similar soil conditions shall be tested. Two adjacent piles shall be subjected first to free vibrations and then to forced vibrations, the third pile shall only be tested under forced vibrations.

The equipment and accessories for the test, setting up and test procedure and recording of observations shall be as described in relevant sections of IS : 9716 (Guide for Lateral Dynamic Load Test on Piles). The tests shall normally be carried out without sustained vertical load other than that of the oscillator assembly. However, sustained weight can be used to increase dynamic force to obtain resonance or nearly resonance condition.
From analysis of test data, the following parameters shall be determined:

i) Frequency of vibrations

ii) Amplitude of vibrations

iii) Imparted dynamic force

iv) Natural frequency

v) Damping coefficient

vi) Soil-pile stiffness

vii) Coefficient of horizontal soil modulus variation

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

The tenderer should submit the following information along with his tender.

5.01.01 **Design Data**

The contractor will submit full details of the method of construction, design data and drawings for the type of piles he wishes to adopt.

5.01.02 **Programme of Construction**

The contractor will also submit the details of the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and

possible delays due to modifications of design should be drawn up and submitted along with the tender, keeping in view the completion dates stipulated in the tender.

5.02.00 **After Award**

After award of the contract, the successful tenderer is to submit the following details :

5.02.01 **Execution Plan**

Within 15 days of receiving the letter of intent the contractor will submit six (6) copies of drawings showing the sequence of piling. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the engineer.

5.02.02 **Detailed Construction Programme**

Within thirty (30) days of award of the contract, a detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the engineer, incorporating the various factors that have caused or are likely to cause changes in the programme.

5.02.03 **Requirement of Materials, Tools and Plants and Equipment**

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the owner is to supply or is to help in procurement as per the terms and conditions of contract is to be submitted within thirty (30) days of award of the contract.

5.02.04 **Test Results**

The test data and results for the various items like welding of pipes, ingredients of RCC, concrete cubes and cylinders, driving of the shell, static load tests on single piles and pile groups and dynamic tests on working pile will be submitted regularly and as and when directed by the engineer.

TECHNICAL SPECIFICATION
FOR
IX) FABRICATION OF STRUCTURAL STEEL WORK

CONTENTS

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IX) FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable required for fabrication and supply of all bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract. However, for any special structures such as rail & road bridges, steel chimney, tanks, transmission towers, furnace structures, etc., the relevant Indian Standard or IRC specification and Codes of Practices shall be given due consideration over & above this specification.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following :

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on design drawings to be furnished by the Owner.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections. The field connection materials supplied by the contractor shall be to the extent of actual requirement plus 10% (ten percent).

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Despatch lists, Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

i) Furnish necessary test certificates of all raw steel material supplied by the Contractor.

2.02.00 **Work by others**

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 **Codes and standards**

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed:-

List of IS Codes - Relevant to Fabrication of Structural Steel Work

IS Codes	**Description**
IS:800	Code of practice for general construction in steel.
IS:801	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS:806	Code of practice for use of steel tubes in general building construction.
IS:808	Dimensions for rolled steel beams, channels and angle sections.
IS:812	Glossary of terms relating to welding & cutting of metals.
IS:813	Scheme of symbols for welding.
IS:814	Covered electrodes for metal arc welding of carbon and carbon manganese steel.
IS:815	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
IS:816	Code of practice for use of metal arc welding for general construction in mild steel.
IS:817	Code of practice for training & testing metal arc welders.
IS:818	Code of practice for safety and health requirements in electric and gas welding and cutting operations.

IS:819	Code of practice for resistance spot welding for light assemblies in mild steel.
IS:822	Code of practice for inspection of welds.
IS:919	Recommendations for limits and fits for (Part-1&2) engineering.
IS:1161	Steel Tubes for structural purposes.
IS:1182	Recommended practice for Radiographic Examination of fushion welded butt joints in steel plates.
IS:1200	Method of measurement of steel work and iron (Part-8) work
IS:1239	Mild steel tubes, tubulars and other wrought (Part-1&2) steel fittings
IS:1363	Hexagon head bolts, screws and nuts of product (Part-1 to 3) grade C.
IS:1364	Hexagon head bolts, screws and nuts of product (Part-1 to 5) grade A & B.
IS:1365	Slotted counter sunk head screws (dia. 1.6 to 20 mm)
IS:1367	Technical supply conditions for threaded steel (Part-1 to 18) fasteners.
IS:1608	Method for tensile testing of steel products.
IS:1730	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
IS:1852	Rolling and cutting tolerances for hot-rolled steel product.
IS:1977	Structural steel (Ordinary quality)
IS:2016	Plain washer
IS:2062	Steel for general structural purposes.
IS:2629	Recommended practice for hot-dip galvanizing of iron and steel.
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:3644	Code of practice for ultrasonic pulse echo testing by contact and immersion method.
IS:3757	High Strength Structural Bolt

IS:4000	High strength bolts in steel structure
IS:4759	Specifications for hot-dip zinc coatings on structural steel and other allied products.
IS:4923	Hollow steel sections for structural use.
IS:5334	Code of practice for magnetic particle flaw detection of weld.
IS:5369	General requirements for plain washers and lock washer.
IS:6005	Code of practice for phosphating of iron and steel.
IS:6649	Specification for hardened and tempered washers for high strength structural bolts and nuts.
IS:6623	Specification for high strength structural nuts.
IS:7215	Tolerances for fabrication of steel structures.
IS:7280	Bare wire electrode for submerged arc welding
IS:8500	Structural steel micro alloyed (medium & high strength quality).
IS:8629	Code of practice for protection of iron and (Part-I to III) steel structures from atmospheric corrosion.
IS:9595	Recommendation for metal arc welding of carbon manganese steels.

Painting

IS:117	Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.
IS:128	Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.
IS:1477	Code of practice for painting of ferrous metal (Part-I & II) in building.
IS:2074	Ready mixed paint, air-drying red-oxide zinc chrome priming.
IS:2339	Specification for aluminium paints for general purposes in dual container.
IS:2932	Specification for enamel, synthetic exterior type-I.
IS:2933	Specification for enamel, synthetic exterior type-II.

2.04.00 **Conformity with Designs**

Except where the standard connection details are furnished, the contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer Keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 **Materials to be used**

2.05.01 **General**

All steel materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant.

If desired by the Engineer, Test Certificates of materials supplied by the contractor in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tonnes or less of any particular section.

The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and ampereage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 **Steel**

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable :

1)	IS:801	Cold formed light gauge steel structural member.
2)	IS:806	Steel tubes in general building construction.
3)	IS:1161	Steel tubes for structural purpose.
4)	IS:1977	Structural steel (Ordinary quality) St-42-0.
5)	IS:2062	Steel for general structural purpose
6)	IS:8500	Structural steel-micro alloyed (Ordinary & high strength quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 **Electrodes**

All electrodes to be used under the Contract shall comply with any of the following Indian Standard Specifications as may be applicable :

1) IS:814 Covered electrodes for metal arc welding structural steel

2) IS:815 Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.

3) IS:7280 Base wire electrode for submerged arc welding.

2.05.04 **Bolts and Nuts**

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS:1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm2 and a minimum elongation of 23 per cent on a gauge length of $5.6\sqrt{A}$, where 'A' is the cross sectional area of the test specimen :

   1) IS:1367 Technical supply conditions for threaded fastners.

   2) IS:1608 Method for tensile testing of steel other than sheet, strip, wire and tube.

b) High Tensile Steel : The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Engineer.

2.05.05 **Washers**

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract :

1) IS:1977 Structural steel (Ordinary Quality) St-42-0

2) IS:2062 Steel for general structural purpose

3)	IS:8500	Structural steel - microalloyed (medium & high strength quality)
4)	IS:6623	High Strength Structural Nuts
5)	IS:6649	Hardened and tampered washers for high strength structural bolts & nuts.

2.05.06 **Paints**

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS:2074 - Ready mixed Paint, Air Drying, Red Oxide - Zinc Chromate Priming.

In highly corrosive environment other type of primer such as epoxy resin based zinc rich primer may be necessary.

2.06.00 **Storage of Material**

2.06.01 **General**

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.06.02 **Steel**

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground sectionwise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.06.03 **Electrodes**

The electrodes for electric are welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.06.04 **Bolts, Nuts and Washers**

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

2.06.05 **Paints**

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.07.00 **Quality Control**

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work :

1)	Steel	Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
2)	Bolts, Nuts Washers	Manufacturer's certificate, dimension checks, material testing.
3)	Electrodes	Manufacturer's certificate, thick-ness and quality of flux coating.
4)	Welders	Qualifying Tests
5)	Welding sets	Performance Tests
6)	Welds	Inspection, X-ray, Ultrasonic tests
7)	Paints	Manufacturer's certificate, physical inspection reports
8)	Galvanizing	Tests in accordance with IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-Dip Zinc

coatings on Structural Steel and other allied products.

2.08.00 **Standard dimensions, forms and weights**

The dimensions, forms, weights and tolerances of all rolled shapes bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.09.00 **Shop Drawings**

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and delivery of structural steelwork for approval. He shall within forty five (45) days after issue of design drawings start to submit progressively for approval, the shop drawings based on the Design Drawings furnished to him and, before proceeding with the fabrication work, shall get the said shop drawings approved in accordance with the contract.

The sequence of submission of shop drawings for approval shall match with the approved fabrication and delivery schedule. The approval for the shop drawings will be accorded only towards the general conformity with the design requirements as well as specification and will ensure the correctness of general arrangement for centreline dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates. The correctness of all other details like cutting lenghts, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. will be entirely the contractor's responsibility. The approval of the drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The shop drawings shall include but not be limited to the following :

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolt location etc.

c) Details of all connections with supporting calculations.

d) Comparison sheets to show that the proposed alternative section, if any, are as strong as the original sections shown on the Design Drawings.

e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked -up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS:800 - Code of Practice for use of Structural Steel in General Building Construction and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification IS:1852 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600 Deg. C.

3.01.03 Cutting

Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gauges not more than 4 mm deep will be permitted. Gouges greater than 4 mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 **Planning of edges**

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 **Clearances**

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

3.02.00 **Bolted construction**

3.02.01 **Holes**

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 as specified in IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for bolts shall not be formed by gas cutting process.

3.02.02 **Assembly**

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 **Welded Construction**

3.03.01 **General**

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS:817.

3.03.02 **Preparation of Material**

Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 **Assembling**

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 Deg.).

The work shall be positioned for flat welding whenever practicable.

3.03.04 **Welding Sequence**

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 **Welding technique**

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the Contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03.06 **Temperature**

No welding shall normally be done on parent material at a temperature below (-) 5 Deg.C. However, if welding is to be undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5 Deg. C and 0 Deg. C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is

greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20 Deg. C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03.07 **Peening**

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03.08 **Equipment**

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 **Finish**

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

3.05.00 **Slab bases and caps**

Bases and caps fabricated out of steel slabs, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.06.00 **Lacing bars**

The ends of lacing bars shall be neat and free from burrs.

3.07.00 **Separators**

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.08.00 **Bearing Plates**

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.09.00 **Architectural Clearances**

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.10.00 **Shop connections**

a) All shop connections shall be welded as specified on the Drawings.

b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Contractor will have to make the desired changes at no extra cost to the Owner.

3.11.00 **Castings**

Steel castings shall be annealed.

3.12.00 **Shop erection**

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before despatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchangeability.

3.13.00 **Shop painting**

3.13.01 **General**

Unless otherwise specified, steelwork which will be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by through sweeping with a fibre brush.

After completion of the precleaning, the metal surface shall be immediately painted with red oxide zinc chromate primer conforming to IS : 2074.

In highly corrosive environment, all steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum. The shop paint shall be epoxy rasin based zinc rich primer.

Painting on Structural Steel

All structural steel shall receive 2 coats of red oxide zinc chromate primer (conforming to IS:2074), over 2 coats of synthetic enamel paint (of approve quality) Minimum thickness of each coat shall not be less than 25 micron).

3.13.02 **Inaccessible parts**

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.13.03 **Contact surfaces**

Contact surface shall be cleaned in accordance with Sub-clause 3.13.1 before assembly.

3.13.04 **Finished surfaces**

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.13.05 **Surfaces adjacent to field welds**

Unless otherwise provided for, surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.14.00 **Galvanizing**

3.14.01 **General**

Structural steelwork for switchyard or other structures as may be specified in the Contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS : 2629 - Recommended practice for Hot-Dip Galvanising of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.14.02 **Surface Preparation**

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.14.03 **Procedure**

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

4.00.00 **INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY**

4.01.00 **Inspection**

Unless specified otherwise, inspection to all work shall be made by the Engineer or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract.

The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 **Testing and Acceptance Criteria**

4.02.01 **General**

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost, unless otherwise specified in the Contract. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 **Steel**

All steel supplied by the Contractor shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T. or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be borne by the Contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

4.02.03 **Testing Criteria for checking Lamination in raw steel plates**

All raw steel plate of thickness more than 20 mm supplied by the contractor shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Engineer.

a) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.

b) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Engineer.

c) All raw steel plate of thickness more than 40 mm shall be procured with UT tested condition.

If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop, if the Engineer requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Contractor. If the plates in the fabricated item are found to be laminated, the component will be rejected.

4.02.04 **Welding**

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Engineer may ask for at least 1 (one) test- destructive or non-destructive including X-ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor. In the event of further tests as may be desired by the Engineer, the cost of such test shall be borne by the Contractor if the results are found to be unsatisfactory; and if the test shows no defect, the cost shall be borne by the Owner. In cases of the test results showing deficiency, the Engineer shall have option to reject or instruct any remedial measures to be taken free of charge to the Owner.

4.02.05 **Bolts, nuts and washers**

All bolts, nuts and washers shall be procured from reputed manufacturer approved by the Engineer and shall conform to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor.

4.02.06 **Shop painting**

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02.07 **Galvanizing**

All galvanizing shall be uniform and of standard quality when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 **Tolerance**

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS:1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and

thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

4.04.00 **Acceptance**

Should any structure or part of a structure be found not to comply with any of the provisions of this Specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check the test results obtained at the Contractor's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory, the costs shall be borne by the contractor, and if satisfactory, the costs shall be borne by the Owner.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue an acceptance certificate, upon receipt of which, the items will be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 **Delivery of materials**

4.05.01 **General**

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. the Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 **Marking**

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 **Packing and Shipping**

All projecting plates or edges and all ends of members of joints shall be stiffened, all straight members and plates, shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers, and small loose parts shall be packed separately in order to prevent damage or distortion during shipping.

Shipping shall be strictly in accordance with the sequence stipulated in the agreed programme. Payment may be held up for items sent in advance of the sequence till they could be erected. The Contractor shall include and provide for in his rates, the freight and other charges for despatching the materials to

the worksite and also for securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All packings shall allow for easy removal and checking at site. Special precautions shall be taken against rusting, corrosion, breakage or damage otherwise of the materials. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following :

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water- proof envelope, quoting especially

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each package shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner without any extra payment.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel

belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above mentioned charges, the amount paid will be deducted from the progressive bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information are required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

1) Preparation and approval of shop drawings

2) Procurement of materials

3) Fabrication and shipping of all anchor bolts

4) Fabrication and shipping of main steelwork

5) Fabrication and shipping of steelwork for bunkers. Tanks and / or silos as applicable.

6) Fabrication and shipping of all other remaining steel work including miscellaneous steelwork

7) Final date of completion of all shipments

Time required for completion being one of the main criteria for selecting the successful bidder, it is desired that the bidder quotes the minimum time required by him for completing the work.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following :

a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings furnished to him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day of each month, giving the up to date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Results of any test as and when conducted and as required by the Engineer.

d) Manufacturer's mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.

TECHNICAL SPECIFICATION
FOR
X) ERECTION OF STRUCTURAL STEEL WORK

CONTENTS

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X) ERECTION OF STRUCTURAL STEEL WORK

1.00.00 **SCOPE**

This specification covers the erection of structural steelwork and installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 **GENERAL**

2.01.00 **Work to be provided for by the Contractor**

The work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.

b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. any defect observed in the foundation shall be brought to the notice of the Engineer. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, leveling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures if required by the Contract.

g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:

   i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size bolt if required.

iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting will be permitted only at the discretion of the Engineer.

v) Re-fabrication of parts damaged beyond repair during transport and handling or Re-fabrication of parts which are incorrectly fabricated.

vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

viii) Carry out tests in accordance with this Specification if directed.

2.02.00 **Work by others**

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 **Codes and Standards**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS-800 : Code of Practice for general construction in steel

IS-456 : Code of Practice for plain or reinforced concrete

IS-7205 : Safety Code for erection of Structural Steel work

IS-12843 : Tolerance for erection of Steel Structures

2.04.00 **Conformity with designs**

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard Specifications and/or the instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and /or the instructions of the Engineer.

2.05.00 **Material**

2.05.01 **General**

All fabricated steel structures and connection materials shall be supplied by the Contractor for fabrication work. The Contractor may also have to take delivery directly from railway wagons or trucks at Site as per terms & condition of the contract, in which case he shall have to unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.1.0 and as specified herein before.

While taking delivery, the Contractor will check the quantity, quality and the sizes of the materials and verify the adequacy of the same in accordance with the Drawings and Specifications. In case the Contractor finds any material inadequate, he shall inform the Engineer immediately prior to taking delivery of the same. No claim whatsoever, in respect of bad quality, shortages or difference in size will be entertained once the delivery is taken and the Contractor shall make good any such deficiency, if detected later, either by repair or with fresh material as may be directed by the Engineer at the Contractor's Own cost.

Excepting all field connection materials like bolts, nuts, washers and electrodes, which will be supplied by the fabrication Contractor to the extent of 10% in excess of the estimated requirements as per Drawings, all other consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract will be supplied by the contractor for erection work and will be deemed to have been included in this rates.

2.05.02 **Materials to conform to Indian Standards**

All materials required to be supplied by the Contractor under this Contract shall conform to the relevant Indian Standard Specifications.

2.06.00 **Storage of materials**

2.06.01 **General**

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the Engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 **Yard**

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of

sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work.

The Tenderer should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 **Covered Store**

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 **Quality control**

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following items of work :

a) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

b) Grouting : Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.

c) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 **Taking Delivery**

The erection Contractor shall take delivery of fabricated structural steel and necessary connection materials supplied by the fabrication Contractor from railhead, trucks at site as may be necessary and as per terms & conditions of the contract or as directed by the Engineer. He shall check, unload, transport the materials to his stores for proper storing at his own cost. The erection Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The erection contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.

3.01.03 Temporary bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The responsibility of the Contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, leveled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work and cribbing shall be removed immediately upon completion of the steel erection and shall return to the Owner's store in good condition if the materials are supplied by the Owner otherwise permission shall be given to Contractor to take out the materials from the project site. The Owner may remove and return the materials in good condition to the Contractor without any charge if they have been left in place under other agreed arrangement.

3.01.04 Temporary floors for buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or by-laws of state, Municipal or other local authorities.

3.01.05 **Setting out**

Positioning and leveling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. Concrete foundations, where required, shall be made by other agencies. Anchor bolts and other anchor steel shall be embedded by other agencies. The Contractor shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Contractor shall set proper screed bars if desired by the Engineer, to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.

3.01.06 **Field bolting**

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following :

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 x dia. or 200 mm	Bolt length exceeding 8xdia. or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30 over or under.

Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm)	Torque to be applied (Kg.M) for bolt class 8.8 of IS:1367
20	59.94
22	81.63
24	103.73

Note :

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia., 18.2 MT for 22 mm dia.; and 21.2 MT for 24 mm dia., bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.07 **Field Welding**

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.08 **Holes, cutting and fitting**

No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done unless specifically approved and / or instructed by the Engineer.

The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 **Drifting**

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 **Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)**

Grouting shall be carried out with Ordinary Cement grout as described below :

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm downgraded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

Admixtures like aluminium powder, "ironite" or equivalent may be required to be added to the grout to enhance certain desirable properties of the grout.

Alternatively, the grouting may be done with non-shrink high strength free flow cementious grout (ready mixed) like "Sika grout - 214", or "Anchor NSG" or approved equivalent.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally leveled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

3.04.00 **Painting after erection**

Field painting, if required to be done by the erection Contractor, shall only be done after the structure is erected, leveled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. However, touch up paintings, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the erection Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in rainy or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which will be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabricated steel members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project. The number of coats and the shades to be used shall be as specified or as directed by the Engineer.

3.05.00 Stainless Steel Plate Lining in Bunker Hopper

The hopper portion of the coal bunkers shall be lined with stainless steel plates of 3 mm thickness. The stainless steel shall be of AISI-316 quality. The work includes supply, fabrication, welding and fixing of stainless steel lining plate to bunker M.S. plate as per drawing & specification.

The stainless steel liner shall be fixed to the bunker hopper MS by plug welding using special electrodes (such as, Inox-CW coding AWS-310-16, ISMBOS-311 or Inox-D2 coding AWSE-309-16, ISMB 04-311 manufactured by Advani Oerlikon Ltd. or equivalent). Such plug welding shall be done by drilling 21.5 mm dia. holes at 300 mm centre to centre both ways as per drawings. The plug welding shall be ground flush with the lining plate.

3.06.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the Contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

3.07.00 Safety Measures during Erection

The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slinging, welding, gas cutting, etc.) should be taken as per IS:7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract of either fabrication or erection of steelwork whoever is responsible for it and no payment towards the cost of the dismantled portion and any connected work shall be made to the Contractor, unless it is proved that the deficiency is due to reasons beyond the Contractor's scope. On the basis of the tests, the Engineer will decide whether the fabricator or the erector is responsible for the unacceptable member or structure and his decision will be final. In case it is established that the unacceptability of the member or

structure is due to design deficiency, the cost of replacement and/or modifications will be borne by the Owner. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor responsible, to the satisfaction of the Engineer. The cost of the tests specified hereinafter shall be borne by the Owner. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following Sub-clauses 4.1.1, 4.1.2 and 4.1.3. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 **Stiffness Test**

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 **Strength Test**

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 **Structure of same design**

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of

comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 **Repair for subsequent test and use after strength tests**

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 herein before and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.1.1. herein before.

4.02.00 **Tolerances**

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steelwork applicable to this Project and as specified below:

I. For Buildings Containing Cranes

Component	Description		Variation Allowed	
Main columns	a)	Shifting of column axis at foundation level with respect to building line		
		i) In longitudinal direction	i)	$\pm$ 3.0 mm
		ii) In lateral direction	ii)	$\pm$ 3.0 mm
	b)	Deviation of both major column axis from vertical between foundation and other member connection levels :		
		i) For a column upto and including 10M height	i)	$\pm$ 3.5 mm from true vertical

Component	Description		Variation Allowed
	ii)	For a column greater than 10M but less than 40M height any 10M	ii) ± 3.5 mm from true vertical for length measured between connection levels, but not more than ± 7.0 mm per 30 m length
	c)	For adjacent pairs of columns across the width of the building prior to placing of truss.	± 9 mm on true span.
	d)	For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e)	For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
Trusses	a)	Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord	1/1500 of the span or not greater than 10 mm whichever is the least
	b)	Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is the least
Crane Girders & Tracks	a)	Difference in levels of crane rail measured between adjacent columns.	2.0 mm
	b)	Deviation to crane rail gauge	± 3.0 mm

Component	Description		Variation Allowed
	c)	Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm
	d)	Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps		At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per Deg.C per unit length.	

II. For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10M section of height and not more than 7.0 mm per 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 **Acceptance**

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1.0, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this Contract.

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **Before Tender**

Along with the Tenders the Tenderers will be required to submit the following information :

5.01.01 **Tentative Programme**

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 **Constructional Plant & Equipment, Tools, Temporary Works & Manpower**

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 **Erection yard**

A site plan showing the layout and location of the erection yard proposed to be established by the Tenderer shall be attached with the Tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00 **After award of the Contract**

After award of the contract, the Contractor shall submit the following :

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 **Fortnightly Progress Report**

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub- clause 5.2.1 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

TECHNICAL SPECIFICATION
FOR
XI) ROADS AND DRAINAGE

PART-I : CONSTRUCTION OF ROADS & DRAINS

CONTENTS

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5.00.00	INTERLOCKING PAVING BLOCKS

XI) ROADS AND DRAINAGE

PART-I : CONSTRUCTION OF ROADS & DRAINS

1.00.00 SCOPE

This specification covers all work required for the construction of road including box-cutting, edging, sub-base, water bound macadam, bituminous macadam, wearing course etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification also includes all work required for drainage including road side drain, R.C.C. culverts, pipe-culverts, drainage pipes, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 Work to be Provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.

b) Submit for approval detailed schemes of all operations required for executing the work e.g., material handling, placement, services, approaches etc.

c) To carry out and submit to the Engineer results of tests whenever required by the Engineer to assess the quality of work.

2.02.00 Work to be Provided for by Others

No work under this specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and Codes of Practice.

1. Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.

2. IRC-19 Standard specifications and Code of Practice for Water Bound Macadam.

3. IRC:SP-11 Hand Book of Quality Control for Construction of Roads and Runways.

4. IS:456 Indian Standard Code of Practice for Plain and Reinforced Concrete.

5. IS:2212 Code of Practice for Brickwork.

6. IS:783 Code of Practice for Laying of Concrete Pipes.

7. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard Specification, any other standard practice as may be specified by the Engineer shall be followed.

2.04.00 **Conformity with Designs**

The contractor shall carryout the work as per the drawings issued to him and/or contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be Used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.06.00 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used.

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for roadworks are described hereinafter.

i) Horizontal Alignments

Horizontal alignments shall be reckoned with respect to the center line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of $\pm$ 25 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be $\pm$ 40 mm.

ii) Longitudinal Profile

The levels of the sub-grade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer, beyond tolerances mentioned below:

Sub-grade	$\pm$ 25 mm
Sub-base	$\pm$ 20 mm
Base course	$\pm$ 15 mm
Wearing course	$\pm$ 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6 mm.

iii) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of completed sub-bases, base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table-I.

TABLE-I

PERMITTED TOLERANCES OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal Profile with 3 m straight edge					Cross Profile
		Max. Permissible undulation.	Max. number of undulations permitted in any 300 metres length exceeding :				Max. permissible variation from specified profile under camber template
			mm	mm	mm	mm	
			18	12	10	6	
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50mm & 40-63mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing ** (two coat) over WBM (20-50mm or 40-63mm size metal), Bituminous penetration macadam or built-up spray grout	12	-	-	20	-	8
6.	Open graded premix carpet, mixseal surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20 ***	6
8.	Semi-dense carpet	10	-	-	-	20 ***	6
9.	Asphaltic Concrete	8	-	-	-	10 ***	4

The longitudinal profile shall be checked with a 3 meter long straight edge, at the middle of each traffic lane along a line parallel to the center of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10 metres.

Notes :

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However, this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 EXECUTION

3.01.00 Shoulder Construction

3.01.01 Description

This work shall consist of constructing shoulders on either side of the pavement, in accordance with the requirements of this specification and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

3.01.02 Materials

Shoulder may be of selected earth or granular material conforming to the requirements of embankment construction or granular sub-base construction respectively.

3.01.03 Construction Operations

Except in the case of bituminous constructions, shoulders shall be constructed in advance of the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and included area cleaned of all spilled material before proceeding with the construction of the pavement layer.

In the case of bituminous courses, shouldering operations shall start only after the pavement course has been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement and the area so affected thoroughly cleaned.

During all stages of shoulder construction, the required cross-fall shall be maintained to drain off surface water.

3.02.00 **Kerb**

3.02.01 **Material**

Kerb, if required for construction of footpath, shall consist of precast concrete blocks with a concrete grade of M-20 (minimum).

3.02.02 **Laying**

The Kerb shall be laid by cutting trenches 150 mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the Kerbs shall be in plumb and the gap between the block shall not be more than 10 mm.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.03.00 **Sub-base (Granular Sub-base)**

3.03.01 **Description**

This work shall consist of laying and compacting well-graded material on prepared sub-grade in accordance with the requirements of these specifications. The material shall be laid in one or more layers as shown on the drawings and according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

3.03.02 **Materials**

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kanker etc. or combinations thereof depending upon the grading required. The mixed materials shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table-II below.

TABLE-II
GRADING FOR GRANULAR SUB-BASE MATERIALS

Sieve designation	**Percent by weight passing the sieve**		
	Grading 1	**Grading 2**	**Grading 3**
80 mm	100	100	100
63 mm	90-100	90-100	90-100
4.75 mm	35-70	40-90	50-100
75 micron	0-20	0-25	0-30
CBR Value (Minimum) : for fraction of material passing 20 mm sieve	30%	25%	20%

Note : The material passing 425 micron sieve for all the three gradings when tested according to IS:2720 (Part V) shall have liquid limit and plasticity index of not more than 25 percent and 6 percent respectively.

3.03.03 **Physical Requirements**

The fraction of material passing 20 mm sieve shall give a CBR value as specified in Table-II when tested in accordance with IS:2720 (Part XVI) after preparing the samples at maximum dry density and optimum moisture content corresponding to IS:2720 (Part VII) and soaking the same in water for 4 days.

3.03.04 **Spreading and Compacting**

Immediately prior to the laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary, and rolled with one pass of 8-10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of the layer after consolidation does not exceed 150 mm.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part II) and suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part VIII). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be started with 8 to 10 tonne smooth wheeled rollers or other approved plant. Rolling shall commence at the edges and progress towards the center longitudinally except that on super elevated portions it shall progress from the lower to the upper edge parallel to the center line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density for the material determined as per IS:2720 (Part VII). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

3.04.00 **Water Bound Macadam Sub-base/Base Course**

3.04.01 **Description**

Water bound macadam shall consist of clean, crushed aggregates mechanically interlocked by rolling, and bonded together with screenings, binding material, where necessary and water, laid on a prepared sub-grade or sub-base, as the case may be, and finished in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or otherwise directed by the

Engineer.

3.04.02 **Materials**

3.04.02.1 Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table-III.

TABLE-III

PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM

Sl. No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value*	IS:2386 (Part IV)	50 percent maximum.
		or		
		Aggregate Impact Value	IS:2386 (Part IV)	40 percent maximum.
		or IS:5640**		
2.	Base	a) Loss Angeles Abrasion Value*	IS:2386 (Part IV)	50 percent maximum.
		or		
		Aggregate Impact Value	IS:2386 (Part IV)	40 percent maxi mum.
		or IS:5640**		
		b) Flakiness Index***	IS:2386 (Part I)	15 percent maximum.

* Aggregate may satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water, shall be tested for impact value under conditions in accordance with IS:5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

3.04.02.2 Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt and other objectionable matter.

3.04.02.3 Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table-IV, provided, however, the use of Grading No. 1 shall be restricted to sub-base courses only.

TABLE-IV

GRADING REQUIREMENTS OF COARSE AGGREGATES

Grading No.	Size range	Sieve designation	Percent by weight passing the sieve
1.	90 mm to 40 mm	100 mm	100
		80 mm	65-85
		63 mm	25-60
		40 mm	0-15
		20 mm	0-5
2.	63 mm to 40 mm	80 mm	100
		63 mm	90-100
		50 mm	35-70
		40 mm	0-15
		20 mm	0-5
3.	50 mm to 20 mm	63 mm	100
		50 mm	95-100
		40 mm	35-70
		20 mm	0-10
		10 mm	0-5

3.04.02.4 Screenings

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the gradings set forth in Table-V Screenings of Type A in Table shall be used with coarse aggregates of grading 1 in Table IV. Screenings of Type A or B, shall be used with coarse aggregates of grading 2. Type B screenings shall be used with coarse aggregates of grading 3.

TABLE-V

GRADINGS FOR SCREENINGS

Grading Classifi-cation	Size of screenings	Sieve designation	Percent by weight passing the sieve
A.	12.5 mm	12.5 mm	100
		10.0 mm	90-100
		4.75 mm	10-30
		150 micron	0-8
B.	10 mm	10 mm	100
		4.75 mm	85-100
		150 micron	10-30

3.04.02.5 Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value of less than 6 as determined in accordance with IS:2720 (Part V).

Application of binding material may not be necessary, when the screenings used are of crushable type such as moorum or gravel.

3.04.03 **Construction Operations**

3.04.03.1 Preparation of Base

The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50 mm x 50 mm furrows shall be cut at an angle of 45 degrees to the center line of the road at 1 meter intervals in the latter before laying the coarse aggregate.

3.04.03.2 Inverted Choke

If the water bound macadam is to be laid directly over the sub-grade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) shall be spread on the prepared sub-grade before application of the coarse aggregates is taken up.

3.04.03.3 Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly upon the prepared surface in such quantities that the thickness of the compacted layer is 100 mm for grading 1 and 75-100 mm for gradings 2 and 3 for each layer.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted base be permitted.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall not normally be spread more than 3 days in advance of the subsequent construction operations.

3.04.03.4 Rolling

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the center. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the center line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re-rolling until the entire surface conforms to desired camber and grade. In no case shall the use of screenings be permitted to make up depressions.

3.04.03.5 Applications of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreaders, or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

3.04.03.6 Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excessive quantities of water during construction.

3.04.03.7 Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

3.04.03.8 Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.05.00 Tack Coat

3.05.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.05.02 Materials

Binder : The binder used for tack coat shall be bitumen of a suitable grade as directed by the Engineer and conforming to IS:73, 217 or 454, as applicable, or any other approved cutback.

3.05.03 Construction Operations

3.05.03.1 Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous material before the application of the binder.

3.05.03.2 Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight-run bitumen shall be 5 kg. per 10 square meter area for an existing bitumen treated surface and 10 kg per 10 square meter area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers.

The tack coat shall be applied just ahead of the on-coming bituminous construction.

3.06.00 **Bituminous Macadam Binder Course**

3.06.01 **Description**

This work shall consist of construction, in a single course, of 50 mm / 75 mm thickness of compacted crushed aggregates premixed with a bituminous binder, laid immediately after mixing, on a base prepared previously in accordance with the requirements of these Specifications, and in conformity with the lines, grades and cross sections shown on the drawings or directed by the Engineer.

3.06.02 **Materials**

3.06.02.1 Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS:73.

3.06.02.2 Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, of fairly cubical shape and free of disintegrated pieces, organic and other deleterious matter, and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table-VI.

TABLE-VI

PHYSICAL REQUIREMENTS OF AGGREGATES FOR BITUMINOUS MACADAM

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion * Value	IS:2386 (Part IV)	35% Maximum
2.	Aggregate Impact Value *	-do-	30% "
3.	Flakiness Index	IS:2386 (Part I)	35% "
4.	Stripping Value	IS:6241	25% "
5.	Water Absorption	IS:2386 (Part III)	2% "

* Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thicknesses shall conform to the grading A or B given in Tables-VII & VIII.

TABLE-VII

AGGREGATES GRADING FOR 75 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90-100	
40 mm	35-65	100
25 mm	20-40	70-100
20 mm	-	50-80
12.5 mm	5-20	-
4.75 mm	-	10-30
2.36 mm	-	5-20
75 micron	0-5	0-4

TABLE-VIII

AGGREGATE GRADING FOR 50 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90-100	
25 mm	50-80	100
20 mm	-	70-100
12.5 mm	10-30	-
10 mm	-	35-60
4.75 mm	-	15-35
2.36 mm	-	5-20
75 micron	0-5	0-4

3.06.02.3 Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate grading A and B respectively, except when otherwise directed by the Engineer.

The quantities of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

3.06.02.4 Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content of $\pm$ 0.3 percent by weight of total mix shall, however, be permissible for individual specimens taken for quality control tests.

3.06.03 **Construction Operations**

3.06.03.1 Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

3.06.03.2 Preparation of Base

The base on which bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free from dust and foreign matter.

3.06.03.3 Tack Coat

A tack coat shall be applied over the base.

3.06.03.4 Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix.

The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg.C and that of aggregates in the range 125 Deg. - 150 Deg.C, provided that the difference in temperature between the binder and aggregate at no time exceeds 25 Deg.C.

Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly.

The mixture shall be transported from the mixing plant to the point of use in suitable vehicles. The vehicles employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

3.06.03.5 Spreading

The mix shall be spread immediately after mixing by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However, in restricted locations and in narrow widths, where the available plants cannot operate in the opinion of the Engineer, he may permit manual laying of the mix.

The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg.C.

In multilayer construction, the longitudinal joint in one layer shall offset that in the layer below by about 150 mm. However, the joint in the topmost layer shall be at the center line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the center line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

3.06.03.6 Rolling

After the spreading of mix, rolling shall be done by 8 to 10 tonne power rollers or other approved plant. Rolling should start as soon as possible after the material has been spread. Rolling shall be done with care to keep from unduly roughening the pavement surface.

Rolling of the longitudinal joint shall be done immediately behind the paving operation. After this, the rolling shall commence at the edges and progress towards the center longitudinally except that on super-elevated portions it shall progress from the lower to the upper edge parallel to the center line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface or having the mix pick up on the roller wheels. The second or inter-mediate rolling shall follow the break down rolling as closely as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh material. The rolling shall then be continued till the entire surface has been rolled to compaction, there is no crushing of aggregate and all roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking to the wheels and being picked up. In no case shall fuel lubricating oil be used for this purpose.

Rolling operations shall be completed in every respect before the temperature of the mix falls below 80 Deg.C.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with final surfacing without any delay. If there is to be any delay, the course shall be covered by a seal coat before allowing any traffic over it.

3.07.00 **Open-Graded Premix Carpet**

3.07.01 **Description**

This work shall consist of laying and compacting an open-graded carpet of 2 cm thickness in a single course composed of suitable small sized aggregates premixed with a bituminous binder on a previously prepared base, to form a wearing course, in accordance with the requirements of these specifications.

3.07.02 **Materials**

3.07.02.1 Binder

The binder shall be bitumen of a suitable grade, as directed by the Engineer, and satisfying the requirements of IS:73, 217, 454 or other approved cutback as applicable.

3.07.02.2 Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, and vegetable or other deleterious matter. They shall preferably be hydrophobic type.

The aggregates shall satisfy the quality requirements set forth in Table-VI except that the Flakiness Index shall be limited to a maximum of 30.

3.07.02.3 Proportioning of Materials

The materials shall be proportioned as per quantities given in Table IX.

TABLE-IX

QUANTITIES OF MATERIALS REQUIRED FOR 10 SQ.M OF ROAD SURFACE FOR 2 CM THICK OPEN-GRADED PREMIX CARPET

Aggregates of Carpet

a)	Stone chippings - 12 mm size; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
b)	Stone chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total :	0.27 Cu.m

Binder for premixing (quantities in terms of straight run bitumen)

a)	For 0.18 Cu.m of 12 mm size stone chippings at 52 kg per Cu.m	9.5 kg
b)	For 0.09 Cu.m of 10 mm size stone chippings at 56 kg per Cu.m	5.1 kg
	Total :	14.6 kg

3.07.03 **Construction Operation**

3.07.03.1 Weather and Seasonal Limitations

Open-graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg.C or below.

3.07.03.2 Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade & cross section in accordance with Table I as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matter with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

3.07.03.3 Tack Coat

A tack coat complying with clause 3.5 shall be applied over the base preparatory to laying of the carpet. Application of tack coat shall, however, not be necessary when the laying of carpet follows soon after the provision of a bituminous course.

3.07.03.4 Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer, in boilers of suitable design avoiding local overheating and ensuring a continuous supply.

The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified.

The mixing of binder with chippings shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

3.07.03.5 Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader, without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material has been laid rolling shall commence with 6 to 8 tonne power rollers, preferably of smooth wheel tandem type, or other approved plant. Rolling shall begin at the edges and progress toward the center longitudinally, except that on the super elevated portions it shall progress from the lower to upper edge parallel to the center line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

3.07.03.6 Seal Coat

A seal coat conforming to clause 3.8 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.08.00 **Seal Coat**

3.08.01 **Description**

This work shall consist of application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and camber.

Seal coat shall be of either of the two types below, as specified:

Type A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.08.02 **Materials**

3.08.02.1 Binder

The binder shall be bitumen of a suitable grade as directed by the Engineer and conforming to the requirements of IS:73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be utilised, in terms of straight run bitumen shall be 9.8 kg and 6.8 kg per 10 square meter area for Type A and Type B seal coat respectively.

3.08.02.2 Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matter. Stone chippings shall be of 6 mm size defined as 100 percent passing through 10 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cubic meter per 10 square meter area. The chippings shall satisfy the quality requirements spelled out in Table-VI except that the upper limit for flakiness Index shall be 30.

3.08.02.3 Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky

material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic meter per 10 square meter area.

3.08.03 **Construction Operations**

3.08.03.1 Preparation of Base

The seal cost shall be applied immediately after the laying of bituminous course which is required to be sealed. Before application of seal coat materials the surface shall be cleaned free of any dust or other extraneous matter.

3.08.03.2 Construction of Type A Seal Coat

The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state, shall be spread uniformly on the surface, preferably by means of a mechanical gritter, otherwise manually so as to cover the surface completely. If necessary, the surface shall be broomed to ensure uniform spread of chippings.

Immediately after the application of the cover material, the entire surface shall be rolled with a 8-10 tonne smooth wheeled roller. Rolling shall commence at the edges and progress towards the center except in super elevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

3.08.03.3 Construction of Type B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter are thoroughly coated with the former.

The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6-8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.08.04 **Opening to Traffic**

In the case of Type B Seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. However, as regards Type A seal coat, traffic shall not be permitted until the following day.

3.09.00 **Repair of Existing Water Bound Macadam Surface**

Pot holes or patches and ruts in water bound macadam base or surface course, which is to be surface treated, shall be repaired by removal of all loose material by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under :

Pot holes, patches and ruts shall be drained of water and cut to regular shape with vertical sides, and then be filled either with i) coarse aggregate and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer or ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer. Payment for i) shall be done as per items for water bound macadam and for ii) as per item for open graded premix carpet.

The above is only applicable in case of damage to the existing water bound macadam surfaces. In case, however, it is found that there has been damage to the granular sub-base as well, the area of the damaged surface shall be repaired by removal of all loose materials, cut to regular shape with vertical sides & relaid with graded material as per specification of granular sub-base & then surfaced with water bound macadam as per specification for the same.

For the record purposes, measurements for stone metal shall be taken before they are actually used on the work. Pre-measurements of materials taken for record purposes shall simply serve as a guide and shall not form the basis for payment. Thickness of treatment shall be the ruling criterion for payment for repair of water bound macadam surfaces and sub-base.

Payment for repairs shall be made on the basis of unit rates quoted by the Contractor for the items and shall include supply and laying of sub-base, water bound macadam, rolling etc. including labour, materials, tools, plants, tackle etc. required for the work.

3.10.00 **Road Side Drains**

3.10.01 **Formation of Drains**

The road side drains shall be made in sizes and slopes as shown on drawings and/or as instructed by the Engineer. The minimum side slope shall be as instructed by the Engineer. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts, outside plant area, as per instructions of the Engineer.

The excavated spoils shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for the drains shall be as per approved drawing. Lining of drains will be of RCC construction with necessary slopes.

3.11.00 **Culverts**

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Engineer after clearing the site, etc. as per specifications of earthwork. Backfilling with ramming and watering shall be done after construction of the foundations.

The construction of culverts shall be done true to lines and levels and as shown on the drawing. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed, as applicable.

3.12.00 **Pipe Culverts and Drainage Pipes**

3.12.01 **Materials**

The drainage pipes unless otherwise shown on drawings or instructed by the Engineer shall be made of R.C.C. and shall be either Class NP2 or NP3.

Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP3 or of RDSO class for railway as decided by the Engineer or shown in the drawing. All pipes shall meet the requirements of IS:458 - Latest edition and shall be procured from approved manufacturers with collars as per manufacturer's standard specifications. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269 - Latest edition.

Aggregates shall be as per IS:383 - Latest edition - Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller.

Fine aggregates for concrete shall be as per IS:383 - Latest edition.

3.12.02 **Laying of Pipes**

Laying of concrete pipes shall correspond to IS:783 - Latest edition - and to specification given below :

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings or as directed by the Engineer. When trenching is involved its width on either side of the pipe shall not be less than 150 mm nor more than one-third the diameter of pipe unless otherwise instructed/ permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water, etc. as required shall be done by the Contractor without any extra cost to the Owner. Side slips, if there be any, shall be removed by the Contractor without any extra cost to the Owner. After laying of the pipes are completed, backfilling of the trenches shall be done in 250 mm layers, measured loose, clods & lumps broken, watered and compacted with iron rammers to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area, as instructed by the Engineer.

When bed-rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented material, shaped to the requirements and thoroughly

compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

Laying of pipes shall start from the outlet and proceed towards inlet.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from a height.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS:783 - Latest edition - having a projection ratio of not greater than 0.70, in which the pipe is carefully bedded on fine granular materials in an earth foundation carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height, and in which earthfilling material is thoroughly rammed and tamped in layers not exceeding 15 cm in depth around the pipe for the remainder of the lower 30 percent of its height.

If the pipe is laid in trench, pipe bedding shall be first class bedding as per IS:783.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a craddle constructed of concrete having a mix not leaner than M15. The shape and dimension of the cradle shall be as indicated on the drawing or directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete has set.

c) The drop walls shall be made with Fly ash brick or first class clay bricks having compressive strength minimum of 50 kg/cm^2, in 1:4 cement:sand mortar.

d) The pipe culverts shall be made with proper care regarding the invert of the pipe, gradient, if any, etc. as specified on drawings and/or as instructed by the Engineer.

e) Where R.C.C. pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and remaining height of block to be concreted subsequently.

f) The R.C.C pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 parts of clean sand with only enough water for workability. Procedure of jointing shall be as per IS:783 - latest edition.

3.12.03 **Relation with Water Supply Pipeline**

Unless specifically cleared by the Engineer, under no circumstances shall drainage pipes be allowed to come close to water supply pipelines.

3.13.00 **Manholes and Inspection Chambers**

The maximum distance between manholes shall be 30 meter unless specifically permitted otherwise. In addition at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be watertight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels & drains shall be shaped and laid to provide smooth flow.

Connection to existing pipelines shall be through a manhole.

Manholes shall be provided with standard covers, usually C.I. or as directed by the Engineer. The covers shall be close fitting so as to prevent gases from coming out.

3.14.00 **Masonry**

3.14.01 **Brick Masonry**

All bricks shall be Fly ash brick or clay bricks of first class (Class A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws or nodules of free lime. Bricks shall be soaked in water for at least two hours prior to use and shall be laid truly horizontal and vertical in headers and stretchers with cement mortar consisting of one part of cement and four parts of sand, unless otherwise mentioned in the schedule of Items or directed by the Engineer, in layers not exceeding 1.5 M in height. Each layer shall be allowed at least 24 hours to settle itself before another layer is placed on it and every layer cured with water until the starting of next layer above it.

Materials for mortar such as sand and cement shall be of approved quality. Mortar shall be well mixed, first dry mixed and then by adding water slowly to have a thick workable consistency. Mortar shall be mixed in small batches consistent with the rate of consumption so that no mortar is used after one hour of mixing.

Mortar joints shall be kept uniformly 10 mm thick and all joints should be full of mortar. Brickwork shall be carried up regularly in plumb every course being horizontal. No vertical joints shall come directly over one another.

Joints of the brickwork shall be raked minimum 10 mm deep using raking tool while mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. The brickwork shall be kept moist for 14 days.

All bricks which absorb water more than 20% of their own dry weight after being immersed in water for 24 hours shall be rejected. Brick should be as per IS:1077. Bricks shall have minimum crushing strength of 50 kg/Sq.cm.

3.14.02 **Stone Masonry**

All stones shall be from approved quarries, hard, tough, durable, compact grained, uniform in texture & colour and free from decay, flaws, veins, cracks & sand holes. A stone shall not absorb more than 5% of its weight of water after 24 hrs. immersion. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

Stone shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall not be less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.14.03 **Pointing to Masonry**

After raking out of the joints, the brickwork shall be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water, mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finished with suitable tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

3.15.00 **Plaster to Masonry and Concrete**

Before application of plaster the surface shall be cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess water shall be mopped up.

Unless otherwise mentioned in the schedule of items plastering shall be done with cement sand mortar - 1 part by volume of cement to 4 parts by volume of clean, sharp, well graded sand. For sand cement plaster, sand & cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency. For lime gauge plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall than be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No mortar which has stood for more than half an hour shall be used.

Plaster, when more than 12 mm thick, shall be applied in two coats. All plaster work shall correspond to IS:1661 - latest edition.

3.15.01 **Finish**

Generally, all plastered surfaces shall have a standard finish unless otherwise shown on the drawing or directed by the Engineer. The interior plaster shall be finished to a smooth surface by steel trowelling. The exterior surfaces shall be finished with a wooden float.

However, if shown on the drawing or directed by the Engineer the plastered surface shall have a neat cement finish. Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg per Sq.M. and rubbed smooth with a trowel.

3.16.00 **Cement Concrete (Plain and Reinforced)**

3.16.01 **General**

All concrete work shall be according to ISI relevant Codes unless mentioned otherwise herein and the ISI Codes particularly IS:226, IS:455, IS:385, IS:1786 & IS:456 - latest editions - shall form a part of the present specification.

3.16.02 **Materials**

a) Cement : The cement used shall be ordinary portland cement of grade 43 / 53 of approved manufacture and shall be fresh when delivered. Consignments shall be used in the order of delivery. Damaged or partly set cement shall not be permitted to be used and shall be removed from site at once.

Admixture shall be used only if approved by the Engineer. The Contractor shall furnish to the Engineer, the manufacturer's certificate for cement for each consignment, procured by the Contractor direct. If at any time, the Engineer feels that the quality of cement is not upto the specification, he can stop the work and send samples of cement for testing to an approved laboratory. The Contractor shall have no claim for any loss arising out of such suspension of work.

If the cement is procured by the Owner and issued to the Contractor, the Contractor shall satisfy himself at the time of taking delivery that quality and freshness of cement are upto the specified standard. No complaint will be entertained later on from the Contractor for poor concrete work due to the poor quality of cement supplied by the Owner. All rectification work on this account shall be done entirely by the Contractor at his own expenses.

b) Aggregate :

i) General

Aggregate shall consist of natural sand, crushed stone procured from a source known to produce satisfactory aggregate for concrete and shall be chemically inert strong, hard, durable against weathering, of limited porosity and free from adhering coatings, clay lumps, coal and coal residues, clinkers, slag, organic and other impurities that may cause corrosion of the reinforcements or may impair the strength and/or durability of the concrete. They shall conform to IS:383 - latest edition.

ii) Sand and Fine Aggregate :

It shall be clean, sharp and coarse and free from all impurities

and shall be washed and/or screened at the site if so demanded by the Engineer. Sand and fine aggregate shall correspond to IS:383 - latest edition. The fine aggregate shall not contain more than 3 percent of clay or foreign matter. Fineness modulus of sand shall not be less than 2.5.

iii) Coarse Aggregate:

This shall consist of broken trap, basalt or granite or some other suitable stone from a source to be approved by the Engineer and shall meet the requirements of IS:383 - latest edition. The coarse aggregate shall be machine crushed, hard, strong, durable, free from clayey films or loamy admixtures, vegetable or organic matters and shall be washed with water and/or screened if so demanded by the Engineer. The aggregate shall be well graded. The pieces shall be angular in shape and shall have granular or crystalline surface. Friable, flaky and laminated pieces, mica and shell may be present only in such quantities that will not affect adversely the strength and/or durability of concrete and to the approval of the Engineer. The maximum size of coarse aggregate shall be 38 mm for lean concrete and M10 Grade concrete and 20 mm for M15 Grade concrete.

Where permitted by the Engineer, the maximum size of the coarse aggregate may be large. All aggregate shall be uniformly graded. The amount of fine particles occurring in the free state or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% of the weight.

c) Water :

Water shall be clean, fresh and free from organic or deleterious matter in solution or in suspension in such amounts that may impair the strength or durability of the concrete. The Contractor shall, however, satisfy himself that the quality is upto the desired standard and shall also submit an analysis from an approved analyst if so desired by the Engineer, free of charge.

d) Reinforcements :

The reinforcement shall be mild or torsteel bars conforming to the latest edition of IS:432 or IS:1786.

All reinforcing bars must be completely free from grease, oil, dirt, scales, scrapable rust, bituminous material, paint, pitted surface and manufacturing defects.

e) Formwork :

The formwork shall be composed of best quality well seasoned hardwood, steel, suitable plywood or equivalent, well seasoned best quality soft wood (for ornamental works) as directed by the Engineer. Bamboos, small diameter ballies, etc. shall not be used unless specially approved by the Engineer in specific cases.

3.16.03 **Storage of Materials**

a) Cement :

Cement shall be stored at the works in such a manner as to prevent deterioration either through moisture or intrusion of foreign matter. Sufficient storage shall be arranged by the Contractor to ensure continuity of consumption. Cement shall be stored in easily countable stacks.

b) Aggregates :

Aggregates shall be stored on planking, steel plates or concrete. Different sizes shall be separated with wooden, steel, or concrete bulkheads. Care shall be taken to prevent any segregation of various sizes of particles. The aggregates must not be allowed to come in contact with dirt, clay and other injurious substances at any stage. The aggregate shall be stored in easily measurable stacks. Procurements must be at least two months in advance of consumption in dry season and four months in advance in rainy season.

c) Reinforcement :

Reinforcing steel shall be stored as far as possible under cover. It shall be protected from oil, grease, dirt, etc. The stacks shall be easily measurable.

3.16.04 **Workmanship**

a) Reinforcement

i) Bending :

Reinforcement bars shall be bent by machine or other approved means producing a gradual & even motion. All the bars shall be cold bent unless otherwise approved. Bars correctly bent only will be used. Bends and shapes shall comply strictly with the dimensions in the approved bar bending schedule. Bending schedule shall be prepared by the Contractor and got approved by the Engineer before bending and he shall be entirely responsible for its correctness. No reinforcement shall be bent when in position in the work without approval of the Engineer, whether or not it is partially embedded in concrete. Unless described otherwise, lapping dimensions shall conform to IS:456 - latest edition and all bending shall correspond to IS:2502 - latest edition.

ii) Placing in Position :

Fixing of reinforcement shall correspond to IS:2502 - latest edition. Reinforcements shall be accurately fixed & maintained in position by such means as mild steel chairs and concrete spacer pieces, Bars intended to be in contact at passing points shall be securely bound together at all such points by No. 20G annealed soft iron wire conforming to IS:280 - latest edition. Binders and the like shall tightly embrace the bars with which

they are intended to be in contact and shall be securely bound.

The vertical distances between successive layers of bars shall be maintained by provision of mild steel spacer bars at such intervals that the main bars do not sag perceptibly between adjacent spacer bars.

The placing of reinforcements shall be completed well in advance of concreting. Immediately before concreting, the reinforcement shall be examined for accuracy of placing and cleanliness by the Engineer and corrected if it is so desired by him. The cover for concrete over the reinforcements shall be as shown or as specified on the approved drawings. Unless otherwise directed, all laps shall be minimum 52 times the diameter of the bar in case of H.T. deformed bar and 40 times diameter of the bar in case of mild steel. If the bars in a lap are not of same diameter, the smaller will guide the lap length. The laps shall be staggered.

Where concrete blocks are used for ensuring the cover and position, they shall be made of mortar not leaner than one (1) part cement to two (2) parts sand and cured for at least seven days.

b) Formwork :

The formwork shall conform to the shape, line and dimensions as shown on the plans and shall be made of timber close and tight to prevent leakage of mortar with necessary props, bracings and wedges sufficiently strong and stable so that it should not yield on laying of concrete. Formwork shall conform to IS:456 - latest edition - in respect of above and stripping time, cleaning and oiling, etc.

c) Concrete :

Mix : The following concrete mixes shall be used as specified in drawings or as directed by the Engineer :

Grade	**Mix**	**Minimum Cement Content**
M-15	To be designed	325 kg/Cu.M.
M-20	-do-	360 kg/Cu.M.
M-25	-do-	410 kg/Cu.M.
Plain Concrete	1:3:6 (nominal) 1.4.8 (nominal)	

i) Water cement ratio and slump shall be determined to suit strength requirements of the concrete mix.

ii) Mixing : The aggregate and sand shall be washed free from all dust and earthy matter if required by the Engineer. The above materials will then be accurately measured in boxes. The quantity of cement shall be determined by weight. The quantity of water shall be predetermined after allowing for

moisture content in the aggregate. All the ingredients as proportioned shall then be mixed in a mechanical mixer till the mass is uniform in texture and consistency, but in no case the mixing time shall be less than two minutes. Hand mixing if permitted by the Engineer as a special case shall be carried out on a water tight platform using 10% extra cement at Contractor's cost and care shall be taken to ensure that the mixing is continued till the mass is uniform in colour and consistency.

iii) Placing and Compacting : Concrete shall be transported from the place of mixture to the place of final deposit within 45 minutes after water has been added and shall be compacted before initial setting commences and should not be subsequently disturbed. Method of transporting & placing shall be such as to preclude segregation. Concrete shall be thoroughly worked around the reinforcements, etc. and into all corners of formwork. For compaction of concrete, mechanical vibrators shall be used. Concrete shall not be placed in water. Mixing, transporting, placing and compacting of concrete shall conform to IS:456 - latest edition.

iv) Curing : Concrete shall be cured for at least 28 days from the date of placing of concrete.

v) Testing of Concrete : Concrete shall be tested in accordance with IS:516 - latest edition and accepted in accordance with IS:456 - latest edition.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Roads

All testing, as mentioned in the body of the specification and as mentioned in Clause No. 900 of Specification for Roads and Bridge Works, 1983 published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per direction of the Engineer. No extra payment shall be made for such tests.

4.02.00 Masonry and Plastering

Masonry and finish to masonry and concrete shall fully comply with the drawings, specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness and any other special criteria as mentioned in the body of the specification or as shown on drawing.

4.03.00 Cement Concrete

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS:456.

5.00.00 INTERLOCKING PAVING BLOCKS

5.01.00 Area of roads and pavements for vehicular traffic to be paved with precast interlocking concrete blocks shall be placed over 250 mm thick crushed aggregate sub-base and 100 mm thick water bound macadam base. For other pavement areas these are to placed over 150 mm thick crushed aggregate sub-base and 100 mm thick water bound macadam base.

5.02.00 A stable edge shall be provided to retain the paving units and sand bedding by means of precast concrete edging unit or kerb set in-situ concrete.

5.03.00 The paving blocks shall be laid true to levels and grades for the finished work over a sand bedding of 50 mm uncompacted thickness.

5.04.00 The sand for bedding shall be a fine, well graded in a dry to moist condition.

5.05.00 The interlocking paving blocks shall be a minimum of 80 mm thick and the concrete quality shall be approved by the Engineer. The mix of paving block shall contain a water repelling additive. The sample of paving block shall be submitted to the Engineer for approval. No orders shall be placed with the manufacturer until the Engineer's approval has been given.

5.06.00 The paving blocks shall be laid in accordance with the manufacturer's instruction and shall be compacted at completion of each days work.

PART-II
TECHNICAL SPECIFICATION FOR CONSTRUCTION OF WET MIX MACADUM ROAD

1.0.0 WET MIX MACADAM

1.1.0 Description

Wet mix macadam shall consist of clean, crushed, graded aggregates premixed with water and laid and shall be rolled to a dense mass on a prepared sub-grade, sub-base, base or existing pavement as the case may be. In each case the construction shall be carried out to conform to specified lines, grades and cross-sections.

1.2.0 Materials

1.2.1 Aggregates - General Requirements

The aggregates shall consist of hard, durable particles of crushed stone, crushed gravel or crushed slag of requisite quality as stated hereinafter. These shall satisfy the physical requirements set forth in Table-1.

Table-1

Physical Requirements of Aggregates for Wet-Mix Macadam

Sl. No.	Type of Construction	Test Method	Test	Requirement
1.	Sub-base	Los Angeles Abrasion Value	IS:2386 (Part IV)	Max. 60%
		or		
		Aggregate Impact Value*	-do-	Max. 50%
2.	Base	a) Los Angeles Abrasion Value*	-do-	Max. 50%
		or		
		Aggregate Impact Value*	-do-	Max. 40%
		b) Flakiness Index	IS:2386 (Part I)	Max. 30%

Note :

1. *Aggregates may pass the requirements of either the Los Angeles Test or Aggregate Impact Value Test.

2. Fraction of the aggregates passing 425 micron sieve when tested in accordance with IS:2720 (Part V) should not have a PI value of more than 6.

1.2.2 **Crushed Stone/Gravel**

Crushed stone/gravel shall be free of flat, elongated, soft and disintegrated particles. They shall also not contain an excess of dirt or other objectionable matter.

1.2.3 **Crushed Slag**

Crushed slag shall be manufactured out of air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free of any thin, elongated and soft pieces, as well dirt or other objectionable matter. Crushed slag shall not weigh less than 1120 kg. per m' or absorb more than 10 percent water by its weight when tested in accordance with IS:2386 (Part III).

1.2.4 **Aggregates - Grading Requirements**

As far as possible, aggregates for wet-mix macadam shall conform to one of the gradings given in Table-2.

Table-2

Grading Requirements of Aggregates for Wet-Mix Macadam

	Percent by Weight Passing the Sieve	
Sieve Designation (IS:460)	**Grading 1 Max. Nominal Size 40 mm**	**Grading 2 Max. Nominal Size 20 mm**
50 mm	100	
40 mm	95-100	
25 mm	-	100
20 mm	60-80	90-100
10 mm	40-60	-
4.75 mm	25-40	35-55
2.36 mm	15-30	-
600 micron	8-22	10-30
75 micron	0-8	2-9

The nominal size of aggregate to be used in a given case shall depend on availability. While both the grading can be used for base/sub-base course construction, preferably layers of grading No. 1 shall not be used above layers of grading No. 2.

Generally it should be possible to obtain aggregates conforming to the above gradings directly from the crusher. However, where this is not so for any reason, necessary quantities of missing fractions shall be blended as to bring the grading of the mixed material upto the specified limits.

1.2.5 Quantity of Aggregates

Approximate quantity of aggregates required for 75 mm & 100 mm compacted thickness of wet-mix macadam will range from 1.1 to 1.2 cu.m and 1.45 to 1.6 cu.m respectively per 10 sq.m area.

1.3.0 Construction Operations

1.3.1 Preparation of Foundation for Receiving the Wet-Mix Macadam Courses

The sub-grade, sub-base or base to receive the wet-mix macadam course shall be prepared to the required grade and camber and cleaned of all dust, dirt and other extraneous matter. Any ruts or soft yielding places that have appeared due to improper drainage, service under traffic, or other reasons, shall be corrected and rolled until firm. If necessary, the existing surface may be scarified and reshaped to achieve this objective.

Where the existing road surface is black-topped, 50 mm x 50 mm furrows shall be cut in the existing surface at 45 deg. to centre line of the carriageway, spaced every one metre, before proceeding with the laying of the coarse aggregates.

In all cases, the foundation shall be kept well drained throughout the construction operations.

1.3.2 Provision of Lateral Confinement of Aggregates

Before starting with wet-mix macadam construction, necessary arrangements shall be made for the lateral confinement of aggregates. This could be done by constructing side shoulders in advance to a thickness corresponding to the compacted layer of the wet-mix macadam course. After the shoulders are ready, their inside edges shall be trimmed vertical and the included area cleaned of all spilled material, thereby setting the stage for spread of aggregates. The practice of constructing the macadam in a trench excavated after finishing formation shall be completely avoided.

1.3.3 Mixing of Aggregates with Water

Aggregates for wet-mix macadam shall be mixed with the requisite quantity of water in a power mixer of suitable capacity and optimum moisture for mixing shall be determined in accordance with IS:2720 (Part VII) after replacing the aggregate fraction retained on 20 mm sieve with material of 4.75 mm to 20 mm size. While adding water due allowance shall be made for evaporation losses. However, at the time of compaction, water in the wet mix shall not vary from the optimum value by more than $\pm$ 0.5 percent. The mixed material shall be uniformly wet and no segregation shall be permitted.

1.3.4 Spreading of Aggregates

Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared base in required quantities. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base to be permitted. The aggregates shall be spread to proper profile by using templates placed across the road about 6 metre apart.

Where possible approved mechanical devices may be used for this purpose so as to minimise the need for their manipulation by hand.

Wet mix macadam course shall normally be constructed in layers each not exceeding 75-100 mm in compacted thickness. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles shall be allowed. The aggregates as spread shall be of uniform gradation with no pockets of fine materials.

1.3.5 Rolling

After aggregates have been laid to the required thickness, grade and camber, these shall be compacted to the full width by rolling with either three-wheeled power roller of 8 to 10 tonnes capacity or an equivalent vibratory roller.

The rolling shall begin at edges with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road, uniformly lapping each preceding rear wheel track by one half width.

On super elevated portions of the road, rolling shall commence from the lower edge and progress gradually towards the upper edge of the pavement.

Rolling shall not be done when the sub-grade is soft or yielding or when it causes a waver-like motion in the base course or sub-grade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface shall be loosened and aggregates added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and cross-section. The surface shall also be checked transversely by template for camber, and any irregularities corrected in the manner described above. In no case shall the use of un-graded material or fines permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 100 percent of the maximum dry density for the material determined in accordance with the procedure explained in para 1.3.3. After completion the surface of any finished layer shall be well-closed, free from movement under compaction plant or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and re-compacted.

1.4.0 **Opening of Traffic**

Preferably no vehicular traffic of any kind shall be allowed on the finished wet-mix macadam surface till it has dried and the wearing surface laid. In exceptional cases, construction traffic may be permitted for short durations once the course is completely dry provided vehicles move over the full width avoiding any rutting or uneven compaction.

1.5.0 **Surface Evenness of Wet-Mix Macadam Course**

The surface evenness of the completed wet-mix macadam course in the longitudinal and transverse directions shall be within the following tolerances :

i)	Longitudinal profile when tested with a 3 metre straight edge	Maximum permissible variation	12 mm
ii)	Cross profile when checked with a camber template	Maximum permissible variation	8 mm

The longitudinal profile shall be checked with a 3 metre long straight edge at the middle of each traffic lane along a line parallel to the centre line of the road. The transverse profile shall be checked with a series of three camber boards at intervals of 10 metres.

1.6.0 **Rectification of Defective Construction**

Where the surface irregularity of the wet-mix macadam course exceeds the tolerances specified in Para 1.5.0, or where the course is otherwise defective due to sub-grade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and recompacted in accordance with Para 1.3.1 thru' 1.4.0. The area treated in the aforesaid manner shall not be less than 10 sq.m. In no case shall depressions be filled up with un-graded material or fines.

TECHNICAL SPECIFICATION
FOR
XI) ROADS AND DRAINAGE

PART-III : CONSTRUCTION OF RCC ROAD WITHIN PLANT

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA

XI) ROADS AND DRAINAGE

PART-III : CONSTRUCTION OF REINFORCED CEMENT CONCRETE ROAD WITHIN PLANT

1.00.00 SCOPE

This specification covers all work required for the construction of road including box-cutting, edging, reinforced cement concrete pavement slab on lean concrete base, water bound macadam sub-base including preparation of subgrade etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification also includes all work required for drainage including road side drain, R.C.C. culverts, pipe-culverts, drainage pipes, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.

b) Submit for approval detailed schemes of all operations required for executing the work e.g., material handling, placement, services, approaches etc.

c) To carry out and submit to the Engineer results of tests whenever required by the Engineer to assess the quality of work.

2.02.00 Work to be provided for by Others

No work under this specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and Codes of Practice.

1. Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.

2. IRC-19 Standard specifications and Code of Practice for Water Bound Macadam.

3. IRC:SP-11 Hand Book of Quality Control for Construction of Roads and Runways.

4. IS:456 Indian Standard Codes of Practice for Plain and Reinforced Concrete.

5. IS:2212 Code of Practice for Brickwork.

6. IS:783 Code of Practice for Laying of Concrete Pipes.

7. IRC:15 – 2002 Standard Specifications and Code of Practice for Construction of concrete roads

8. IRC:58 - 2002 Guidelines for the design of plain jointed rigid pavements for Highways.

9. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard Specification, AASHTO and any other standard practice as may be specified by the Engineer shall be followed.

2.04.00 **Conformity with Designs**

The contractor shall carryout the work as per the drawings issued to him and/or contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be Used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.06.00 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used.

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for road works are described hereinafter.

i) Horizontal Alignments

Horizontal alignments shall be reckoned with respect to the center line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of $\pm$ 25 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be $\pm$ 40 mm.

ii) Longitudinal Profile

The levels of the sub-grade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer, beyond tolerances mentioned below:

Sub-grade	± 25 mm
WBM Sub-base	± 20 mm
Lean concrete Base	± 15 mm
RCC Pavement Slab	± 10 mm

Tolerance in RCC Pavement Slab shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6 mm.

iii) Surface Regularity of Sub-grade and Sub base WBM

The surface regularity of completed sub-bases and base courses in the longitudinal and transverse directions shall be within the tolerances indicated in Table-I of Technical Specification for Roads and Drains – Part-I (flexible pavement.

iv) Surface regularity and surface texture of Reinforced Cement concrete pavement

The surface levels and regularity of concrete pavement shall be within the tolerance indicated in Section 600 of MORT&H (Ministry of Road Transport & Highways) – specifications for Road and Bridge Works.

Texture depths shall not be less than the minimum required when measurements are taken as given in Table 600-2 of MORT&H nor greater than a maximum average of 1.25mm.

TABLE- : 600-2. Texture Depth

Time of Test	Number of Measurements	Required Texture Depth (mm)	
		Specified Value	Tolerance
1. Between 24 hours and 7 days after the constn., of the slab or until the slab is first used by vehicles	An average of 5 measurements	1.00	±0.25
2. Not later than 6 weeks before the road is opened to public traffic	An average of 5 measurements	1.00	+0.25 -0.35

After the application of the brushed texture, the surface of the slab shall have a uniform appearance.

Where the texture depth requirements are found to be deficient, the Contractor shall make good the texture across the full lane width over length directed by the Engineer, by retexturing the hardened concrete surface in an approved manner.

v) Minimum thickness of RCC pavement slab will be 300mm of M25 grade concrete. Reinforcement bars will not be less than 0.18% of Gross cross-sectional area. Reinforcement bars shall be placed in both layers – top & bottom. Minimum cement content will be 360 Kg/cum.

vi) Design and detailing of RCC pavement shall be done in accordance with IRC:58 – 2002 and IRC:15 – 2002. The spacing of control joints shall be as follows:

a)	Transverse expansion joint	=	30m (maximum)
b)	Transverse crack control/ contraction joint	=	4.5m (maximum)
c)	Longitudinal separation joint	=	One at centre for 7.5m wide road

Tender drawing no. K9213R-DWG-S-0007 may be referred for details of joints.

3.00.00 EXECUTION

3.01.00 Shall be as per Technical Specification for Road & Drainage Part-I and MORT&H specification for Road and Bridge.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Shall be as per Technical Specification for Road & Drainage Part-I and MORT&H specification for Road and Bridge.

TECHNICAL SPECIFICATION
FOR
XII) REINFORCED CONCRETE CHIMNEY

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA
5.00.00	INFORMATION TO BE SUBMITTED

I) REINFORCED CONCRETE CHIMNEY

1.00.00 SCOPE

This specification covers plain and reinforced cement concrete work, lining and insulation work, miscellaneous steel and metal work, painting and protective treatment work, lightning protection system and aviation obstruction lighting system, connected with construction of RCC Chimney.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

Work to be provided by the Contractor, unless specified otherwise, shall include but shall not be limited to the following :

a) Furnish all labour, supervision, services, insurance, material, power, fuel, forms, templates, supports, scaffolding, tools, plants, construction equipment, approaches, transportation etc. required for the entire work.

b) Design and prepare working drawings for formworks, scaffoldings, supports, staging etc. and submit them for approval.

c) Prepare and submit for approval, as per approved schedule, detailed drawings for R.C. work in foundation, shell, hopper, platforms & ground floor & bending schedules for reinforcement bars, showing the positions and details of spacers, chairs, supports, hangers, openings etc.

d) Prepare detailed fabrication and erection marking drawings for steel and metal works and submit them for approval.

e) Prepare detailed shop drawings for various inserts, anchors, sleeves, frames, templates, anchor bolts etc. showing relative locations of their installations and submit them for approval.

f) Prepare and submit for approval the detailed schemes for operations like material handling, placement of concrete etc. and for items like approaches, services etc.

g) Design and submit for approval the mix proportions for concrete to be adopted on job.

h) Furnish samples and submit for approval the results of tests for various properties of the following materials :

   i) Ingredients of concrete
   ii) Concrete
   iii) Metal work components
   iv) Acid proof bricks

v) Fire bricks
vi) Castable refractories
vii) Insulation material
viii) Paints
ix) Electrical Items.

i) Provide all incidental items not specified or shown on drawings in particular but reasonably implied or necessary for successful completion of the work in accordance with drawings and specifications.

j) Produce, if directed by the Engineer, a guarantee, in approved proforma, for satisfactory performance, for a specified period, of material manufactured by specialist firms.

2.02.00 **Work by others**

No work under this specification will be provided for by agency other than the Contractor for this Contract unless specifically mentioned otherwise in the Contract.

2.03.00 **Codes and Standards**

All works under this Specification, unless specified otherwise, shall conform to the latest revisions/replacements of the following Indian Standard Codes, Criteria, Specifications, alongwith those mentioned therein. In case any particular aspect of work is not covered by Indian Standards, other standard specification, as may be specified by the Engineer, shall be followed. 'IS Specification' shall mean Codes, Criteria etc. of ISI :

IS:6 Moderate heat duty fire clay refractories, Group-A.

IS:104 Ready mixed paint, brushing, zinc chrome, priming.

IS:158 Ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and heat resisting for general purposes.

IS:269 Ordinary, and low heat Portland cement.

IS:383 Coarse and fine aggregates from natural sources for concrete.

IS:432 Mild steel and medium tensile steel bars.

IS:456 Code of practice for plain and reinforced concrete.

IS:516 Methods of test for strength of concrete.

IS:732 Code of practice for electrical wiring installations (System voltage not exceeding 650 Volts).

IS:800 Code of practice for general construction in steel.

IS:808 Rolled steel beam, channel & angle sections.

IS:813	Scheme of symbols for welding.
IS:814	Covered electrodes for metal arc welding of structural steel.
IS:816	Code of practice for use of metal arc welding for general construction in mild steel.
IS:817	Code of practice for training and testing of metal arc welders.
IS:818	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS:822	Code of procedure for inspection of welds.
IS:9595	Recommendation for Metal Arc Welding of Carbon and Carbon Manganese steels.
IS:1139	Hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcements.
IS:1161	Steel tubes for structural purposes.
IS:1199	Methods of sampling and analysis of concrete.
IS:1200	Methods of measurement of building works.
IS:1239 (Part-I)	Mild steel tubes.
IS:1367	Technical supply conditions for threaded fasteners.
IS:1526	Sizes and shapes for firebricks (230 mm. series).
IS:1566	Hard-drawn steel wire fabric for concrete reinforcement.
IS:1608	Methods for tensile testing of steel products.
IS:1730	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
IS:1731	Dimensions for steel flats for structural and general engineering purposes.
IS:1786	Cold-twisted steel bars for concrete reinforcement.
IS:1791	Batch type concrete mixers.
IS:1977	Structural steel (ordinary quality).
IS:2062	Steel for general structural purposes
IS:2074	Ready mixed paint, red oxide - zinc chrome priming.

IS:2309	Code of practice for the protection of buildings and allied structures against lightning.
IS:2386	Methods of test for aggregates for concrete. (Part-I) Particle size and shape.
IS:2386	Estimation of deleterious materials & organic (Part-II) impurities.
IS:2386	Specific gravity, density, voids, absorption and (Part-III) bulking.
IS:2386	Mechanical properties. (Part-IV)
IS:2386	Soundness. (Part-V)
IS:2386	Measuring mortar making properties of fine aggregate. (Part-VI)
IS:2386	Alkali aggregate reactivity. (Part-VII)
IS:2386	Petrographic examination. (Part-VIII)
IS:2502	Code of practice for bending & fixing of bars for concrete reinforcement.
IS:2505	Concrete vibrators, immersion type.
IS:2506	Screed board concrete vibrators.
IS:2633	Methods of testing uniformity of coating on zinc coated articles.
IS:2722	Portable swing weigh batchers for concrete (single and double bucket type).
IS:2750	Steel scaffoldings.
IS:2751	Code of practice for welding of mild steel bars used for reinforced concrete construction.
IS:3025	Methods of sampling and test (Physical and Chemical) for water used in industry.
IS:3346	Method for the determination of thermal conductivity of thermal insulation materials (two slab, guarded hot-plate method).
IS:3495	Method of test for clay building bricks. (Part-I to IV).
IS:3550	Methods of test for routine control for water used in industry.
IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.

IS:3677 Unbonded rock and slag wool for thermal insulation.

IS:4014 Code of practice for steel tubular scaffolding. (Part-I&II).
IS:4031 Method of physical tests for hydraulic cement.

IS:4634 Method for testing performance of batch-type concrete mixers.

IS:4687 Gland packing asbestos.

IS:4860 Acid-resistant bricks.

IS:4990 Plywood for concrete shuttering work.

IS:4998 Criteria for design of reinforced concrete chimneys. (Part-I).

IS:5410 Cement paint, colour as required.

IS:5445 Long fluted machine reamers with Morse taper shanks.

IS:5495 Sizes and shapes for firebrick (300 mm. and higher series).

IS:8112 High strength ordinary portland cement.

CP326 British Standard - Protection of structures against lightning.

NEPA 78 Code of protection against lightning.

Draft Code of Practice for the protection of buildings against lightning - 1954 of Institution of Engineers (India).

The Indian Electricity Rules.

The requirements of Department of Civil Aviation, Govt. of India.

2.04.00 **Conformity with drawings and specifications**

The Contractor shall carry out all the work in strict accordance with the drawings stamped 'Released for Construction' and specification issued to him and as per Contractor's detailed drawings approved by the Consulting Engineer. Prior to concreting, the Contractor shall prepare a check list on a set format of all items of work involved, and inform the Engineer well in advance so that the Engineer shall have the opportunity of satisfying himself if the works mentioned in the format are done according to drawings and specification, and he can allow the Contractor in writing to start pouring of concrete. The entire operation of concreting shall be carried on as per specification, to the complete satisfaction of the Engineer. No deviation from the drawings will be allowed unless otherwise directed by the Engineer in writing.

For steelwork and metal work, the Contractor shall design all connections, inserts for scaffolding, supply and fabricate all steelwork and metal work and furnish all connection materials in accordance with approved shop drawings prepared by him and/or as instructed by the Engineer, keeping in view the

maximum utilisation of the available sizes and shapes for metal components.

2.05.00 **Materials to be used**

2.05.01 **General Requirement**

All materials, whether to be incorporated in the work or to be used temporarily for the construction, shall conform to the relevant IS specifications unless stated otherwise and shall be of the quality approved by the Engineer.

2.05.02 **Cement**

Generally, cement shall be 43 grade / 53 grade ordinary Portland Cement conforming to IS-8112 / IS 12269. In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Engineer :

a) 33 Grade ordinary Portland Cement conforming to IS-269.

b) Rapid hardening Portland Cement conforming to IS-8041.

c) Portland slag cement conforming to IS-455.

d) Portland Pozzolona Cement (fly ash based) Conforming to IS-1489 (Part-1).

e) Portland pozzolona Cement (calcined clay based) conforming to IS-1489 (Part-2).

f) Hydrophobic Cement conforming to IS-8043.

g) Low heat Portland Cement conforming to IS-12600.

h) Sulphate Resisting Portland Cement conforming to IS-12330.

2.05.03 **Coarse Aggregate**

Coarse aggregate shall be graded crushed or broken stone from approved sources, free from impurities and shall be screened free of dust and other deleterious matter. It shall conform to IS:383 or IS:515 and shall be washed clean, if necessary. The max. size of coarse aggregate for chimneys shall be 20 mm. down graded, unless otherwise stated (vide serial 5(b) of clause 3.3.6). Grading for a particular size shall conform to relevant IS Codes and shall be such as to produce a dense concrete of specified proportion and strength and shall be of consistency that will work readily into position without segregation.

2.05.04 **Fine Aggregate**

Fine aggregate shall be river or pit sand, free from any clay, earth, vegetable matters, salt or other impurities and shall be clean and fit for use, to the satisfaction of the Engineer. Sand acceptable for the work shall normally have a grading falling within the limits of one of the three grades, mentioned

in the relevant IS Specifications.

2.05.05 **Water**

The water for both mixing and curing of concrete shall be clean, free from oil, acid, alkali, organic or other deleterious substances. Contractor shall test the water as and when required by the Engineer, at no extra cost to the Owner.

2.05.06 **Reinforcement**

Mild steel or Medium or High Tensile steel deformed bars specified for reinforcement shall conform to the latest relevant IS Specifications and shall be of tested quality under ISI Certification Scheme. The reinforcement shall be free from any oil, foreign material or mill or rust scales.

Reinforcement bars shall be procured from approved manufacturers for example SAIL/ TISCO/ VIZAG Steel or equivalent.

2.05.07 **Structural Steel**

All steel materials to be used in construction of Chimney ladder, hand rails, flue opening frame, access door frame, door shutters etc. shall comply with IS:2062, IS:1239, IS:1367, IS:1608 & with other relevant IS Specifications.

2.05.08 **Paints**

Paints to be used for shop coat of fabricated steel shall conform to the IS:2074. Paint for treatment of outside face of Chimney shall be with Poly .urethane paint.

2.05.09 **Fire Bricks, Acid Resistant Bricks and Castable Refractories**

Fire Bricks for the internal lining of the shell shall conform to IS:6-1967 Group-A and IS:5445. Acid resistant bricks for internal lining of shell and hopper shall conform to IS:4860. Castable refractories shall be of hydraulic setting, rapid hardening type. It shall have refractory properties similar to Fire bricks conforming to IS:6, Group-A and working temperature shall be upto $1350^{o}C$.

2.06.00 **Storage of Materials**

2.06.01 **General**

All materials shall be so stored as to prevent deterioration & intrusion of foreign matter and to ensure the preservation of their quality and characteristics for the work. Any material, which is deteriorated or is damaged or is otherwise considered defective by the Engineer, shall not be used for construction and shall be removed from site immediately, failing which the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain an upto date accounts of receipt, issue & balance of all materials issued by the Owner.

2.06.02 **Cement**

Contractor shall store cement in water-tight and properly designed stores so that the Cement can be kept dry and the stock can be handled in rotation. The doors of stores shall be at least 30 cm above G.L. Deteriorated cement shall be removed immediately from the site. Not more than ten bags of cement shall be stacked one above the other.

2.06.03 **Aggregate**

Different materials shall be transported, handled and stored separately in such a manner as to prevent damage, deterioration or contamination. Stock piles of fine and coarse aggregates shall be allowed to drain, so that aggregates do not contain too much water.

2.06.04 **Reinforcement**

Reinforcement shall be stored preferably under cover and stacked off ground in size and grade-wise separate stacks for easy identification.

2.06.05 **Steel, Metal and Fittings**

All steel, metal & fittings to be used for fabrication and erection shall be stored sectionwise and lengthwise in separate stacks, off ground, so that they can be handled, inspected, measured and accounted for easily at any time. If required by the Engineer, the materials may have to be stored in a covered shed.

2.06.06 **Paints**

Paints shall be stored under cover, in air-tight containers. Paints supplied in sealed containers shall be used as soon as possible once the container is opened. Left over paints shall be kept in air-tight containers.

2.06.07 **Bricks**

Bricks shall be stored in systematic stacks for ease of handling and counting. While unloading the bricks from trucks, they shall be stacked right away and shall not be dumped in a heap.

2.06.08 **Insulation Material**

All insulation materials like glass or mineral wool, asbestos ropes etc. shall be stored in packing boxes, under covered shed, avoiding their coming in contact with objectionable matter.

2.06.09 **Electrical Items**

All electrical items shall be stored properly under covered water-tight shed so that they do not come in contact with moisture or cement dust.

2.07.00 **Quality Control**

Contractor shall establish and maintain quality control for different items or work and materials as may be directed by the Engineer to assure compliance with contract requirement and submit to the Engineer records of the same. The Contractor shall submit all records and test results in original to the Engineer for his approval, if so desired by him.

The quality control operation shall include but shall not be limited to the following items of work :

a)	Cement	:	Test to satisfy relevant IS Specifications if supplied by the Contractor.
b)	Aggregate	:	Physical, Chemical and Mineralogical qualities, grading, moisture contents and impurities.
c)	Water	:	Impurities Test.
d)	Reinforcement	:	Material tests or certificates to satisfy relevant IS Specification if supplied by the Contractor
e)	Structural Steel	:	Material tests or certificate to satisfy relevant IS Specification if supplied by the Contractor.
f)	Bricks	:	Compressive strength, water absorption, efflorescence, warpage.

3.00.00 **EXECUTION**

3.01.00 **Concrete**

3.01.01 **Trial Mix, Grades of Concrete**

At least three weeks before commencing any concreting in the work the Contractor shall make trial mixes using samples of coarse aggregates, sand, water and cement, typical of those to be used in the work. A clean dry mixer shall be used for mixing and the first batch shall be discarded.

For guidance in designing the mix, standard tables for maximum allowable water-cement ratio, minimum cement content, maximum proportion of aggregates and limits of consistency may be used by the Contractor. The Contractor's design mix shall fall within limits of the following tables :

i)	Strength requirements of concrete	:	Table-2 of IS:456-2000.
ii)	Concrete Mix Proportion	:	Design mix concrete as per Clause no.9 of IS:456-2000.

iii) Minimum cement content/Cu.m. of finished concrete shall be as per Table 5 of IS:456-2000 unless otherwise stated (vide serial 5(c) of clause 3.3.6).

iv) Limit of consistency : Refer Table in Item 3.1.4 of this specification.

v) Cement/Total Aggregate Ratio : As per the following table.

TABLE-II

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO (FOR GUIDANCE)

CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/ CEMENT RATIO	RATIO BY WEIGHT OF CEMENT TO GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT TO CRUSHED STONE AGGREGATE	
		20 mm size	38 mm size	20 mm size	38 mm size
Very low Slump 0-25 mm	0.4	1:4.8	1:5.3	1:4.5	1:5.0
	0.5	1:7.2	1:7.7	1:6.5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low Slump 25-50 mm	0.4	1:3.9	1:4.5	1:3.5	1:4.0
	0.5	1:5.5	1:6.7	1:5.0	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7.0
	0.7	1:8.0	1:8.5	1:7.4	1:8.0
Medium Slump 50-100 mm	0.4	1:3.5	1:3.8	1:3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5.0
	0.6	1:6.0	1:7.3	1:5.2	1:6.2
High Slump 100-175 mm	0.4	1:3.2	1:3.5	1:2.9	1:3.3
	0.5	1:4.4	1:5.2	1:3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

Note: 1 Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

Note: 2 It should be noted that such high aggregate cement ratios will be required or concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.

The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

For each grade of concrete, a set of eighteen cubes shall be made. Of these not more than six may be made on any day and further, of the six cubes made in one day not more than two cubes may be made from any single batch. Nine of these cubes each representing a different batch of concrete shall be tested at the age of seven days and remaining at twenty-eight days. The making of the cubes, their curing, storing, transporting and testing shall be in accordance with the relevant IS Specifications. The test shall be carried out in laboratory approved by the Engineer. If the average strength of the concrete cubes falls below the requirement, the method described above shall be repeated till acceptable results are obtained. The method may have to be repeated whenever there is a significant change in the quality of any of the ingredients for concrete, at the discretion of the Engineer. All cost for trial mixes and tests shall be borne by the Contractor and shall be included in the contract rates.

3.01.02 **Batching of concrete**

For controlled concrete, only weigh batching shall be allowed. All concrete ingredients, except water, shall be batched by weight, using an approved make of weigh batcher. Batching shall be accurate to 1/2 Kg. The batcher shall be tested for accuracy of calibration, first before commencement of work and at least once a fortnight or as directed by the Engineer thereafter. Water shall be batched by weight or by volume measures, as approved by the Engineer.

3.01.03 **Mixing of Concrete**

Materials for concrete shall be emptied in rotation into the mixer. When all the ingredients are in the drum, the drum will rotate for one minute for dry mixing. After that water shall be added in measured quantities in the manner specified. The mixer shall then rotate for at least two minutes, or at least forty revolutions or until there is apparent uniform distribution of the materials and till the mass is uniform in colour. The entire content of the drum shall be discharged before the ingredients for the succeeding batch are fed into the drum. The mixer shall be thoroughly cleaned to the satisfaction of the Engineer, before a different quality of concrete is put through the mixer and also at the end of day's work.

3.01.04 **Workability of Concrete**

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments, and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. 15 mm. to 40 mm. slump in chimney works shall be adopted

subject to Engineer's approval unless stated otherwise (vide serial 1(d) of clause no. 3.3.6). The usual limits of consistency for various types of structure are given below:

LIMITS OF CONSISTENCY

Degree of workability	**Slump in mm. with standard concrete**		**Use for which concrete is suitable**
	Min.	**Max.**	
Very Low	0	15	Large mass concrete work with heavy compaction equipment.
Low	15	35	Uncongested wide and shallow RCC structures.
Medium	35	65	Deep and wide RCC structures with congestion of reinforcement and inserts.
High	65	100	Very narrow and deep RCC structures with congestion due to reinforcement and inserts.

Note :

The above table is for guidance only. Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately, to keep the ratio of water to cement same, as adopted in trial mix design, for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively, where facilities exist or if required by the Engineer, the compacting factor test, in accordance with IS:1199, shall be carried out.

3.01.05 **Placing and Compaction of Concrete**

Concreting shall proceed in a manner directed by the Engineer, concrete shall be placed in forms as soon as possible but in no case later than twenty minutes, after mixing.

The height of any single lift of concrete, for different structural members, shall be decided by the Engineer. The concrete shall be placed in the forms gently and not dropped from a height which may cause segregation of aggregates. Each layer of concrete shall be compacted fully before the succeeding layer is placed and separate batches shall follow each other so closely that the succeeding layer shall be placed and fully compacted before the layer immediately below has taken an initial set.

The concrete, after placing, shall be consolidated only by power driven vibrators. The vibrators shall be of a make and size, approved by the Engineer. In using the vibrator, the standard practice and the Engineer's directions, shall be followed.

Vibration shall begin as soon as one batch of concrete has been placed and shall continue till the entire section being poured has been thoroughly consolidated.

To secure even and dense surfaces, free from aggregate pockets, vibration shall be supplemented by tamping or rodding by hand in the corners of forms and along the form surfaces while the concrete is plastic, without damaging or endangering the stability of the formwork.

A sufficient number of spare vibrators including petrol vibrators shall be kept readily accessible to the place of deposition of the concrete to assure adequate vibration in case of breakdown of those in use.

3.01.06 **Curing of Concrete**

Curing of exposed surface of concrete shall commence immediately after the concrete has set. Exposed sides shall be covered with canvas etc. immediately after stripping of forms, and curing shall be continued for a period of not less than 14 days, reckoned from the date and hour of completion of concreting. All surfaces of the pour shall be kept wet with water at all times after concreting and till the curing period is over. The Contractor shall plan and employ proper equipment and sufficient labour considered adequate by the Engineer under able supervisor for curing and all cost for this purpose shall be borne by him.

3.01.07 **Construction Joints**

In concreting the chimney shell one full ring lift shall be completed in a day's pour. Before the formwork for the following pour starts the horizontal surface of the Chimney shell shall be chipped, cleaned and washed with water, and when the formwork is complete, the surface shall be cleaned and washed again and covered with 1:2 sand cement slurry before fresh concrete is placed. The horizontal construction joints shall be so arranged and made that they are regular and neat. No vertical joint shall be allowed. No separate payment shall be allowed to the Contractor for forming joints or chipping and cleaning them or cover with slurry prior to concreting. The number of construction joint shall be kept minimum and the spacing should not exceed three (3) meters. The Contractor shall submit to the Engineer, any proposal of providing construction joints to facilitate his work, for the study and approval of the Engineer well in advance.

3.01.08 **Ordinary Concrete**

Ordinary concrete like lean concrete shall be of nominal mix as per relevant clauses of IS:456.

3.02.00 **Reinforcement**

3.02.01 **Bending of Reinforcement**

All bars shall be carefully and accurately bent by the Contractor in accordance with approved Drawings and bar bending schedules. Special care shall be taken to ensure correct lengths of laps. The bars shall not be bent or straightened in any manner that will injure the bars or impair the bond between reinforcement & concrete. Bends and hooks are to be provided as laid down in the IS:2502.

3.02.02 **Placing**

All reinforcement shall be placed and maintained in the position shown in the drawings. Contractor shall provide approved type of cover blocks to suit the requirement of the Drawings. Where reinforcement is to be provided on two faces of the shell, the Contractor shall provide adequate number of separators, with the approval of the Engineer. Any additional support to the reinforcing cage, if required at the time of concreting, shall also be provided, to the satisfaction of the Engineer. Lapping of reinforcement as specified in the drawings or as directed by the

Engineer, shall be provided. Laps shall be staggered and too many laps shall be avoided. Welded laps shall be provided only when directed or approved by the Engineer.

3.02.03 **Fixing of Reinforcement**

18 SWG annealed steel wire shall be used as binding wire. Bar crossing one another and contact laps shall be bound with this wire twisted tight to make the skeleton or network rigid so that the reinforcement is not displaced during placing of concrete.

3.03.00 **Forms**

3.03.01 **Design and Material of formwork**

The shuttering for the chimney shell shall be either steel formwork or steel framed plywood formwork of adequate thickness, proper surface texture and with requisite supports and battens to produce a shell surface which will be even, smooth and of uniform curvature and batter as per Drawing and free from all blemishes.

The Contractor shall be responsible for designing the formwork, alongwith its supports etc. Contractor shall obtain the approval of the Engineer for the design of forms, before assembling them. Approval of the Engineer does not relieve the Contractor of his responsibility to ensure the soundness of formwork.

3.03.02 **Installation of Formwork**

All formwork shall be set to plumb and to line and level, or curvature or batter as per drawing. All shutters shall be adequately supported, to the satisfaction of the Engineer, to prevent deflection under dead weight of concrete, imposed load of workmen, materials and plant and to withstand vibration.

No joint in any props shall be allowed. The joints in formwork shall be watertight. Surface of formwork shall be oiled with approved quality mould oil which shall not stain the surface of the shell.

3.03.03 **Tolerance**

The formwork shall be so made as to produce a finished concrete true to shape, lines, levels, plumb and dimensions, as shown on the drawings, subject to the following tolerances, unless otherwise specified.

a)	Out of plumb between two consecutive lifts	:	3 mm.
b)	Errors in level	:	3 mm.
c)	Errors in sectional dimensions	:	5 mm.
d)	Out of plumb in general	:	1 in 1000 of height subject to a maximum of 200 mm.

However, the Contractor shall aim at improving upon this figure. Should the limitations exceed, the Contractor shall, if directed by the Engineer, demolish that portion of work and recast at his own cost, to the complete satisfaction of the Engineer. No tolerance shall be allowed between the two consecutive plates of the formwork either radially or vertically placed.

3.03.04 **Stripping of formwork**

Unless otherwise permitted in writing by the Engineer, the minimum period of keeping formwork in position after the completion of pouring of concrete shall conform to relevant clause of IS:456. For the chimney shell the stripping time shall be 48 hours minimum.

Formwork shall be so arranged as to permit removal without jarring or damaging the concrete. Immediately after stripping of formwork, the Engineer shall be informed by the Contractor. The Contractor shall ensure that the site is cleared of stripped shuttering nails or any other material which might hinder the inspection, so that the Engineer can inspect the concrete surface.

3.03.05 **Re-use of formwork**

Before re-use, all forms shall be thoroughly scraped, cleaned, examined, repaired, and treated with mould oil as specified herein before. Formwork, declared unfit or unserviceable, by the Engineer, shall not be used or reused.

3.03.06 **Construction by slip-form Method**

Slip-form construction will be encouraged if proposed by the Tenderer. Type of Slip-form proposed should be indicated in the offer with sketches, drawings and construction statement as explained hereinafter. Number, type and capacities of jacks, the control system and achievable rate of progress in mm/hour should also be indicated. The chosen scheme shall be of a past proven design. A certified performance record of the scheme should be submitted with the offer to guarantee workability of the scheme both from execution time and safety point of view.

The Tenderer should furnish a brief but comprehensive statement indicating the planning & programme and method of work to be followed, for the approval of Owner at the time of submitting Tender. This statement shall include the following items :

i) Type and description of Slip-form equipment and its accessories.

ii) Design of scaffolding and staging.

iii) Description of materials including admixtures to be used for construction.

iv) Manpower planning, construction spaces required, standby arrangement.

v) Rate of Slip-forming.

vi) Proposed workability requirement of concrete and type of cement & admixture to be used.

vii) Quality assurance programme.

viii) Method of Transportation of material

ix) Method of curing and rectification of defects.

x) Planned interruption, if proposed, and activities during planned interruption. Treatment of construction joint.

xi) Contingency solution for unplanned interruptions.

xii) Time of completion.

While selecting the Contractor, due consideration will be given to the merit of the above mentioned statement proposed by the Tenderer and minimum time of completion, apart from his past experience in such types of work as also technical and financial resources of the Tenderer.

Not withstanding what have been specified in earlier clauses, following guide lines are being presented which should be kept in view by intending Tenderers, while quoting for Slip-form method of construction :

1. Care to be taken to prevent dragging of concrete alongwith upward movement of the shuttering. For this purpose following steps are advisable :

   a) Shutter plates have to be smooth and should be thoroughly clean. Before fixing them in position all the surfaces which will be coming in contact with concrete to have a coat of epoxy paint.

   b) In areas where concrete thickness is 750 mm or more rate of pouring should be such that minimum slipping of shuttering is 100 mm per hour.

   c) Mix design should be so done that it will be self-lubricant at the contact face of shutter and concrete and thus reduce friction. Suitable cement of approved manufacturer (conforming to relevant I.S. Specification) may be used for the purpose. An optimum ratio of coarse/fine aggregate should be established to suit the purpose depending on availability of aggregates.

   d) Mix design also should be so done that it has a slump of 50 mm at the point where concrete is placed under an ambient temperature of around 40^{o}C. This will also keep vibration by needle vibrators to required minimum. Slump should not drop down to zero in less than 45 minutes. Suitable retarding agent or plasticizer of approved manufacture may be added in mix to achieve this purpose. These admixtures to be properly identified by preliminary tests both for performance and for compatibility with particular type of cement proposed to be used.

      Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40^{o}C.

2. Care must be taken to prevent twist, which predominantly occur in the initial stages because of low slipping rate, in the horizontal plane of Slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes interval. One person should exclusively be assigned this work together with rectifying any defect.

3. Every endeavor has to be made so as not to occur any tilt in the shutter assembly. To achieve this following steps need be taken

   a) Performance of jacks has to be closely observed and any defective one needs immediate replacement. Difference in levels of opposite jacks at any instant of time should not exceed 5 mm.

   b) Loading on Slip-form truss/yokes has to be fairly equal.

c) Sleeve through which jacking rod passes has to be of sufficient length so that later gets an uniform clearance and does not get any chance to tilt. Sleeve should have a minimum wall thickness of 3.25 mm and should be such that jacking rod gets a maximum clearance of 1 mm to 1.5 mm around.

4. For taper walled chimneys overlapping of shutters which are kept to effect the tapering, needs careful attention otherwise these may be filled with concrete slurry.

5. In designing the mix following aspects should be borne in mind:

a) Cement used should have an initial setting time of not less than 50 minutes and preferably should have a specific surface around 3600 Sq.Cm. per gram.

b) Coarse and fine aggregates should be well graded and rounded aggregates offer better performance in Slip-form technique. These help to keep down water/cement ratio and also offers better lubrication between concrete and shutter surface. 40 mm down size of coarse aggregates should preferably be used unless reinforcement detailing calls for lesser size aggregates.

c) From the point of view of creep, shrinkage as well as initial setting property of concrete, cement content should not preferably be more than 400 Kg. per Cu.M of concrete.

d) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slipform proceeds should be between 0.1 to 0.2 Newton/ Sq.mm.

e) It is advisable to use cement from a single source during the entire operation of slipform technique since once the system starts, there might not be any time left for conducting trial mixes if the source of procurement of cement changes.

6. Large dia. vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter and to 40 mm diameter - only in exceptional cases. At least two nos. standby vibrator units should always be maintained on top of working deck at all time during the entire period of slipform operation.

7. It is preferable to have membrane curing compounds sprayed on fresh surfaces emerging out of shutter panels for ensuring proper curing at great heights.

In case such spraying is not envisaged then elaborate arrangement has to be made for adequate supply of water both on inside and outside vertical surfaces with spraying arrangement, necessary length of pipelines and pump of adequate head to serve the purpose. It is always advisable to have a stand-by pump for effective utilisation of the system.

8. If Slipforming is carried out in summer, rate of slipping should be around 400 mm per hour. If lesser value is contemplated appropriate retarders should be specified.

9. Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.

   It is desirable that jacking system, based on which the entire slipform system works, should consist of jacks 3 Tonne/6 Tonne capacity and a hydraulic pump with necessary pipe connections.

   Spacing of yoke legs should preferably be kept within 2 metres to prevent overloading on jacks and consequent failure resulting in twist of the formwork.

   Jacking rods should be of 25 mm diameter for 3 Tonne Jacks and 32 mm diameter for 6 Tonne Jacks.

10. At least 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump alongwith a set of loose pipes in perfect working condition on top of working deck.

11. In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slipform yoke.

12. For effective utility of this technique following areas need careful attentions at the very conceptual stage:

    a) Detailed quality assurance programme.

    b) Advance Planning and preparations.

    c) Arrangement for on site supervision and adequate access facilities.

13. Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, description and frequency of various checks and tests for Slipform technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared beforehand by executing agency and to be approved by Engineer before starting the actual work.

14. Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement.

Vertical reinforcements should be kept vertical by providing suitable holders within the slipform system.

15. It is desirable to have a break of at least one day for every two weeks of continuous operation. Such break should be utilised for various maintenance activities, removal of jack rods etc.

16. Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and reinforcement. If felt necessary one hoist may be exclusively earmarked for transporting concrete.

    For movement of personnel supervising the work a separate hoist must be arranged for.

17. The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system alongwith slipform.

18. Winches for lifting men and material and mixers, if located within unsafe area around chimney, should be protected by adequate shelter from possible damage.

19. Proper tele-communication system has to be established between the personnel working on top of Chimney and control room below.

20. A small laboratory should be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube testing machine may also be installed at site for getting quick feed back results.

    Apart from using plumb bobs, level and theodolite instruments for survey purpose arrangement should also be kept for lasers.

21. In case of interruption in the course of slipping of formwork following measures should be taken:

    a) Provision of a key and additional reinforcement at the junction of new and old concrete.

    b) Slipform system should be brought up freely to have a minimum overlap of 100 mm or so over previously cast concrete.

    c) Washing of old concrete surface with compressed air and water jet and thereafter pouring a layer of neat cement grout.

    d) Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Engineer.

e) Neatly finishing the interface of old or new concrete as soon as it comes out of shutter panel.

22. It is preferable to suspend the construction work under high wind condition.

23. It is of utmost importance that for effective implementation of this system an Engineer fully conversant with Slipform technique with enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid level supervisory staff, skilled workers and operators.

24. Operation of slipform method of construction is a continuous one and it demands continuous/intermediate inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.

25. While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety Engineer.

Safety measures as listed below must be adhered to but should not be limited to only these:

a) Safety helmets and belts to be provided to all supervising staff and workers.

b) Safety nets to be provided below both inside and outside platforms as instructed by Engineer.

c) Handrailing and toe guard to be provided around all openings and platforms.

d) Regular maintenance of equipment, checking of hoists, scaffoldings etc.

e) Passenger hoist must have multiple ropes.

f) Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the Specification and to be operative in case of sudden power failure Emergency standby generator must be kept ready during the entire period of slipform method of construction.

g) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

26. Permissible construction tolerances should be limited to the following:

Variation in wall thickness : (-) 5 mm, (+) 25 mm

Variation from Design Diameter	:	(±) 25 mm or (±) 12.5 mm per 3 m dia. whichever is larger, but in no case more than (±) 75 mm.
Out of Plumb in General	:	1 in 1000 of height subject to a maximum of 200 mm.

Although deviations in general will not be encouraged, the Contractor, however may mention in his offer the additions to or deviations from drawings/Technical Conditions/Schedule of items issued with the tender papers and any other special requirement implied with the adoption of the Slipform method, which may include but need not be limited to the following items as applicable:

a) Particular requirement of type and brand of cement, if any.

b) Special admixture to be added to concrete.

c) Any change required in the geometry of the Chimney including the shell thickness or side slope from that shown in the N.I.T. drawing.

d) Any change/special requirement in the arrangement of reinforcement.

e) Implications if any of necessary insitu bending of rebars for corbels/ brackets etc. and straightening/cleaning of the same prior to casting of brackets.

f) Any additional constructional opening in the shell required at ground level for concreting.

All deviations from tenders must be justified and tender price shall include all such variation/deviation. Such deviation without assigning any reason will be rejected.

3.04.00 **Chimney Steel and Metal Work**

3.04.01 **General**

All workmanship shall be of best practice in modern structural shops, and shall conform to the provisions of the IS:800 and other relevant IS Specifications, unless otherwise specified.

3.04.02 **Fabrication**

Rolled materials, before being used for fabrication, shall be straight and shall be within the tolerance laid down in the IS:852. Straightening, if necessary, may be done by mechanical means and if required, by applying localised heat the temperature of the material not exceeding 600 Deg.C locally. Cutting of mild steel members shall be effected by power saw or gas cutting. If gas cutting is used, allowance shall be made in working out the effective length,

based on the shop drawing and templates. Care shall be taken in gas cutting so that the member does not bend or warp. Edge preparation for welding may be done by gas cutting with necessary precautions and cleaning. Holes shall be drilled with power drill. Arrangement shall be made for clamping the member to be drilled so that the member is not displaced while drilling is in progress. When two or more members are to be drilled together, all the parts shall be clamped together. After drilling they shall be separated and burs shall be removed with power driven hand grinder. Bolt holes shall not be formed by a gas cutting torch.

3.04.03 **Assembly**

Riveting, bolting and welding shall be carried out as per requirements laid down in IS:800. Shop assembly of elements of platforms or the entire platforms, brackets and similar items if required and/or asked for by the Engineer, shall be arranged so as to check the accuracy of fit. Necessary temporary supports like props, cross bracings etc. shall be provided to keep the parts in place both for mock up and at the time of erection. Each steel piece shall bear erection marking, written in paint.

3.04.04 **Painting**

If steel and iron members are to be painted as per contract, it shall be done as per requirement laid down in IS:800. A coat of shop painting shall be applied to all steel and metal work, unless stated otherwise. All steel ladder, platforms, balconies, hand railing, frames, doors etc. which are specified for painting shall be painted first with two coats of red oxide zinc chromate paint conforming to IS:2074 and then with two coats of Synthetic enamel paint (as per IS:2932 & 2933) or aluminium paint (as per IS:2339) of approved quality or acid resisting paints as specified in drawing or elsewhere.

Total dry-film thickness of paints provided on structures located outside windshield shall be 190 microns and that on inside be 125 microns minimum.

All paints shall be of make and shade as instructed and approved by the Engineer. Necessary test certificates, manufacturer's literature & samples shall be submitted to the Engineer, for his approval, before bulk purchase is made.

The metal surfaces which are to be painted shall be prepared properly by rubbing, washing, treating prior to application of paint as per paint manufacturer's specifications and as per relevant IS Specifications.

3.04.05 **Galvanizing**

All steel including threaded bolts, nuts and washers, unless specified otherwise in contract, shall be hot dip galvanized in accordance with American Society for Testing and Material Specification ASTM 123 or IS:2629 - Recommended practice for Hot- Dip Galvanising of Iron and Steel.

All members to be galvanized shall be cleaned thoroughly, to the satisfaction of the Engineer, by the process of pickling. Pickling shall be carried out in an acid bath containing sulphuric or hydrochloric acid of suitable and adjusted

concentration and temperature. Pickling process shall be completed by rinsing the members thoroughly in warm water.

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath and it shall meet all the requirements when tested in accordance with IS:2633 and IS:4759. The zinc coating shall be of uniform thickness. If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage and if so directed, the galvanizing may have to be redone in the similar manner stated above.

3.04.06 **Erection**

Erection of structural members and C.I. Chimney caps shall be done as per requirement of IS:800. The Contractor shall submit to the Engineer a programme of erection for his approval. All plant, equipment, tools, tackle and any other accessories required for the erection shall be provided by the Contractor. Storing and handling of fabricated materials for erection, setting out of members, providing temporary supports, bracing, fasteners, bolts, nuts etc. shall be the responsibility of the Contractor and shall be taken into account in quoting the rate.

3.04.07 **Cast Iron Chimney Cap**

The cast iron cap, fitted at the top of the chimney, shall be of thickness not less than 10 mm. This shall preferably be a single cap covering both the concrete shell and the lining, with the segments bolted together securely and properly anchored inside the concrete in such a manner as to form a complete annular unit, allowing for unequal circumferential and vertical expansion and contraction of concrete shell and lining and for deflection of shaft due to wind.

All bolts, nuts, washers, rag bolts and other fasteners as required for fixing cast iron cap shall be of bronze material. Gaps between segments are to be filled with asbestos mill-board or fiber-glass packing. Casting is to be assembled to match with the dimensions specified in drawings, before despatch to site. C.I. caps to be painted with two coats of acid resisting paints over primer coats as recommended by paint manufacturer.

3.05.00 **Insulation and Protective Treatment**

3.05.01 **Acid and Heat Resistant Paint**

The inside surface of concrete shell and corbels and outside surface for height as specified in the drawing shall receive a protective treatment of three coats of acid and heat resistant black paint. The quality and type of the paint shall have the prior approval of the Engineer. For this, a small area shall be painted and a sample of paint shall be shown to the Engineer.

The surface to be painted shall be prepared and primary coat, if required as per the paint manufacturer's specification and direction of the Engineer, shall be applied. The paint shall conform, unless otherwise stated, to the requirement of IS:158. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for his approval.

The surface to be painted shall be completely dry before the paint is applied and the drying time between consecutive coats shall not be less than 5 hours.

3.05.02 **Cement Paint**

The outside face of the Chimney shell, unless specified otherwise, shall be painted with Cement waterproof paint. The quality shall be approved by the Engineer. Necessary samples shall be submitted to the Engineer for his approval. The surface of the shell shall be prepared as per paint manufacturer's specification. In addition, care shall be taken that the surface is free from stain, honey comb and any rough and uneven surface. The joints between two shuttering and two lifts of shuttering shall be so prepared that any unevenness, if by chance exists, shall be removed. If one coat of paint is not sufficient to give the required finish, the Contractor, at his own cost, shall repaint the surface, until the Engineer is satisfied with the workmanship. The paint shall conform, unless otherwise stated, to IS:5410. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for approval.

3.05.03 **Acid Resistant Brick Lining**

The Contractor shall use acid resistant bricks for the job as indicated in the Drawing. They shall be fine grained in texture, dense and homogeneous. The brick shall be sound, true to shape, flat and free form flaws and other manufacturing defects affecting their utility. The bricks shall conform to IS:4860-1968 Class-I for acid resistant bricks. The bricks shall be of necessary curvature and of taper so that the lining conforms to the inner radius of the flue lining and hopper surface. No attempt shall be made to use straight bricks and than to try to match with the inner radius of the lining of chimney by providing extra mortar. No broken bricks shall generally be used. The compressive strength of the bricks shall not be less than 700 Kg/Sq.cm as per IS:4860 Class-I. The Contractor shall provide sample for visual inspection and approval. For testing purposes, the Contractor shall select, at random, bricks from the stack, in presence of the Engineer. The sample bricks thus collected, shall be sent to laboratory for testing of compressive strength, acid resistance and water absorption. The cost of sending to the laboratory, testing and any other incidental expenditure shall be borne by the Contractor and the rate should include such test.

The Contractor shall submit to the Engineer the original test results for his scrutiny and approval.

Bricks shall be thoroughly wetted before using. The mortar to be used shall have similar characteristics, i.e., it shall also be acid resistant. The mortar shall be acid-proof mortar-potassium silicate type (resistant to sulphuric acid) as per IS-4832 Part-I & IS-4441. The mortar shall also be tested at Contractor's cost, in a laboratory approved by the Engineer. The mortar shall be used immediately after mixing. The water cement ratio and the workability shall be strictly maintained. The brickwork shall be flush pointed, after necessary raking of joints and cleaning of surfaces. The lining shall be kept wet for a period of at least 3 days, after which exposed face shall be thoroughly cleaned. The air space and all ventilation holes in the shell and corbels shall be kept clean of any mortar for thorough ventilation. The mortar

between bricks shall not be more than 3 mm thick and the mortar used shall be freshly prepared, used within the setting time. No retampering shall be permitted.

3.05.04 **Fire Brick Lining**

The Contractor shall use fire bricks for lining of the Chimney and hopper as shown in the drawing. The bricks shall be of necessary curvature and of taper so that the lining conforms to the inner radius of the flue lining. No attempt shall be made to use straight bricks and then to try to match with the inner radius of flue lining of chimney by providing extra mortar. Fire bricks shall be well burnt, compact and of homogeneous texture generally white to yellowish white in colour and free from cracks and other flaws; no broken bricks shall be allowed to be used except for closing the course. The crushing strength of the bricks shall be not less than 200 Kg./Sq.cm and shall be of Group-A conforming to IS:6-1983, Specification for Moderate Heat Duty Fire clay Refractories, Group-A. The water absorption of the bricks shall not exceed 13% and the density of bricks shall be approximately 1800 to 2000 kg/Cu.m. Thermal conductivity of fire brick shall not exceed 1 kcal/hr.m.deg.C. Sample of bricks shall be submitted by the contractor for approval of the Engineer. For testing of bricks sample shall be taken according to the scheme given in IS:1528-1962, IS for Sampling and Physical Testing of Refractory Material; and cost for testing and incidental expenditure shall be borne by the Contractor and rates quoted shall include the cost.

The brick shall be laid with air setting fire clay mortar free from potassium/ Sodium silicate. The mortar may be "Tataset-FK-40" manufactured by Tata Refractories Ltd. or equivalent. The material shall be kept in a cool place under covered shed before use. The mortar shall be applied strictly as per manufacturer's instructions.

Thickness of mortar joint shall not be more than 3 mm. The bricks are to be laid one course of header followed by two courses of stretchers and so on or as directed by the Engineer. The exposed face shall be true to the line, parallel to the Chimney shell unless shown otherwise. Steel starps made of flats shall be provided on the exterior surface of brick lining both circumferentially and vertically for both acid resistant brick lining and firebrick lining. The steel straps shall be double hot dip galvanised.

3.05.05 **Insulation and Packing**

All packing and insulation material shall be of thickness, diameter and type, shown in the drawing. The packing and insulating material shall be made of asbestos rope, vermiculite concrete, slag or mineral wool and asbestos mill boards.

a) **Asbestos Rope**

The diameter of the rope shall be as per drawing. The material shall be of best quality available in the market and shall be purchased after a sample is approved by the Engineer. The rope shall be plain, Grade-I, conforming to IS:4687-1968. The strand shall be long, well twisted and no torn thread shall stick out. The rope shall be firmly packed so as to prevent gas leakage.

b) **Slag or mineral wool**

The thickness of packed slag wool shall be as shown in the dwg. The packed density of the wool shall be within the range of 175 to 200 Kg./cu.m and the co-efficient of thermal conductivity shall conform to the requirement of IS:3677 at a mean temperature of 150 Deg.C. The material shall be well packed in position where possible. IS:3677 for Rock and Slag wool mats for thermal insulation may be referred for guidance. The co-efficient of thermal conductivity and packed density shall be tested according to IS:3677 and IS:3346.

c) **Vermiculite Concrete**

Vermiculite concrete shall be made by mixing exfoliated vermiculite, portland cement and water. It shall be of Grade-B, having a density of 210 Kg./Cu.M. The vermiculite aggregate size shall be maximum 6 mm. The mix shall be 1 cement and 8 vermiculite by volume.

d) **Asbestos Mill Board**

Asbestos mill board shall be of thickness as indicated in drawing. It shall be of best quality of standard make available in the market and samples shall be submitted to the Engineer for approval. It shall be plain, dense and homogeneous texture, without cracks, flaw and any other manufacturing defect. It shall be laid directly onto the concrete bed after removing any loose material or any aggregate. The concrete shall be prepared without mortar so that the board can have a good seating.

3.06.00 **Lightning Protection System**

3.06.01 Refer electrical specification volume II F / 2, Section – XV – “Technical Specification fpr Chimney and Natural Draft Cooling Tower – Electrical Works.”.

3.06.02 Not used.

3.06.03 Not used.

3.06.04 Not used.

3.06.05 Not used.

3.07.00 **Aviation Obstruction Lighting System**

3.07.01 Refer electrical specification volume II F / 2, Section – XV – “Technical Specification for Chimney and Natural Draft Cooling Tower – Electrical Works.”.

3.07.02 Not used.

3.07.03 Not used.

3.07.04 Not used.

3.07.05 Not used.

3.07.06 Not used.

3.08.00 **Sampling Port**

Sampling ports of minimum 0.1 m dia. shall be provided in the Chimney as shown in the drawing to maintain records of emission. Minimum length of port shall be 0.5 m measured from inside face of the lining to the outside end of the port. The port shall be provided with industrial flange capped when not in use. Location of port shall be at least two times the top diameter below the stack exit and at least eight times the stack diameter above the last obstruction. One meter below sampling port a working platform has to be provided at least 1 m wide with safe guardrail and access ladder. Ladder well shall be located at least 1 m away from ports. There shall be no obstructions within 1 m horizontal radius on platform beneath ports. A power source of 220 V, 15A single phase 50 Hz AC shall be located on the platform. There shall be two ports 90 Deg. apart when stack dia. is less than 3 m plus port length and 4 ports when stack dia. is more than 3 m plus port length.

3.09.00 **MS insert plates for mounting of instruments for the measurement of amplitude of vibration and wind speed**

For mounting of accelerometer and wind speed censors 600 x 600 x 20 thick, MS inserts with 25 nos. threaded (1/2" whitworth) holes shall be fixed on the outer circumference of the chimney shell with MS lugs as shown on the drawing. During casting, the holes shall be temporarily plugged to prevent concrete from filling in the holes. Two nos. of such inserts shall be fixed at the top of the chimney for mounting accelerometers and a set of four nos. of such inserts shall be fixed at one-third and two-third heights of the chimney for mounting wind speed censors. A working platform of 1 meter width with safe guardrail shall be provided 1 metre below each level of these inserts as shown on the drawing.

For laying of cables, the same cable tray used for illumination/ aviation light shall be utilized.

4.00.00 **TESTING AND ACCEPTANCE CRITERIA**

4.01.00 **General**

The Contractor shall carry out all sampling and testing in accordance with the relevant IS Specifications and as supplemented herein, for the following items or any other item as may be required by the Engineer, at his own cost, unless otherwise specified in this specification. The Contractor shall get the specimens tested in laboratory, approved by the Engineer and shall submit to him, the original test results in triplicate, within seven days after the completion of the test.

4.02.00 **Cement**

Representative samples shall be taken as per the relevant IS Specification from each consignment of Cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time, compressive strength and soundness tests, and the Contractor shall carry out the above tests as per relevant Indian Standard. If the cement is supplied by the Contractor the test shall be carried out by him at his own cost.

4.03.00 **Aggregate**

The Contractor shall carry out any or all the tests on aggregates as may be required by the Engineer, in accordance with IS:2386 Parts-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant IS specifications.

4.04.00 **Water**

Sampling and testing of water being used for concrete works shall be carried out as per IS:3550, by the Contractor, at regular intervals and whenever directed by the Engineer. The final acceptance criterion in case of doubt shall be as per IS:3025.

4.05.00 **Concrete**

The Contractor shall take cubes for works test as per requirement laid down in IS:516 regularly from the day's pour. The number of test cubes to be taken shall be as per IS:456. The Engineer may also use his discretion in deciding the rate of cubes to be taken. The acceptance criteria is to meet the requirement of IS:456. If the cube test results indicate that some portions of the work is below the required strength, the Engineer may order demolition of that portion of work which is below strength and ask the Contractor to rebuild, provided a satisfactory method of load testing is not possible. Such testing or demolishing and rebuilding shall be carried out by the Contractor at his own cost.

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

The following technical information are required with the tender:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used. All details as per clause 3.3.6 to be submitted, if slip form method is proposed to be used.

e) Proposal for lifting of men and material in constructing the chimney.

5.02.00 **After Award**

The following information and data including samples where necessary, shall be submitted by the Contractor, progressively during the execution of the Contract.

5.02.01 **Programme of execution and requirement of materials**

Within 30 days of the award of the Contract, the Contractor will submit a Master Programme for completion of the work giving monthwise requirement of materials, particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms & conditions of the Contract. In case the Contractor proposes to take on hire any machinery or tools and plants from the Owner, the detailed phased out programme of such hire is also to be submitted.

The master programme may have to be reviewed and updated by the Contractor quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day to day programme of every month is to be submitted by the Contractor before the commencement of the month.

5.02.02 **Samples**

Samples of all materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities, free of cost, for approval. All samples shall be submitted well in advance of starting work at site. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying material of specified quality.

5.02.03 **Design Mix**

Design mix as per details of this specification giving proportions of ingredients, sources of aggregates and cement along with accompanying test results of trial mixes as per relevant IS Specifications shall be submitted to the Engineer, for his approval, before it can be used on the work.

5.02.04 **Detail Drawings**

Following items shall be provided by the Contractor which are to be approved by the Owner.

a) Detail drawings and designs of form work including scaffolding to be used. If slipform method of construction is adopted, then detail drawings showing all the arrangements for slipform technique including methods for reducing internal diameter and providing required slopes on outer diameter.

b) Detail drawings and bar bending schedules for concrete components.

c) Shop drawings for steel and metal work, including inserts etc.

d) Detail drawings for templates and temporary supports for embedments.

e) Detail lining drawing.

5.02.05 **Reports**

Following Test Reports shall be furnished by the Contractor:

a) Mill Test Report for cement and reinforcing steel if the materials are supplied by the Contractor.

b) Inspection Report of formwork and reinforcement.

c) Reports of tests of various material and concrete.

d) Any other data or report or test result required by the relevant IS Specifications and if required by the Engineer for satisfactory quality control of the workmanship.

TECHNICAL SPECIFICATION
FOR
XIII) PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIAL

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	MATERIALS
3.00.00	STORAGE AND HANDLING OF MATERIALS

XIII) PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIAL

1.00.00 **SCOPE**

The scope of this Section is to specify the properties, storage and handling of common building materials unless otherwise mentioned in drawings or schedule of items.

2.00.00 **MATERIALS**

a) **Bricks**

Bricks for general masonry work shall conform to IS:1077-1970 and for face brick work shall conform to the specifications in IS:2691-1972.

Bricks for general masonry work shall be of class 10, well burnt, of uniform size, shape and colour free from cracks. This brick will have average compressive strength of 50 kg/cm^2. Fractured surface shall show uniform texture free from grits, lumps boles etc. Compressive strength shall be 50 Kg/cm^2 minimum for face bricks. Water absorption after 24 hours immersions shall not exceed 15% by weight for common bricks & 12% for face bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for common bricks and 3% for face bricks. All bricks shall have rectangular faces & sharp straight edges. Maximum permissible chippage for face bricks shall be 6 mm at the edges and 10 mm for corners. The bricks shall show no efflorence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved sample shall be retained by the Engineer for future comparison and reference. The colour and texture of face bricks shall be upto the specification and defective bricks shall be removed immediately from site at the Contractor's own cost.

ai) Fly ash bricks conforming to IS 12894-2002 shall be used where good quality burnt clay bricks are not available or specifically desired by the owner. The Minimum compressive strength shall be 100 Kg/Sq.Cm Only full size bricks shall be used for masonry work. Brick bat shall be used only with permission of engineer to make-up required wall length or boundary. Conventional brick bats with the approval of site Engineer may be used.

b) **Stone**

All stones shall be from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of

water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) **Lime**

Lime shall be stone lime and conform to the specification Building Limes - IS:712. Lime putty may be prepared from hydrant lime or quick lime. Hydrated lime shall be mixed with water to form a putty and stored with reasonable care to prevent evaporation for at least 24 hours before use. Quick lime shall be shaken with enough water to make a cream, passed through a No. 0 Sieve and then stored with reasonable care to prevent evaporation for at least 7 days before use.

d) **Cement**

Cement used shall be ordinary Portland Cement conforming to Code for ordinary cement in IS:8112 / IS:12269, Portland Pozzolona Cement (PPC) conforming to IS 1489 (Part-1) or IS 1489 (Part-2) and shall be fresh when delivered. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If the cement is procured by the Owner and issued to the Contractor, the Contractor shall satisfy himself at the time of taking delivery that the quality, quantity and freshness of cement are upto the specified standards. No complain later on regarding the cement supplied by the Owner shall be entertained and all rectification work on this account shall be done by the Contractor at his own expense. If at any time, the Engineer feels that the cement being used by the Contractor is not upto specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

e) **Coarse Aggregates**

Coarse aggregates shall be as per IS:383 latest edition, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS:383 and shall be such as to produce a dense concrete of the specified proportions and strength and of consistency that will work readily into position without segregation.

f) **Sand**

Sand shall be hard, durables, clean and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosions to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded. Unless otherwise directed by the Engineer all sand shall pass through IS Sieve No. 240 and 15 to 35% of and for masonry mortar and 5 to 50% of sand for plaster shall pass through IS Sieve No. 30. Sand for concrete shall conform to IS:383.

g) **Water**

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

h) **Reinforcement**

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings which may impair proper bond. Structural steel shall conform to IS:226. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS:432 Cold twisted steel bars shall conform to IS:1786. Hexagonal wire netting shall conform to IS:3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

3.00.00 STORAGE AND HANDLING OF MATERIALS

a) **Bricks**

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded, to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) **Stones**

Stones shall be stored at site in manner approved by the Engineer. Dressed stone for wall facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.

c) **Lime**

Lime shall be stored in weatherproof sheds.

d) **Cement**

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

e) **Coarse and Fine Aggregates**

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass or any other injurious substances at any stage. Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

f) **Reinforcement**

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

TECHNICAL SPECIFICATION
FOR
XIV) ANTI-TERMITE TREATMENT

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XIV) ANTI-TERMITE TREATMENT

1.00.00 **SCOPE**

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 **EXECUTION**

2.01.00 **General**

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 **Chemicals and Rate of Application**

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals		**Concentration by Weight, Percentage**
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	:	0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	:	1.0

2.02.01 **Treatment of Column Pits, Wall Trenches and Basement Excavations**

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface & sides of excavation (up to a height of about 300mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres/M^2 of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres/M^2 of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding

the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

2.02.02 **Treatment of Top Surface of Plinth Filling**

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres/M^2 of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.02.03 **Treatment of Soil Surrounding Pipes, Wastes and Conduits**

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.02.04 **Treatment of Expansion Joints**

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.02.05 **Treatment at Junction of the Wall and the Floor**

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.

A small channel 30x30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 **ACCEPTANCE CRITERIA**

The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period at no extra cost to the owner.

4.00.00 **I.S. CODE**

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981: Code of Practice of Anti-Termite Measures in Buildings

Pre-constructional chemical treatment measures.

TECHNICAL SPECIFICATION
FOR
XV) MASONRY AND ALLIED WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	I.S. CODE

XV) MASONRY AND ALLIED WORK

1.00.00 **SCOPE**

This specification covers supplying, Laying, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied work for use in structures and locations covered under the scope of the Contract.

2.00.00 **INSTALLATION**

2.01.00 **Soling**

2.01.01 **Brick Soling**

The ground shall be dressed, consolidated by ramming or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of Item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

2.01.02 **Stone Soling**

The stones for soling shall be selected on the basis of thickness of soling shall be 230mm thick or as directed by the site engineer as per site condition. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

2.02.00 **Brick Edging**

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

2.03.00 **Masonry**

2.03.01 **General**

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

2.03.02 **Mortar**

Mix for mortar shall be as specified in the general specification of Architectural work unless mentioned otherwise mortar shall be cement sand mortar of proportion as specified in schedule of item.

If cement lime and sand mortar is specified in the schedule of item lime shall be hydrated lime and shall be mixed with water to form putty and stored with care to prevent evaporation for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream, passed through a No. 10 sieve and stored avoiding evaporation for seven days before use.

Lime putty and sand in proper proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in a mortar mill. This mix shall be transferred to a mechanical mix, required quantity of cement added and the content mixed for at least 3 minutes. Mixtures of lime putty and sand may be stored avoiding drying out.

For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct to add additional cement and same shall be made without any extra cost. No mortar, which has stood for more than half an hour, shall be used.

2.03.03 **Brick Masonry**

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

2.03.04 **Exposed Brickwork (Not Used)**

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by especially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of windowsills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified in the Schedule of Item, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of

work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

2.03.05 **Reinforced Brickworks**

Reinforcements shall be as specified in the General Specification of Architectural work. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. Columns or welded to steel stanchions.

2.03.06 **Stone Masonry (Not Used)**

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. Al least two stones shall run the full width of the wall for every square meter of surface area.

2.03.07 **Exposed Stonework (Not Used)**

Stonework, which is to be kept exposed, shall be as shown on drawing or described in the Schedule of Items. Especially skilled mason shall execute it. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or the Schedule of Items or instructions. A sample wall, 10 sq.m. In area shall be built and approved by the Engineer and all works shall match with this sample.

2.03.08 **Hollow and Solid concrete block Masonry (Not Used)**

Hollow and solid concrete block shall conform to the requirement of I.S 2185. Hollow concrete block shall be sound, free from broken edges; free from cracks, honeycombing and other defects, which may give a defective work, impaired the required strength.

Dimensional stability: concrete masonry units shall be made of proper sizes and shape to suit the construction need and shall be in neutral of the following sizes:

The nominal size of concrete block /solid concrete block.

Length : 400,500,600.

Height : 200,100

Width : 50,75,100,150,200,250,300.

In addition block shall be manufactured in half-length of correspondence to full length. Maximum tolerance of length shall be (±) 5mm and in height &with shall be ± 3mm.

The average crushing strength shall be determined as per I.S 2185 and shall be of Load bearing wall density of block shall be not less than 1500 kg /mm^3 and minimum average compressive strength of units shall be 3.5 to 7 N/mm^3 and minimum strength of individual unit shall be 2.8 to 5.6 for block density less than 1500 kg /mm^3 but not less than 1000 kg /mm^3 average compressive strength of units shall be 2.0 to5 N/mm^3 and minimum strength of individual unit shall be 1.6 to 4.0 N/mm^3

For non load bearing wall block density shall be not less than 1000kg / mm^3 and minimum average compressive strength of units shall be1.5 N/mm^3 and minimum strength shall be 1.2 N/mm^3**.**

2.03.09 **Composite Masonry (Not Used)**

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and intervels as desired by the Engineer.

2.03.10 **Expansion & Separation Joints**

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

2.03.11 **Moldings, Cornices, Drip Course**

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

2.03.12 **Curing**

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

2.03.13 **Embedding of fixtures**

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required and shall be grouted with concrete.

2.03.14 **Encasing of Structural Steel**

This shall be done by building masonry work round flanges, webs etc. and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer.

The minimum lap in chicken wire mesh shall be 50 mm. Architectural standard details shall be referred for encasement details.

2.04.00 **Damp Proof Course**

Unless otherwise specified Damp-proof course shall be 50 mm thick PCC in proportion 1:1-1/2:3 cemen :sand: stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

2.05.00 **Damp Proof Membrane**

Damp proof treatment using fiber or Hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as mentioned in the Schedule of Items. Sequence or work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150mm lap under slabs on grade.

3.00.00 **I.S. CODES**

Some of the important relevant codes for this section are:

IS: 1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.

I.S 2185 : Code Practice for hollow concrete block.

IS: 1597 : Code of Practice for Construction of stone Masonry.

IS: 1609 : Code of Practice for laying Damp-proof treatment using bitumen felts.

IS: 2212 : Code of Practice for Brickwork.

IS: 2250 : Code of Practice for preparation and use of Masonry Mortar.

IS: 5134 : Bitumen Impregnated Paper & Board.

TECHNICAL SPECIFICATION
FOR
XVI) FINISH TO MASONRY AND CONCRETE

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XVI) FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.00 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brush to remove all loose dust from joints and thoroughly washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 Plastering

2.02.01 Mortar

Mortar for plastering shall be as specified in the General Specification and design criteria for Architectural work.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 **Application of Plaster**

Plaster, when more than 15 mm thick, shall be applied in two coats - a base coat followed by the finishing coat. For 20 mm thick external plaster Thickness of the base coat shall be sufficient to fill up all unevenness in the surface and shall be 12 mm thick and mortar shall be 1:1 Cement Sand plaster. Top coat shall be 8 mm thick with cement sand mortar 1:3. No single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat as indicated in the General Specification and design criteria for Architectural work. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be thrown on rather than applied by trowel.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, door jambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, moldings and cornices as required or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. Drip course shall be provided over all windows, ventilators, louvers and all external doors, rolling shutters and External openings where such course is required for dripping of the water or as instructed by the site engineer. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 **Finish**

Generally, the standard finish shall be used unless otherwise indicated in the General specification or Standard Architectural drawings attach to the documents or directed by the site Engineer. Wherever any special treatment to the plastered surface is indicated in the General Specification for Architectural work, the work shall be done to the entire satisfaction of the Engineer regarding the texture, colour and finish.

a) **Standard Finish**

Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) **Neat Cement Finish**

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. Per Sq.M and rubbed smooth with a trowel. Unless otherwise indicated in the General Specification of Architectural work minimum 300 high neat cement finish shall be provided over plastered external surface from top of plinth protection level.

c) **Coloured Plaster Finish (Not Applicable)**

This shall be done, if indicated in the General specification for Architectural work, in the same way as specified in clause **2.02.01** but using coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest edition.

Samples of colouring material shall be submitted to the Engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) **Pebble-dash Finish (Not Applicable)**

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering clause **2.02.01**. While the mortar is still plastic small pebbles or crushed stone of size generally from 10 mm to 20 mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) **Rough-Cast Finish (Not Applicable)**

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 mm as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) **Scraped Finish (Not Applicable)**

Ordinary plaster as described under Clause **2.02.01** after being levelled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) **Textured Finish (Not Applicable)**

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause **2.02.01** Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) **Textured Finish with Granules**

Surface where Textured granules finish specified shall be prepared Specially as per approved manufacturer's specification and recommendation. Granules shall be mixed thoroughly in colour pigmented resin and shall be applied uniformly with devices as per manufacturer recommendation and by the authorized applicator of the manufacturer. Texture and shade shall be as approved by the owner during detail engineering stage. Textured finish brand shall be HERITAGE or SPECTRUM or Approved Equal.

2.02.04 **Curing**

All plastered surfaces after laying, shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 **Pointing to Masonry (Not applicable)**

All joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 **Plaster with Metal Lath**

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 BG thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two layers. The mortar for plastering shall consist of 1 part cement, and 4 parts sand by volume, mixed

as specified in plastering, Clause 6.1.2.2.1. The application, finish etc. shall be as specified under relevant clause above. Where called for in the Schedule of Items, a 2 mm Plaster of Paris punning shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

Brick encasing of steel beams shall be plastered over wire mesh provided during encasing of Steel beam with bricks.

2.05.00 **Lime Punning (Not Applicable)**

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 **Plaster of Paris Punning (Not Applicable)**

a) Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

b) **Wall Putty Finish to interior & Exterior Surfaces.**

Plastered surfaces, where specified shall be finished with wall putty of approved manufacturer. Wall putty shall be white cement based with a mix of high performance special chemicals and polymers and shall be suitable for both internal and external finishes. Wall putty finishes shall be 1.5 mm -2mm thick as per the condition of the surfaces to be treated.

Wall putty shall be water, fungus and algae resistant. Wall putty manufactured by Birla Cement/ MYK Laticrete India shall be provided for the work.

2.07.00 **Stone Facing**

a) Stone facing where specified shall be done as shown on design drawings & approved shop drawings. The stone shall be as specified e in the General Specification for Architectural work. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 20-25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern approved by the owner. They shall be fastened to wall with suitable noncorrodable anchorage as approved by the Engineer or as indicated in the General specification. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanised (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer. The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Alternately Stone slab shall be fixed with Laticrete 254 platinum thin set adhesive of MYK Laticrete India Pvt. Ltd. or approved equal over plastered surface with 2mm joints in between. Joints shall be filled with matching colour filler grout of the same manufacturer. Thickness of adhesive shall be according to size and weight of the slab and manufacturer specification shall be strictly followed. This alternative fixing system if not indicated in the general specification for Architectural work can be adopted with the approval of owner.

b) **Wall finishes with Vitrified, Ceramic and Terracotta tile**

Wall tile facing where specified shall be done as shown on design drawings and approved shop drawings. The Tiles shall be as specified on drawings and/or schedule of items. Samples of Tiles shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing tiles shall be as specified in the schedule of items or in drawing. Tile shall be fixed over Plastered surfaces with approved Chemical mortar of high bonding strength of approved manufacturer.

c) **Wall finish with Aluminium Composite Panel (ACP)**

Wall facade interior or exterior surface shall be plastered prior to installation of ACP. The exterior plaster surface shall be specially treated with water proof treatment with SIKA top seal or two coats of EMUFAL TE rubberized modified bituminous emulsion of TEXSA or approved equivalent prior to installation of ACP. Water proof treatment shall be made as per manufacturer specification and by manufacturer's authorized applicator.

ACP cladding system shall be based on rain screen principle, with provision for natural ventilation of the space between cladding panels and wall.

Panels shall be fixed as per general arrangement shown in approved drawing. Each panel shall be fixed over extruded aluminium sections as per approved manufacturer details and shall be fastened to Sub structure.

All fasteners shall be concealed within the panel joints. No silicon or similar sealant shall be used within the panel joints. All joints shall be of toughened acrylic adhesive similar to PERMABOND F-245 or as recommended by the manufacturer. All fixing and joint details shall be designed to provide for the expected thermal expansion and contraction and to accommodate structural movement.

Design criteria:

All aluminium composite panel shall be designed to meet the specified performances required to for the prevailing weather conditions.

Design wind load shall be 20N/Sq.m. no cladding element shall sustain permanent deformation or failure under loading equivalent to 1.5 times the design wind pressure specified.

Deflection: deflection of any aluminium frame shall not exceed 1/150 of the clear span.

All cladding shall be minimum 4.0mm thick for external use and minimum 3mm thick for interior paneling and shall conform the approved manufacturer recommendation.

Aluminium composite panel (ACP) shall comprise of polyethylene core sandwiched between two skins of aluminium alloy. Skin shall be of approved shade.

Finish shall be factory pre-finished with a PVDF (Flurocarbon) coating of super polyester coating and shall be suitable to withstand most aggressive climate. DFT of coating shall be minimum 20 micron. Finished surface shall be protected with self adhesive peel off foil. The reverse side of the panel shall be standard factory finish.

Vendors shall furnish general arrangement drawing with details of fixing and also furnish samples for ACP, structural stability assurance with necessary calculation and manufacturer guide lines for fixing and recommended specifications for selection and approval of the material.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 **I.S. CODE**

Important relevant code for this Section:

a) IS: 1661: Code of practice for cement and cement-lime plaster finish on walls and ceilings.

b) IS: 4101: Code of practice for external facings and veneers.

TECHNICAL SPECIFICATION
FOR
XVII) SINGLE SHEET / SANDWICH / DOUBLE SKIN METAL CLADDING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	GENERAL
2.00.00	PRODUCTS
3.00.00	DOUBLE SKIN INSULATED METAL CLADDING
4.00.00	EXECUTION

XVII) SINGLE SHEET / SANDWICH / DOUBLE SKIN METAL CLADDING

1.00.00 **GENERAL**

1.01.00 **Description**

1.01.01 This section covers the furnishing and installation of sandwich i.e., double skin metal / single sheet metal cladding with or without insulation for wall/roof as shown in contract drawings including making cut outs for various openings for doors, windows, ducts, pipes etc and fixing of such components with the cladding arrangement with necessary flashing, sealant as required as per contract drawings. The contractor shall furnish all labour, materials, tools and equipment required to complete the work.

1.02.00 **Applicable Codes and Standards**

1.02.01 The following codes and standards are intended to provide an acceptable level of quality for materials and products. The contractor may propose alternative codes and standards provided they give an equivalent degree of quality as the referred codes and standards and are submitted for consultants/ owner's approval.

1.02.02 ASTM American Society for Testing Materials

1.02.02.1 A446 Zinc-coated (Galvanized) steel sheets of structural quality. Coils and cut lengths.

1.02.02.2 A611 Steel, cold rolled sheet.

1.03.00 **Submittals**

1.03.01 The contractor shall submit to the owner the following items for review before commencing work.

1.03.01.1 Samples

Three 300x300 mm pieces of each type of precoated and preformed metal sheet for top skin and bottom skin. Bottom skin is required for sandwich cladding only.

Type of insulation proposed for use and its thickness in case sandwich cladding.

Fabricated sandwich metal cladding. Sample size shall be 300 x 300 mm three nos.

Edge sealing and flashing.

1.03.01.2 Manufacturer's literature indicating the nature of preformed profiled, colour coating, manufacturer's recommended installation, instructions and maintenance procedure.

1.03.01.3 Manufacturer's certification of compliance with each delivery.

1.03.01.4 Shop Drawings

Showing fabrication details of sandwich/double skin/Single metal cladding with or without Insulation as the case may be, preformed sheet profile and total colour thickness for profiled top skin and slightly ribbed bottom skin, thickness and nature of insulation in case of sandwich cladding, installation and erection, anchorage, fasteners and details of accessories, metal flashing and its fixing including various openings for doors, windows, louvres, pipes etc.

1.03.02 Test Reports

Two copies of Test Reports and Source of Quality Control Tests.

1.03.03 Supplier Certificates

Two copies of technical data showing that the proposed finish product is suitable for the environmental conditions of the job site and that the materials meet specification requirements.

1.04.00 **Product Handling**

1.04.01 Delivery of Materials to job site in manufacturer's original unopened packaging.

1.04.02 Identify contents with name of manufacturer, brand name, thermal value and applicable standard.

1.04.03 Store materials in an area protected from adverse climatic conditions, moisture and open flame or spark and shall be stored off the ground with one end elevated for drainage. The sheets shall be protected from inclement weather with a waterproof covering with ventilation to avoid condensation.

2.00.00 **PRODUCTS**

2.01.00 **General**

2.01.01 all goods and products covered by these specifications shall be procured from manufacturer duly approved by the owner

2.01.02 Roof insulation in case of sandwich roof cladding shall have a minimum R-value of 2.083 M2 oK/Watt. Thickness of sandwich cladding shall be as required to meet the specified "R" values.

2.01.03 Sandwich material shall be of "Rib and Flute" design to ensure wide spanning and quick recovery after being subjected to excessive load. Double skin materials shall be as per approved manufacturer sheet profile and sizes and inner sheet shall be mild rib & flute type profile to ensure quick recovery after being subjected to excessive load.

2.01.04 Material

2.01.04.1 Base Material — High tensile steel

2.01.04.2 Metal protection — Galvalume. This shall be steel sheet with Zinc Aluminium coating offering high corrosion resistance.

2.01.04.3 Organic coating — Silicon Modified Polyester (SMP) or Fluoro polymer (PVF2) and plastisols to resist aggressive climate of the jobsite or as per approved manufacturer's specification and recommendation.

2.01.05 Material shall be single skin or sandwich as per contract requirement in case of sandwich cladding material shall be prefabricated sandwich panel with polystyrene insulation/ resign bonded high density rock wool insulation shall be conformed to relevant ASTM or alternative codes and standard. Insulation shall be bonded to steel sheet with industrial grade adhesive. Sheeting material shall be preformed and precoated profile sheeting of thickness 0.5 mm to 0.55 mmTCT (Total coated thickness) or as recommended by manufacturer to resist the climate of the jobsite. Top skin (Weather side) and Bottom skin or inner side slightly ribbed type and minimum 0.5 mm thick or as recommended by manufacturer of similar pre coated panel. Single skin metal Cladding shall be similar to external top skin specified for Sandwich metal cladding.

2.01.06 Insulating core shall vary from 25 mm to 100 mm thick according to the climatic requirements of the site and shall be either polystyrene block or rock wool slab made to profile of the sheet. The maximum density shall be 32.35 Kg/M3 for polystyrene and shall have minimum R-value 2.083 M2 oK/Watt. And for Rock wool insulation density shall be 48kg/ M3 as per IS: 8183.

2.01.07 Panel size shall be largest available size.

2.01.08 Warranty for precoated profiled metal single skin/ sandwich /double skin cladding shall be for a minimum period of 40 years.

2.01.09 Sealants

Penetration and end laps in sheeting shall be sealed with a non-hardening approved sealant as recommended by the manufacturer.

2.01.10 Profile HDPE Filler

2.01.10.1 Profile HDPE Filler shall be die cut in profile to match the profile of the sheet.

Metal flashing shall be of similar material and match the colour of top skin.

3.00.00 DOUBLE SKIN INSULATED METAL CLADDING

3.01.00 General

3.01.01 Metal cladding may be of double skin separated by an approved insulation in between.

3.01.02 External cladding both for single and Double skin/sandwich wall cladding shall be comprising of external panels manufactured out of0.5mm to 0.55 TCT sheet or as per approved manufacturer sheet detail. Zinc Aluminium coated steel sheet (Galvalume sheet) shall have Coating comprised of 55% Aluminium, 43% Zinc and 1.5% silicon. Coating shall be of class AZ-150 as per AS: 1397, which means 150 gms/sq.m minimum coating mass total of both sides. The base material is steel which shall be high tensile steel of 550MPa. Coating on both sides shall be organic coating as indicated above in cl. No. 2.01.04.3. Coating thickness shall be as per manufacturer specification to resist most aggressive climate. Sheet shall be of approved shade with profile depth 28mm and 195mm pitch with two small additional ribs in between two profiles. Sheet shall be clipped on to the concealed runners and shall be overlapped with each other. The inner sheeting incase of sandwich cladding shall be Hi Rib minimum 0.5mm TCT silicon modified polyester coated galvalume steel (AZ-150 gsm aluminium-Zinc alloy metal metallic coating of total 550 Mpa yield stress as per AS-1397).The external panels shall be of profile mentioned above. The inner sheet shall have 1000-1020 mm cover width 28-30 mm high crests @250-255mm c/c with side laps. The inner sheet shall be fixed to structural system by means of corrosion protected self-drilling, self-tapping fasteners. The sub girts of size 50mmx50mmx50mm manufactured out of 16 G G.I (1.6mm) 'Z' shape shall be fixed to inner sheeting on face side at purline locations. The external panels shall be fixed with the help of concealed runners 34.5 wide x48mm deep out of 0.95 mm thick aluminium strip with cut outs to hold the panels in a module of sheet width as per approved manufacturer standard product and details fastened on side girts @ 1600c/c minimum. The runners shall be concealed and no fasteners are to penetrate the panels. An insulation of 50mm thick resin bonded rock wool insulation of density 48kg/m3 shall be fixed in the cavity between two sheets. Contractor shall make cut out of doors, windows, louvres, pipe, ducts or other cut outs as required as per contract drawings along with flashing, leak proof sealing etc as required for these cut outs/wall openings.

4.00.00 EXECUTION

4.01.00 Inspection

4.01.01 The contractor shall examine the area, which will be covered, and the masonry wall where the edge of the single sheet cladding /sandwich/double skin cladding will be fixed and the structural alignments.

Contractor shall correct any unsatisfactory conditions prior to start of work.

4.02.00 **Installation**

Single sheet panel/Sandwich panel shall be fixed over structural members with joints overlapped and fastened using stainless steel fasteners self-drilling type or as recommended by the manufacturer.

Wall cladding shall be installed strictly as per manufacturer specification and details.

All end laps of profiled sheeting and joints of flashing shall be sealed properly with non-hardening natural cure silicon sealant or as recommended by the manufacturer.

Accessories like fasteners, tape, and foam fillers, flashing etc. as required shall be provided as per recommendation of manufacturer.

4.03.00 **Clean-Up**

Remove sealant splatters and smears remove steel particles generated by drilling to avoid damage.

TECHNICAL SPECIFICATION
FOR
XVIII) CARPENTRY AND JOINERY

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XVIII) CARPENTRY AND JOINERY

1.00.00 **SCOPE**

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for in the schedule. This shall also include the supply and fixing of all hardware and fixtures.

2.00.00 **INSTALLATION**

2.01.00 **Materials**

a) **Timber**

Unless otherwise specified, all timber shall be best quality well seasoned C P teakwood free from large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenter's work, the Tendered shall have the rough timber approved by the Engineer.

b) **Plywood**

Plywood shall be commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde resin of BWR grade conforming to IS: 848.

c) **Decorative Laminated Plastic Sheets**

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number or joints in one surface.

d) **Flush Doors**

Flush doors shall be hollow or solid core doors with commercial or decorative faces and hardwood edges. The core for solid core doors shall be of block board or wood particleboard. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is phenol formaldehyde of BWR grade, conforming to IS: 848. The thickness shall be as specified in the "Schedule of Items".

e) **Panel Doors**

Panel door shall be of teakwood shutter frame unless otherwise noted and panels with teakwood/commercial ply/teakwood particleboard as per "Schedule of Items". Other considerations shall be as mentioned in item (d) above.

f) **Fixtures**

Fixtures for doors, windows, furniture, etc. shall be as shown on drawing or specified in the "Schedule of Fixtures".

2.02.00 **Workmanship**

2.02.01 **General**

Skilled carpenters as per details shown on drawing or instructed by the Engineer shall do the work.

Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. that will come in contact with masonry after fixing shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particleboard. The edge of all plywood, block board and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long MS holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M. S. grills or guard bars shall be provided to windows where called for in the drawings or schedule of items.

2.02.02 **Finish**

All carpentry work after finishing shall be sand papered smooth. Prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 **Surface Treatment**

When shown on drawings or called for in Schedule, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 **ACCEPTANCE CRITERIA**

3.01.00 **Door and Window Frames**

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 **Door and Window Shutters**

Shall be of proper size, shape and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 **Partitions, Paneling, Pelmets, Furniture, etc.**

3.03.01 **General**

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 **Partition**

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 **Pelmets**

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 **Cupboard Shutters**

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 **Drawers**

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 **Loose Furniture**

When placed on a level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 **IS CODES**

Some of the important relevant Codes for the Sections are:

IS: 4021	-	Timber door, window and ventilator frames
IS: 1003	-	Timber paneled and glazed shutters.
IS: 2191	-	Wooden flush door shutter (Cellular and hollow core type)
IS: 2202	-	Wooden flush door shutters (Solid core type)

TECHNICAL SPECIFICATION
FOR
XIX) METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	INFORMATION TO BE SUBMITTED
5.00.00	I.S. CODE

XIX) METAL DOORS, WINDOWS, VENTILATORS, LOUVRES, ETC.

1.00.00 SCOPE

The work in general shall consist of supplying and erecting and installing of all metal doors, windows, ventilators, louvres, glazed partitions, etc. as stipulated here or as specified elsewhere in the general specification for architectural work with all materials complete including supply of glass and glazing and all other materials as required. The scope of work shall also include the assembly of various components.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified in Architectural standard drawing.

Steel sheets for frames, shutters, louvre blades etc. shall be of gauge/ thickness mentioned here or as indicated in the drawing attached or General specification of Architectural work.

For pressed steel door frames steel shall conform to IS 513.

Aluminium sections for fabricating doors, windows, partitions, etc. shall be extruded sections conforming to sections manufactured by HINDALCO.

Hardware and fixtures of the best quality from approved manufacturers shall only be used. The bidder shall l specifically state the particular manufacturer's materials he proposes to use. Best quality fixtures as per approved sample shall be provided and fixed in true alignment. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility and shall be replaced without any extra cost.

All hardware and fixtures shall be able to withstand repeated use. Door closers shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated elsewhere in this document. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the door closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements & endurance test stated in IS: 3564 Appendix-A.

The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for verifications of bulk supply. The samples shall be returned to the Contractor towards the end for incorporation in the job.

The caulking /sealant shall be of best quality from a manufacturer approved by the Engineer. In general, Polysulphide or silicon sealant as approved by the Engineer shall be provided.

2.02.00 **Fabrication**

2.02.01 **Steel Doors, Windows, Ventilators, Louvres, etc.**

a) **Door Frames**

Frames shall be fabricated from 1.6 mm thick steel sheets. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place.

b) **Double Plate Flush Door Shutters**

Door shutters shall be 45 mm thick, completely flush design and shall comprised of two outer sheets or 1.25 mm thick steel sheets, rigidly connected and reinforced inside with continuous vertical 1mm thick steel stiffeners, spot welded in position at not more than 150 mm on centers.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting stile edges beveled or rebated. Where shown on drawing or called for in the schedule of items the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown in drawing, provision shall be made for fixing glazing, vision panels, louvres etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvres blades shall be V or Z shaped and made out of 1.6 mm thick steel sheets.

c) **Single Sheet Door Shutters**

Single sheet doors shall be made from best quality 1.25 mm thick mild steel sheets and shall present a flush surface on the outside. The inside shall be stiffened with semi-tubular edge and central stiffening rail, which shall convey the lock and other furniture. The frames shall be made from best quality 1.6 mm thick mild steel sheets.

Wherever required for vision panel, louvers for air inlet for ventilation through toilet doors provisions for fixing glass panes louvres, etc. shall be made.

The manufacturing shall be done as specified in **2.02.01 b** "Double Plate Flush Door Shutters".

d) **Sliding Doors**

Sliding doors shall be double plate construction made out of 1.25 steel sheets with adequate stiffeners. The Contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. The Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) **Fire Proof Door**

Fire proof doors shall be provided at all fire exit points and also restrict spread of fire generated either in internal or external area.

These doors shall conform to the requirements as stipulated in IS: 3614 (Part I & II) and shall have minimum 2 hours fire rating or as required as per fire rule of the statutory authority.

Fire proof doors shall be of approved manufacturer and shall be double plated metal door with core Packed tightly with insulation or teak wood or yellow pine boards shall include panic exit devices as hardware.

f) **Door Threshold**

Door threshold shall be provided for all external doors. Doors without threshold shall have bottom tie of approved type.

g) **Steel Windows, Sashes, and Ventilators etc.**

These shall conform in all respects to IS:1038 and IS:1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc.

All welds shall be dressed flush on all exposed and contact surfaces.

Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions as per IS 1038/1361. All windows shall be outside glazed fixed with putty or metal glazing beads. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (HIndalco Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer over unexposed side before fixing to windows.

h) **M.S grill**

Mild steel grill shall be provided for windows in specified areas for security reasons. M.S flats of minimum size 20x5 mm shall be used. Opening size shall not be more than 75 mm. all joints of the grill shall be properly welded. Grill shall be fixed to the window frame by welding. Steel primer shall be applied before installation.

2.02.02 **Aluminium Door, Windows and Frames**

Extruded sections of HINDALCO shall be used. All sections shall be approved by the Engineer before fabrication is taken up. Doors, frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15 micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent cover shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job and ready for erection. Shop joints shall be made to hairlines and then welded or braced by such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 **Shop Coat or Paint**

The shop paint for steel doors, windows, etc. shall be best quality two pack epoxy primer enriched with metallic Zinc of approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

All steel doors, windows etc shall have one shop coat and one site coat and two coats of finishing paint unless indicated in these specifications.

Portions of aluminium frame which come in contact with masonry construction shall before shipment from workshop be protected with a heavy coat of alkali paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 **Handling & Storage of Fabricated Material**

All metal doors, windows, etc. shall be packed and crated properly before dispatch to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

All metal doors, windows, etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminum products by rust, mortar, etc.

2.05.00 **Assembly & Erection at Site**

In general, the fixing of steel doors, windows, ventilators, louvres, etc. shall conform to IS:1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvres, etc. including transoms and mullions for composite units in respective places as shown on drawing keeping proper lines and levels, and in approved workman like manner to give trouble free and leak-proof installations. The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take every precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the mastic cement in original sealed containers of manufacturer and shall apply it as per the instructions. Caulking shall be done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metre from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

3.00.00 **ACCEPTANCE CRITERIA**

3.01.00 **For Fabricated Items**

a) Overall dimensions shall be within ±1.5 mm of the size shown on drawings.

b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.

c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 1.5 mm.

d) Door leaves shall be undercut where shown on drawings.

e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.

f) All welds shall be dressed flush on exposed and contact surfaces.

g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures.

h) Provisions for hardware and fixtures to be installed at site.

I) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed aluminium surfaces shall be free from scratches, stains and discolouration. Anodised surfaces shall present a uniform and pleasing look.

m) Glass shall be as per specification for “Glass and Glazing” given elsewhere in this document

3.02.00 **For Installed Items**

a) Installations shall be at correct location, elevation and in general on a true vertical plane.

b) Fixing details shall be strictly as shown on drawings or as per manufacturer details.

c) Assembly of composite units shall be strictly as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.

d) All frames on external walls shall be caulked with sealant either polysulphide or silicon sealant as per type of materials to prevent leakage through joint between frames and masonry.

e) All openable section shall operate smoothly without jamming.

f) Locks, fasteners, etc. shall engage positively. Keys shall be non-interchangeable.

g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

h) Aluminium doors, windows, etc. shall be free from scratches stain or discolouration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

a) Names of manufacturers for doors, windows, etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

b) He shall submit a programme of work to be done for the approval of the Engineer.

c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for verification of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.00.00 I.S. CODES

Following are some of the important I.S. Codes as relevant to this section:

Steel doors, windows and ventilators	-	IS: 1038
Steel windows for industrial buildings	-	IS: 1361

Aluminium doors windows and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows, And ventilators.	-	IS: 1081

TECHNICAL SPECIFICATION
FOR
XX) ALUMINIUM FRAMED GLAZED CURTAIN WALLS AND STRUCTURAL GLAZING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XX) ALUMINIUM FRAMED GLAZED CURTAIN WALLS AND STRUCTURAL GLAZED WALL

1.00.00 SCOPE

This specification covers supply, erection & installation of Aluminium framed glazed curtain wall/ Structural glazing work for wall including fabrication and erection of tubular aluminium frames for large panel glazing work.

It also includes furnishing and installation of glass, aluminium frames, aluminium brackets, angles, tubes, sheet, Shadow box to hide the floor beams and other members as required, adhesive of approved quality, Toughened heat reflecting tinted imported glass etc. For the completion of curtain wall or structural glazing work, a firm specialised in executing similar type of work and duly approved by the Engineer shall be engaged to execute such work.

2.00.00 INSTALLATION

2.01.00 System and Materials

Curtain Wall is a façade with visible supporting frame work for fixing glass. The frame Consist of vertical mullion and horizontal transoms.

Supporting system shall be fixed in one of the following method as per schedule of item.

- **Stick wall system**

  In this system the mullions are first installed to the slabs of the building and then transoms are fixed with or without connecting brackets.

- **Ladder or semi-unitized system**

  In this system Prefabricated mullion and transom frames are taken to site and installed in units of 3 or 4 frames in the same way of stick system.

- **Unitized system**

  Prefabricated frames with split mullions are installed frame by frame between slabs.

Supporting frame and glass fixing arrangement shall consist of mullions, Transom, purlins i.e., continuous cross bars, brackets as connector for mullions and transoms, wall brackets for fixing mullion to slab, pressure plate/ glazing plate to hold the glass, Cap/Cover plate to cover glazing plate and fixing screws.

Aluminium sections for curtain walls with or without doors, windows etc. Shall be approved extruded sections from alluminium alloy of HINDALCO.

Hardware and fixtures shall be of approved manufacturer. Doors, windows and frames shall also conform to the technical specification of "Metal, Doors, Windows, Ventilators, Louvers" inserted in this document.

All aluminium-extruded sections shall have dark brown electro coloured coating irrespective of any indication in General Specification for architectural work. Glass shall be tinted glass as per approved sample as indicated in General specification for Architectural work.

Glazing and insulating gaskets shall be EPDM. Fasteners exposed to outside and inside shall be stainless steel. Brackets and reinforcement shall be aluminium flashing shall be aluminium 16 G. Sheet. Glass and glazing shall conform to the technical specification of "GLASS AND GLAZING". All aluminium members shall be isolated from dissimilar metals/concrete etc. and unexposed surface coming in contact with other structures, walls, etc. shall be painted with a coat of zinc chromate primer.

Water proofing on the rafters shall be achieved by means of continuous slip in gasket above and below the glass. Under no circumstances glass shall come in contact with metal. Weep holes shall be provided at the lower portion of the aluminium bar for drainage of condensed moisture.

Contractor shall provide hardware; fix doors, and windows so that perfect operation is assured. Doors shall stand in any position to operate smoothly.

Silicon sealant shall be used at expansion joints, gasket joints and gaps between the surrounding wall and the glazing members to make the system waterproof.

Aluminium finish shall be electro colored of approved shade conform to minimum 15 microns thick or as recommended by the manufacturer to witness aggressive climatic conditions.

Structural glazing

Structural glazing is a façade without any visible external element ie supporting member profiles. Glass panels are fixed with the frames by using a structural Silicone sealant.

The sealant contract dimension and thickness shall be designed to :

i) Provide a method of structural support to glass

ii) Provide airtight and weather tight seal.

iii) Provide a flexible rubber anchorage that absorbs differentials movements between dissimilar materials from thermal or seismic loading.

Structural glazing shall also be fixed any of the three system as stated for Curtain wall fixing above.

Both Curtain wall and structural glazing shall be designed by the approved vendor. General arrangement showing location and type of windows and doors if required and structural system considering most aggressive climatic condition including sizing of supporting members, required glass thickness and panel size and contact adhesive dimensions etc. shall be submitted for approval. Vendor's drawing with necessary structural design calculation are to be submitted by the vendor for approval of the owner.

3.00.00 INFORMATION TO BE SUBMITTED BY CONTRACTOR

3.01.00 After award of contract

After award of contract and prior to construction contractor shall furnish vendor drawings based on GA drawings and technical data given with details of assemblies, flashing, anchorage, expansion joints, accessories and other necessary items for approval of the owner.

Samples of materials are to be submitted for approval prior to construction and a prototype 750 mmx750 mm In size curtain wall/structural glazing finished in all respect shall be submitted for approval of the Engineer-in-Charge. The samples shall be retained by the Engineer for comparison of supply and returned to the contractor towards the end of the construction.

Vendor drawing shall be submitted prior to fabrication. Shop drawing shall indicate the following information.

i) Plans, elevations and sections of all aluminium curtain walls/ Structural glazing .

ii) Detail of frames and glazing.

iii) Details of hardware locations with dimensions.

Approval of vendor drawings by the owner's side shall be for arrangement only and not for structural system and its stability and shall not relieve the contractor of his responsibilities for errors, omissions or the accuracy of his own dimensions, structural strength and stability, flexibility to thermal condition, weather conditions and other movements.

4.00.00 ACCEPTANCE CRITERIA

4.01.00 For fabricated items

Refer technical specification of Metal Doors, Windows, and Ventilation etc.

4.01.01 For installed items

Refer technical specification of Metal Doors, Windows etc.

5.00.00 **I.S. Code**

IS-12118: 1987: (Part I & II)	Specification for two parts polysulphide based sealants

TECHNICAL SPECIFICATION
FOR
XXI) ROLLING STEEL SHUTTERS AND GRILLS

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXI) ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 **SCOPE**

This specification covers the design, supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 **INSTALLATION**

2.01.00 **Components**

a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 m wide and not less than 2.25 mm thick for shutters 5.5 m wide and above, machine rolled at 75 mm rolling centres, interlocking with each other. The profile, will be such as to prevent excessive deflection under specified wind load.

b) Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia. rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise in the Schedule.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M or as specified in Schedule.

f) Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as described in Schedule or as described by the Engineer.

i) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in Schedule or drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

j) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

2.02.00 **Manually Operated Shutters / Grills**

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general manually operated shutters shall be push pull type for openings upto 9 sq.metre in area. Larger shutters shall be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as described in Schedule or as desired by the Engineer.

2.03.00 **Power Operated Shutters / Grills**

These shall be operable from a push butten station conveniently located beside the door or as shown on drawings. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for in Schedule, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 **Shop Coat**

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.05.00 **Erection**

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS:6248 - Metal rolling shutters and rolling grills.

TECHNICAL SPECIFICATION
FOR
XXII) GLASS AND GLAZING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXII) GLASS AND GLAZING

1.00.00 **SCOPE**

The work in general shall consist of supplying and fixing all glass and glazing including all clips, putty, mastic cement etc. wherever required as stipulated here or elsewhere in the General specifications for Architectural work. Architectural standard drawings including supply of snap glazing beads, EPDM gaskets and all materials as required for completion of the work.

2.00.00 **INSTALLATION**

2.01.00 **General**

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvres, miscellaneous glazing and partitions from approved manufacturer & shall have uniform refractive index and free from flaws, specks and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

a) Glare reducing or heat absorbing glass if provided shall be of approved manufacturer and special care shall be taken to grind smooth and round off the edges before fixing.

b) Clear glass shall be float glass and shall be at least 6 mm thick. for windows and for doors shall be minimum 6mm thick or as indicated in the General specification of Architectural work. Glass for Seamless glazed door shall be 12 mm thick.

c) Wired glass shall be 6mm thick rolled glass with centrally embedded wire mesh of Georgian type. This may be of clear glass.

d) Obscure/ground glass shall have a cast surface in one side.

e) Colour glass shall be as per approved sample.

f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty glass is used where it shall be non-setting type.

g) EPDM gaskets with snap-fit glazing shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.02.00 **Glazing, Setting and Finish**

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing clips shall be provided per glass pan, except for large panes where six or more clips shall be used as per Engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where moulding or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Necessary glazing clips, putty, mastic cement etc. shall be supplied by the Contractor. After completion of glazing work, the Contractor shall remove all dirt stains, excess putty etc. clean the glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the Contractor's own cost.

3.00.00 **ACCEPTANCE CRITERIA**

a) All installation shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by EPDM gaskets to give a leak proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

c) No separate payment shall be made for cutting of glass to require size, edge finishing etc. if the glass is supplied by the Contractor.

d) Payment shall be made for cutting of glass to required size edge finishing etc. if the glass is supplied by the Owner.

e) No separate payment shall be made for cleaning the glass after installation.

4.00.00 **I. S. CODES**

Following are some of the important I.S. Codes relevant to this Section :

IS : 3548 - Code of practice for glazing in building.

IS : 1083 - Code of practice for fixing and glazing metal doors, windows and ventilators.

TECHNICAL SPECIFICATION
FOR
XXIII) FLOOR FINISHED AND ALLIED WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXIII) FLOOR FINISHED AND ALLIED WORK

1.00.00 **SCOPE**

This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes and allied items of work as listed below :

a) **In Situ Finishes**

i) Integral finish to concrete base

ii) Red Oxide of Iron finish

iii) Terrazzo finish

iv) Granolithic finish

v) Patent Stone

vi) Metallic Hardener like “Ironite” finish

vii) Non Metallic hardener finish

viii) Mastic Asphalt finish

ix) Chemical Resistant finish

b) **Tiled Finishes**

i) Terrazzo tile

ii) Chequered tile

iii) Glazed tile

iv) Tesserae (Mosaic etc.)

v) Chemical Resistant

vi) Rubber, Vinyl etc.

vii) Stone slab

viii) Vitrified tile finish

1.01.00 **Base**

The base to receive the finish is covered under other relevant specifications.

1.02.00 **Sequence**

Commencement, scheduling and sequence of the finishing work shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damage whatsoever till handing over.

2.00.00 **INSTALLATION**

2.00.01 **Special Materials**

Basic materials are covered under Specification “Properties Storage and Handling of Common Building Materials”. Special materials required for individual finishing items are specified under respective items. In general, all such materials shall be as per relevant I.S. Codes where available. In all cases these materials shall be of the best quality available indigenously, unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialised manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain the construction schedule.

2.00.02 **Workmanship**

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer’s permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 **Preparation of the Base Surface**

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado & similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water & hard brush & detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification under individual item.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 **In Situ Finishes**

2.01.01 **Integral Finish to Concrete Base**

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and leveled but the concrete is still green a thick slurry made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin a possible by using 2.2 kg. of cement per sq.m. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after laying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings. The marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 **Red Oxide of iron finish (Not Applicable)**

It shall consist of an underbed and a topping over already laid and matured concrete base.

a) **Thickness**

Unless otherwise specified the total thickness of the finish shall be minimum 50 mm or as per schedule of item for horizontal and 20 mm or as per schedule of item for vertical surface of which the topping shall (not less than 10 mm) while the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finishes. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius off 25 mm.

b) **Mix**

i) **Underbed**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume. For vertical and similar surfaces the mix shall consist of 1 part cement to 3 parts coarse sand by volume.

ii) **Topping**

For the topping cement, screened through a fine mesh and red oxide of iron pigment powder similarly screened shall be dry mixed thoroughly in right proportions to produce the desired colour when laid. The mix shall then be prepared with 1 part cement (mixed with pigment) and 3 parts coarse sand by volume. The whole quantity required for each visible area shall be prepared in one batch to ensure uniform colour.

c) **Laying**

The underbed shall be laid in panels of mixing area 5 Sq.M. each and no side shall be more than 2.5 along. For outdoor locations the maximum area shall be 2.0 Sq.M. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. If specified aluminium or glass dividing strips shall be used.

The panels shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid until the contraction of the latter has taken place. The underbed shall be laid, compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. The surface of the underbed shall be roughened for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by trowelling and finished smooth with a slurry made with already prepared cement and pigment mixture. About 2.0 kg. of the mixture shall be consumed/ per sq.m. for horizontal surface and 1.0 kg. for vertical surface. The surface shall be cured for seven days by keeping it moist.

d) Polishing

About 36 hours after laying when the surface has hardened sufficiently it shall be polished with polishing stone till a smooth shiny surface to the satisfaction of the Engineer, is achieved. The finish shall be washed and cleaned just before handing over.

2.01.03 **Terrazo Finish : In Situ (Not Applicable)**

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) **Thickness**

Unless otherwise specified the total thickness of the finish shall be minimum 50 mm for horizontal and 20 mm or as per schedule of items for vertical surface of which the topping shall be not less than 10 mm or as per schedule of items. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary

slopes. The vertical surface shall project cut 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radious of 25 mm.

b) **Mix**

i) **Underbed**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1.½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) **Topping**

The mix for the topping shall be composed of cement, colour pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or grey or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from white marble and shall be finer than IS Seive No. 30. The size of marble chips may be between 1 mm to 20 mm.

Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) **Laying**

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat "green" but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) **Curing**

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) **Grinding and Polishing**

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no. 60) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no. 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no. 320) to get smooth surface without any pinhole. The grinding shall be done by a suitable machine. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no. 60), second rubbing with medium grade (no. 80) and final rubbing and polishing with fine grade (no. 120).

The surface shall be cleaned with water, dried and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. sq.m. water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy but not slippery.

2.01.04 **Granolithic Finish**

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) **Thickness**

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) **Mix**

The mix shall consist of 1 part cement : 1 part coarse sand : 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) **Laying of Monolithic Topping**

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully "green" the topping shall be laid evenly to proper thickness & grade. If considered necessary the surface of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly & work vigoraously and quickly to secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stonechips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) **Laying of Topping Separately on Hardened Base**

The base concrete shall be prepared as stated in clause 2.01.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

e) **Curing**

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) **Grinding**

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.03 (e) shall be followed. However, the ultimate polish required shall be decided upon by the Engineer.

g) **Finishing**

Where specified, sodium silicate or magnasium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as specified in the Schedule of Items. The concentration and method of application of the solutions shall be as specified in IS:5491.

2.01.05 **Patent Stone**

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) **Thickness**

The patent stone finish shall have thickness as stipulated under clause 2.01.03(a) except that the topping shall be 6 mm thick.

b) **Mix**

i) **Underbed**

The mix shall be as stipulated under clause 2.01.03 (b).

ii) **Topping**

The mix for the topping shall consist of 1 part cement and 1 part fine sand by volume.

c) **Laying**

The Patent Stone finish, including the underbed shall be laid in alternate bays or in chequered board pattern. No panel shall be as in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M long.

A cement grout shall be applied and worked into the surface to receive the finish, the underbed then laid, compacted and levelled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.06 **Metallic Hardener Like "Ironite" Finish**

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is "Green".

a) **Thickness**

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) **Material**

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the engineer, actual samples shall be tested.

c) **Mix**

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) **Laying**

The concrete floor shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The forms, if any shall remain sufficiently projecting to take the finish. The surface shall be roughened by wire brush as soon as possible.

The finish shall be laid while the concrete underbed is still very "green" within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06(A) **Non Metallic Hardener Like SIKA' Chapdur' Finish**

Non metallic hardener shall be of hard granules of mineral origin. Floor hardener shall be laid by authorized applicator of the Manufacturer as per specification and recommendation of the manufacturer. For heavy duty finish 5.5 to 6kg/Sq.m for a thickness of 3mm surfacing shall be provided. The ready made Chapdur compound of SIKA shall be spread over newly laid smooth concrete surface at a stage when a nail mark of 3 to 4 mm will be obtained at standard pressure. Spreading shall done by hand @ of approximately 6.0 kg/Sq.m for heavy duty finish.

While the mixture will be uniformly moistened by the surface water the surface shall be made smooth with the mechanical hand trowel.

Curing shall be made to protect the surface from rapid drying. Curing shall be made for at least for 3 days by means of wet guny bags or pooling water on the surface.

Floor using time shall be as per manufacturer recommendation.

2.01.07 **Mastic Asphalt Finish (Not used)**

This is a one layer treatment on concrete or brick base.

a) **Thickness**

The thickness shall be as specified in the drawing or schedule of items.

b) **Materials**

Bitumen shall be industrial bitumen of the grades 90/15 and 75/15 conforming to IS:702.

Mineral filler shall be dry stone dust passing through 75-micron IS Sieve.

Fine aggregate shall be crushed and graded natural lime stone or other hard-work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick and 10 mm chips for thicker finish.

c) **Composition**

Bitumen mastic shall conform to IS:1195 and shall be either brought to site in blocks weighing about 25 Kg. or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers & coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205^{o}C.

d) **Laying**

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 15 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.08 **Chemical Resistant in Situ Finish (Not used)**

Chemical resistant in situ finish shall be an epoxy resin with suitable filler material over a primer or called for in the Schedule of Items. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The Contractor shall get it done by a specialised manufacturer, get guarantee of performance from the organisation and pass it on to the Owner in addition to his own guarantee.

2.02.00 **Tiled Finish**

These shall include finish tiles, stone slabs and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 **Terrazzo Tile Finish**

The finish will consist of manufacture terrazzo tile and an underbed.

a) **Thickness**

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) **Tiles : Terrazzo**

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.Cm.

Each tile shall bear on its back permanent and legible trade mark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform

throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness ± 3 mm. Face of the tile shall be plane, free from pin holes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary grey cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.03 (b).

The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) **Mix : Underbed**

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) **Laying**

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02 (c) may be used for dividing the work into suitable panels.

c) **Grinding and Polishing**

Procedure shall be same as Clause 2.01.03(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02 **Heavy duty Cement Concrete (Carborundum) tile**

Heavy duty concrete tile shall be procured from reputed manufacturers only. This tile shall be produced in a well set up factory under strict quality control. Tiles should be compressed under a high pressure of about 0.15 t/sq.cm. Samples of the tile shall be submitted to the Engineer for approval before starting regular production.

IS:1237 shall be followed as general quidance for the specification of heavy duty concrete tile.

Size of the tile shall be 300x300 mm unless otherwise specified. Minimum thickness shall be 22 mm. However, actual thickness shall be as per designed strength requirement.

Store grit shall be used in the bottom layer of tile and the mix shall not be leaner than 1:3. Thickness of wearing layer shall be not less than 8 mm. For top layer nominal proportion of cement to aggregate shall be 1:1.5 unless otherwise agreed. Distribution of chips appearing over top surface should be uniform for aesthetic appearance. For darker shade of colours, 50% white cement of the total cement content shall be used. However, for lighter shade of colours, only white cement shall be used. Aggregate shall be hard stone chips of different colours. Carborundum, granite, quartzite chips shall be used. Properly graded-aggregate upto 10 mm size shall be used. Marble chips shall not be used unless specifically approved by the Engineer and shall not exceed 10% of the total quantity. Only good quality pigment having durable colour shall be used. Organic colours and lead pigments shall not be used. Manufacturer should ensure durability of the colour against possibility of any colour fading. Matching of colour between different batches shall be ensured. Physical properties and dimensional tolerance of the tile shall be as per IS:1237. However, surface hair cracks shall not be acceptable. For slipperage prone areas, rib tile/fluted type or chequered tiles shall be used. Tile shall be supplied with initial grinding (preferably twice) at factory premises. For laying and finishing of tile, IS:1443 shall be followed for general guidance.

For bedding, Lime-surkhi mortar shall be used as specified for Terrazo tiles.

Joints between tiles shall be filled with matching grouting same as used in topping and shall be supplied by the manufacturer of the tiles.

Grinding shall be done as per recommendations of the manufacturer including use of special type grinding stone. At least two additional grindings shall be done at site after laying, besides the initial grinding at factory premised. Oxalic acid polishing shall be done after grinding.

2.02.02 (A) **Chequered Tile Finish**

The finish shall consist of manufactured grey or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) **Thickness**

Thickness shall be same as in clause 2.01.03(a).

b) **Tiles : Chequered**

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm c/c, Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain grey cement or colour pigment added to cement as specified.

c) **Underbed**

As per clause 2.01.03 (c).

d) **Laying**

As per clause 2.01.03 (d).

e) **Grinding and Polishing**

As per clause 2.01.03 (e) except that the tiles shall be ground and polished by hand after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 **Glazed Tiles/Ceramic Tiles Finish**

This finish shall be composed of glazed earthenware tiles/Ceramic tiles with an underbed laid over a concrete or masonry base.

a) **Thickness**

The total thickness shall be 50 mm including Underbed for floor.

The total thickness shall be between 20 mm and 25 mm including underbed for wall finish.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) **Tiles : Glazed/ mat finish Ceramic tiles**

The floor tiles shall be of earthenware, covered with mat white or coloured, plain or with designs, of nominal sizes 300x300 mm 7.2 mm minimum thick approximately as per approved manufacturer product unless otherwise specified. The tolerance shall be $\pm$ 1.5 mm for length and breadth and $\pm$ 0.5 mm for thickness specials like internal and external angles, beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be matt unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

For wall finishes Tiles shall be ceramic tiles Matt / glazed as per General specification of Architectural work and size of tiles shall be 300x200x5 to 6mm thick or 300x450x7.2 mm - 10 mm thick approximately of approved manufacturer. Tile shall be laid over prepared base in 15 mm thick cement sand mortar 1:3 including cement slurry and jointing with approved matching filler.

c) **Mix : Underbed**

The mix for the underbed for floor shall consist of 15mm 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified. Under bed with 1:2:4 PCC shall be provided as required for total floor thickness of 50 mm.

d) **Laying**

Same as clause 2.02.01 (d).

e) **Finishing**

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handing over.

2.02.03 (A) **Vitrified tiles**

Vitrified tiles shall be of approved manufacturer and premium quality. Size of tiles shall be 600x600x10 mm thick. Tiles shall be made from special quality ball clay and high quality minerals and shall be formed by compression in a PH3590 T press and fired in a kiln at an ultra high temperature of 1200 degree salcius for vitrification.

Tiles shall be absolutely non porous and water absorbtion shall not be more than 0.05% and shall be high resistance to chemicals, stains and free from bacteria breeding. Edges of the tiles shall be perfectly in right angles, perfectly flat and straight to give hair joints between two tiles and shall be dimensionally perfect. The hardness of the tiles shall be 8 on MOH scale. Deviation in length shall be limited to +/- 0.08% and in thickness +/- 2%.

Straightness of sides +/- 0.1%. Tiles shall be pre polished, ready to use and of high gloss.

Tiles shall be fixed over under bed with minimum 15mm thick cement sand mortar of 1:3 and necessary cement slurry.

Joints shall be filled with approved filler.

2.02.04 **Tesserae Finish (Mosaic etc.) (Not Used))**

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) **Thickness**

The total thickness including the underbed shall be between 16 mm and 25 mm.

b) **Tesserae Finish**

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass or similar hard wearing, strong and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) **Mix : Underbed**

Same as clause 2.01.03(b)

d) **Laying**

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.01.03(d) shall generally be followed. However, instead of grey cement the slurry shall be made with white cement to fix the panels. The paper mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.05 **Chemical Resistant Tiled Finish**

This shall include all varities of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) **Tiles**

The chemical resistant tiles as detailed in the Schedule of items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour and textures.

Glazed tiles if permitted to act as chemical resistant finish shall be considered under clause 2.01.03.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/Cm2. The surface shall be abrasion resistant and durable.

b) **Laying**

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 **Rubber, Vinyl or Vinyl Asbestos Tiles Finish**

This shall include various types of tiles manufactured from rubber, vinyl, etc. set with a adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) **Thickness**

The thickness of the tiles shall be mentioned in the Schedule or in drawing.

b) **Tiles**

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trade mark, the thickness, sizes, batch number and date of manufacture.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) **Mix : Underbed**

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty : 1 part cement : 4 parts coarse sand mixed with just sufficient water to make it workable.

d) **Laying**

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive

squeezed out through the joints shall be removed immediately.

e) **Finishing**

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried and polished with an approved type of polish just before handing over.

2.02.07 **Store Slab Finish : Marble, Stone and Similar Fine Grained Stone**

a) **Thickness**

The underbed shall be composed of PCC 1:2:3 and Cement Sand mortar !:3 minimum 15 mm and average 20 mm thick remaining portion shall be PCC underbed. The slabs may be 20-25 mm, 30 mm or 40 mm thick as specified.

b) **Stone Slab**

The stone slabs shall be made from selected stock which are hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of $\pm$ 5 mm in dimensions and $\pm$ 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm or as specified elsewhere in the documents.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) **Mix : Underbed**

Same as clause 2.01.03 (c).

d) **Laying**

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed clean before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, a thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, grey/white/mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid

and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) **Polishing, Finishing**

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.01.03 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 **Stone Slab Finish : Sand Stone & Similar Coarse Grained Stone Finish**

Generally clause 2.01.03 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto $\pm$ 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to $\pm$ 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement.

2.02.09 **Base and Sub base for Flooring**

Ground Floor shall consist of the following:

i) Well compacted (90-95%) earthen sub grade.

ii) 230 mm thick dry rubble soling on rammed earth. Rubble shall be hand packed as directed by the Engineer. This shall be laid closely in position on sub grade. The stones for soling shall be selected on the basis of thickness of soling as directed by the Engineer. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

iii) 75 mm thick PCC 1:4:8 or as specified elsewhere in this document with 40mm nominal size stone aggregates laid over compacted rubble soling.

iv) RCC floor slab shall be laid over PCC

v) Floor finish 50 mm thick including under bed as specified shall be laid over RCC floor slab.

3.00.00 **ACCEPTANCE CRITERIA**

The finish shall be checked specially for :

a) Level, Slope, Plumb as the case may be

b) Pattern and Symmetry

c) Alignment of joints, dividing strip etc.

d) Colour, texure

e) Surface finish

f) Thickness of joints

g) Details at edges, junctions etc.

h) Performance

i) Precautions specified for durability

4.00.00 **I.S. CODES**

Important relevant codes for this section :

IS : 777	:	Glazed earthenware tiles
IS : 1196	:	Code of practice for laying bitumen mastic flooring.
IS : 1197	:	Code of practice for laying of rubber floors
IS : 1237	:	Cement concrete flooring tiles
IS : 1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
IS : 2114	:	Code of practice for laying in situ terrazzo floor.
IS : 3461	:	PVC asbestos floor tiles
IS : 4860	:	Specification for acid resistant bricks
IS : 5518	:	Code of practice for laying of flexible PVC sheet and tile flooring.
IS : 5491	:	Code of practice for laying in situ granolithic floor topping.

TECHNICAL SPECIFICATION
FOR
XXIV) FALSE FLOORING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXIV) FALSE FLOORING

1.00.00 **SCOPE**

This specification covers supplying, installation, repairing, finishing, testing, protection and maintenance till handing over of removable free access false flooring systems consisting of an assembly of panels mounted on adjustable pedestal and supporting steel grid system to provide an under floor space.

The entire Access floor system shall be made from steel cementation in filled access floor tile and shall provide for adequate fire properties, acoustic barrier and air leakage resistance and antistatic floor system.

2.00.00 **FALSE FLOORING SYSTEM**

2.01.00 **Base**

The system shall be placed over a base of R.C.C. floor slab and with necessary grouting etc. to fix the supporting structure.

In general solid feel UFP laminated HPL/PVC panel with rigid under structure support system shall be provided. The Access floor shall be minimum 600 high finish floor from concrete sub floor.

2.02.00 **Supporting Structure**

The supporting structure shall conform CISCA 1986-87 and MS comprise of fabricated jacks made out of 25.5mmOD and 22.5mm ID with 2 mm embossed steel base plate 100x100x2 mm and pedestal head make out of size 75mmx75 mmx4 mm thick steel plate with 45 mm long steel pipe size 27mm ID x32 mm OD tag welded to the head plate and rest on the pedestal with 2 no MS Check nut speedy assembly and removal for relocation and maintenance. Pedestal base shall be secured firmly in position on sub floor.

Stringer:

Stringer channel made of 1.2mm thick galvanized steel sheet and the size of stringer shall be 575 x28mmx20mm.

The pedestal shall be equipped with conducting grounding pad. All MS members shall be treated with steel protective paint. The concrete sub floor shall be painted with two coats of synthetic enamel pain.

2.03.00 **Floor Panel**

2.03.01 Panels shall be made from steel. The bottom of the panel shall be embossed in hemispherical shape to give strength and flexural rigidity. The top sheet shall be plain and resistant welded at various location after the top and bottom sheet have been degreased and phosphate to form a single composite unit (as per CISCA 1986-87). The entire panel shall be coated with epoxy coating on the exposed surface and then the hollow panel shall have factory laminated Antistatic HPL/PVC with 6mm beading on all the sides for

edge protection. Panels shall remain flat, through and stable unaffected by humidity or fluctuation in temperature throughout its normal working life. Panels shall provide for impact resistance top surfaces minimal deflection, corrosion resistance properties and shall not be combustible or aid surface spread of flame. Panels shall be insulated against heat and noise transfer. Panels shall provide qualities of concrete slabs. Panels shall be of size 600x600mm fully interchangeable with each other within the range of specified layout. Panels shall be free standing (Simple supported) onto the understructure.

2.04.00 **Strength**

Each 600 mm x 600 mm floor panel must be capable of supporting an uniform minimum live load of 1220 Kg/Sq. or a concentrated minimum load of 450 Kg. applied through a phenolic caster 75 mm in diameter and 45 mm wide, or a rolling minimum load of 450 Kg. at any point with a maximum deflection of 2 mm.

2.05.00 **Surface Finish**

All removable panels shall have the top surface finished with 2.5 mm thick Anti static Vinyl Flooring bonded to the surface with adhesive as per manufacturer's specification.

2.06.00 **Skirting**

Skirting shall be of the same Antistatic Vinyl tiles, 150 mm. high and 2.5 mm. thick, completely matching with the false flooring surface and shall be fixed with the plastered wall surface as per manufacturer's specification.

2.07.00 **Installation**

All steel surface are to be protected by pointing over a primer as per schedule of items and any damage to the paint during installation shall be made good. Finished floor surface, when specified by the Engineer-in-Charge shall be protected by the Contractor with kraft paper taped and sealed at edges to prevent tearing.

Any damage to the sub floor during installation of the false flooring system shall be made good by the Contractor without any extra cost to the owner.

3.00.00 **ACCEPTANCE CRITERIA**

The false flooring system shall be checked specially for :

a) Level
b) Alignment of joints
c) Thickness of joints
d) Surface finish
e) Colour and texture

TECHNICAL SPECIFICATION
FOR
XXV) PAINTING, WHITE WASHING AND POLISHING ETC.

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXV) PAINTING, WHITE WASHING AND POLISHING ETC.

1.00.00 SCOPE

This specification covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plastered surfaces finished with plaster of paris/ wall putty, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on drawings, schedule or as directed by the Engineer.

Copper, bronze, chromium plate, nickel, stainless steel, aluminium and monel metal shall generally not be painted or finished except if otherwise specified.

The painting Contractor shall inspect the work of others prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting contractor shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing that results.

Before commencing painting, the painting contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.01.00 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint or one shade is obtained the same manufacturing batch. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognised manufacturers and shall be approved by the Engineer.

All colour shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) **White Washing (Not Used)**

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the Engineer, and shall conform to IS:712 latest edition. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank of water for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100grams of gum to 6 litres of white wash water and a little quantity of indigo or synthetic ultramarine blue shall be added to the lime.

b) **Dry Distemper (Not Used)**

Shall be made from suitable pigments, extenders, lime proof tinters, water soluble binders etc. and shall conform to IS:427.

c) **Oil Bound Washable Distemper (Not Used)**

Shall be of oil emulsion type, containing suitable preservatives and shall conform to IS:428.

d) **Waterproof Cement Paint**

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS:5410.

e) **Acrylic Emulsion Paint internal and external use.**

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide. It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild detergent and water without any deterioration in colour, or without showing flaking, blistering or peeling.

f) **Acrylic Washable distemper.**

Acrylic washable distemper shall be similar to **e)** above. The paint, after it is dried, shall be able to withstand washing with mild detergent and water without any deterioration in colour, or without showing flaking, blistering or peeling.

f) **Synthetic Enamel Paint**

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and interior surfaces. White and pastel shades shall resist yellowing and darkening with aging. The paint shall conform to IS:2932 and IS:2933.

g) **Aluminium Paint**

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS:2339.

h) Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) **French Polish (Not Used)**

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS:348.

French polish shall not be used on bare wood. It shall only be used as finishing coat on wood after the wood is pretreated with a liquid wood filler conforming to IS:345 is applied and rubbed out.

2.02.00 **Storage**

The contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement and stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.03.00 **Preparation of Surface**

Before starting the work the contractor shall obtain the approval of the Engineer regarding the soundness and readiness of the surface to be painted on.

2.03.01 **Wood**

All surfaces shall be free from dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails and screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly and extended 25 mm beyond the area. All large, loose or resinous knots shall be removed and filled with sound wood. All work shall be done as perIS:2338.

2.03.02 **Masonry, Concrete and Plastered Surface**

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of re-surfacing may lead to the finishing paint being different in shade from the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with mildew or efflorescence shall be treated as below :

a) **Mildew**

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80 ml. liquor ammonia and diluted to 1 litre with water or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.03.03 **Metal**

All metal surface shall be absolutely clean, dry and free from wax, grease or dried soap films. In addition, all steel and iron surfaces shall be free from rust, surfaces shall be cleaned by mechanical power tools to remove mill scales unless otherwise approved by the Engineer for exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanised iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat.

2.04.00 **Application**

2.04.01 **General**

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings if used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor holes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to be free of sags, runs, crawls or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoats for painting shall be applied by brush only and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable for production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall be done as per IS:1477 (Part 1 & 2). The total dry thickness of the film should not be less than 120 micron.

2.04.02 **White Washing (Not used)**

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before application of the lime solution.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer f eels that one or more coats are required the contractor shall do so without any extra cost to the owner. No brush marks shall show on the finished surface.

2.04.03 **Dry Distemper (Not Used)**

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement plastered surface, the surface shall be washed with a solution of 100 gms. of zinc sulphate to 1 litre of water and then allowed to dry.

Dry distempering shall be done as per manufacturer's instruction. In applying the distempers the brush should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long as otherwise brush marks may result.

2.04.04 **Oil bound Washable Distemper (Not Used)**

The distemper shall be applied after surface is primed with an alkali resistant primer and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.04.05 **Waterproof Cement Paint**

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.04.06 **Acrylic Emulsion Paint**

Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be strictly as per manufacturer's specification.

2.04.07 **Synthetic Enamel Paint**

Shall be applied on properly primered surface. Subsequently coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.04.08 **Aluminium Paint**

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.04.09 **Clear Synthetic Varnish * Not Used)**

The varnish shall be applied on wood surface after (a) filling, (b) staining and (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbour hood. Damp atmosphere and draughts shall be avoided and exposure to extreme heat or cold and dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid fronthing. It shall be allowed to flow on while the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has began to set, shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.04.10 **French Polish (Not Used)**

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the wood shall be filled up with a paste of whiteing in water or methylated spirit with a suitable pigment like burnt sienna or amber.

After application of the filler paste, the french polish shall be applied with a pad of woolen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.04.11 **Chemical Resistant Paint**

For chemical resistant paints, epoxy, chlorinated rubber or vinyl butyl paint system shall be used manufacturer's recommendation regarding the paint system exposed to moderately severe corrosive condition and subject to acid/alkali spillage and fumes, shall be followed.

2.04.12 **Epoxy coating/painting**

On the clean surface of concrete after properly drying of the following system is to be adopted as per manufacturers specification:

One coat of primer of following proportion to be applied over clean and dried concrete surface by brush application.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 840 - 50 Parts by weight

Over the primer, the uneven surface of concrete should be filled with levelling putty as mentioned above. The cost of putty is included in the item rate without fixing prior limit to consumption of putty. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 830 - 45 Parts by weight

HARDENER BY 850 -15 Parts by weight

SILICA FLOUR - 20 Parts by weight

FLOW CONTROL - 2 Parts by weight
AGENT

Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat is applied.

2.05.00 **Protection**

Furniture and other movable objects, equipments, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipments shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.06.00 **Cleaning up**

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been spilled, splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 **ACCEPTANCE CRITERIA**

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes and splatters of paints and varnishes shall be removed from surrounding surfaces.

4.00.00 **I.S. CODE**

Important relevant IS Codes for this Sections are listed below :

IS:348 : Specification for French Polish

IS:427 : Specification for Distemper, dry colour as required.

IS:428 : Specification for Distemper oil emulsion, colour as required.

IS:1477 (I & II)	:	Code of Practice for painting of ferrous metal in buildings.
IS:2338 (I & II)	:	Code of Practice for finishing of wood and wood based materials.
IS:2339	:	Specification for Aluminium Paints for general purposes in dual containers.
IS:2395	:	Code of Practice for painting concrete, masonry and plaster surface.
IS:2932	:	Specification for enamel, synthetic, exterior, type-I.
IS:5410	:	Specification for cement paint, colour as required.

TECHNICAL SPECIFICATION
FOR
XXVI) SUSPENDED CEILING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXVI) SUSPENDED CEILING

1.00.00 **SCOPE**

The work under this Section shall include the supply and insulation of suspended ceiling using insulation / acoustic boards, Gypsum board, Metal linear interlocking strips etc. together with the suspension system as per manufacturer standard details with all materials complete. The work shall also include providing of openings in the ceiling for lighting, air conditioning diffusers, fir fighting detector etc. as shown required or instructed by the Engineer.

Aluminium linear ceiling similar to luxalon shall be provided.

2.00.00 **INSTALLATION**

2.01.00 **Suspension System**

2.01.01 **General**

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses.

All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All M S sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer. All wood supports shall be painted with two coats of “fire resistant paint.

2.01.02 **Metal Grid Suspension System**

Metal grid suspension system shall be provided as per manufacturer specification and details. For gypsum board suspension system of India Gypsum board shall be followed. In case of Linear metal strip interlocking system details of manufacturer shall be followed.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by M S flats angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2 centers. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as per manufacturer specification of the respective materials.

The cross tees shall intersect main runners in pattern shown on drawing and positively looked together with intersection clips. All perimeter areas shall

have angle moldings fixed to vertical wall surfaces and end tees shall rest on the moldings, unless otherwise specified.

2.01.03 **Timber Grid Suspension System (Not used)**

Unless otherwise shown on drawings, the suspension system shall consist of 50 mm x 50 mm pretreated teakwood batten grid suspended in the same manner described for metal grid system. The spacing of timber battens shall be as shown on drawing. Extra battens shall be provided where necessary for openings for light fixtures A C grills etc.

2.02.00 **Ceiling Panels**

2.02.01 **Materials**

Ceiling panels shall be best quality material in thickness and properties and as specified. The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of the following types:

a) Gypsum boards of India gypsum with concealed suspension system.

b) Expanded polystyrene insulation boards (Not Used)

c) Fibre insulation boards (Not Used)

d) Wood particle boards (Not Used)

e) Glass fibre reinforced polystyrene sheets (Not Used)

f) Pre coated (Dry film thickness of coating 15-20 micron thick) aluminium alloy linear interlocking strips of size 84x12.5 deep x 0.5mm thick with concealed suspension system.

Acrylic plastic sheets translucent or figured glass sheets moulded plastic louvres etc. shall be from approved manufacturers and in thickness specified in schedule.

2.02.02 **Installation of Ceiling Panels**

Installation of ceiling panels shall be strictly as per manufacturer's instruction and specification.

For exposed grid ceiling system, tile hold down clips shall be used at the rate of min. 1 per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Engineer.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner as specified by the manufacturer. Where V joints in tiles are called for, these shall begin true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Surface of ceiling boards shall be finished in a true and even surface without undulations with putty to make the surface suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions

with walls, light fixtures, diffusers etc. All hangers shall be fixed to the RCC ceiling with Anchor Fastener.

For interlocking ceiling system carrier shall be roll formed 32 mm wide and 39 mm deep out of 0.9 mm thick aluminium and magnesium alloy with cut up prongs to hold the panels in module 100 mm at maximum 1.6 m center to center. Carrier shall be suspended from roof / truss by galvanized steel rod 4mm dia. in required length with height adjustment galvanized turn buckle. Hanger shall be fixed with the ceiling with anchor fastener.

3.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards, joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

4.00.00 I. S. CODES

IS:2441 - Code of Practice for fixing ceiling coverings.

TECHNICAL SPECIFICATION
FOR
XXVII) SHEET WORK IN ROOF AND SIDING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

SHEET WORK IN ROOF AND SIDING

1.00.00 SCOPE

This specification covers the erection of asbestos, C.G.I., aluminium or other sheet covering to roof and side walls at various elevations and the fabrication and/or installation of asbestos, C.G.I or aluminium gutters, flashings etc

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage. If the materials are issued at site by the Owner, the Contractor shall at the time of issue, satisfy himself about the condition of issued sheets, gutters, etc. and no complaints shall be entertained later.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a water tight finish to the satisfaction of the Engineer fixing of gutters and down pipes shall be according to IS:2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as stated in the Schedule of Items, shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification Hook bolts or J-bolts shall be 8 mm dia. at 305 centres 6 mm dia galvanised iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stiching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used the end laps shall be minimum 100 mm. Holes in C.G.I sheets shall preferably be made on the ground the sheets should be placed on trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washets. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum 305 mm apart. The length of the hook or J-bolts shall be to suit the sections of the bearers.

Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanised iron seam bolts and G.I. flat washers and bituminous washers.

2.02.03 **Fibre Glass Reinforced Plastic Sheeting**

This shall be of thickness and profile as mentioned in the Schedule of Item. Colour and light transmittance shall be as mentioned in drawings and or schedules. Where used in conjunction with C.G.I. or asbestos sheeting the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads as mentioned in schedule of items. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure as mentioned in Schedule.

2.02.04 Precoated metal sheeting for roof shall be of precoated cold rolled sheet of total coated thickness (TCT) 0.58 to 0.68 mm of approved manufacturer. The sheet shall be metallic hot deep coated with an alloy of 55% aluminium, 43% zinc and 1.55 silicon coating mass shall be 150 gms/sq.m. sheet shall be fixed with fastening clip and self tapping fastener. Ridge for slope roof shall be of similar material and shall be fixed with necessary self tapping screws as per manufacturer details.

Thermally insulated sandwiched metal cladding for external facaade shall be of approved manufacturer. Sheeting shall Hi Rib 0.5 mm troughed sheeting manufactured from aluminium alloy high tensile steel (550Mpa) coated with fluro polymer (PV F2 or equivalent) and shall have life span sustenance against aggressive weathering action. Inner profiled sheet shall be with profile sheet of .6 mm thick (total coated thickness) permanently coated galvanised sheet.

Galvanised coating shall be not less than 120 gm/sq.m. and sandwiched insulation of 25 mm thick or as per design requirement shall be bonded mineral wool blanket or equivalent conforming to IS: 8183 (minimum density of 32/kg/cum for glass wool and 48/kg/cum for rock wool) having minimum coefficient of thermal conductivity of 0.49 mW/cm deg C (at 50 degreeC) Cladding shall be fixed to supports/rails by nuts, bolts, hooks, washers self tapping screws of stainless steel Austentic grade) conforming to IS:1367 (part 14) including sealents, gaskets, PVC tape 0.25 mm thick, flashing, black synthetic rubber external trough filler and 25X3 mm aluminium earthing.

2.02.05 **Poly Carbonate Roofing vault etc.**

Poly carbonate sheet shall be translucent thermomoclear multiwall sheet similar to LEXAN of GE Plastic with both side UV protection and thermal insulation properties. Sheet shall be of thickness varying from 6mm to 32 mm thick and shall be multi wall. Sheet shall be fixed over light tubular structure of square hollow steel tube painted with two coats of synthetic enamel paint over coat of zinc chromate primer. Structure shall be of the shape as indicated in General Specification. LEXAN Polycarbonate sheet

Shall be fixed with aluminium flat section 50mm wide 4 mm thick With stainless steel screws. EPDM gasket and shall be sealed with Silicon sealant. Thickness of sheet shall be as specified in the General specification of Architectural work and unless otherwise indicated shall be minimum 8mm thick /2 RS structure.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked :

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing

4.00.00 IS CODES

The following are some of the important IS Codes relevant to this sections :

IS : 3007 : Code of practice for laying of asbestos cement sheets

IS : 2527 : Code of practice for fixing rain water gutters and down pipes for roof drainage

IS : 1626 : Specification for asbestos cement building pipes gutters and fittings

IS : 277 : Specification for galvanised steel sheets (plain and corrugated)

TECHNICAL SPECIFICATION
FOR
XXVIII) ROOF WATER PROOFING, INSULATION AND ALLIED WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE AND STANDARDS

XXVIII) ROOF WATER PROOFING, INSULATION AND ALLIED WORK

1.00.00 SCOPE

This specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof water-proofing, insulation and allied work for buildings and at locations covered under the scope of the Contract.

2.00.00 INSTALLATION

2.01.00 Grading Underbed

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 100 and as directed by the Engineer. Upto an average thickness of 25 mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete.

The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 The grading plaster shall be average 25mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The same and cement shall be throughly mixed dry and them water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.02.00 Concrete

The concrete shall be used where the subgrade is more than average 25mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.03.00 **Insulation**

The Tenderer shall along with the tender send specification of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the treatment as specified, unless otherwise indicated in the General Specification of Architectural work if any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12mm and it shall be cured for seven days

2.04.00 **Foam Concrete (Not Used)**

This shall be of light weight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m degree C. The weight of the insulating material shall be from 0.3 to 0.5 gm/cm.

Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to make the usual work load and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.05.00 **Expanded Polystyrene Blocks**

The expanded polystyrene block insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 KCl m/m degree C. and density Maximum 32.35 Kg/M^3 It must be strong enough to withstand without deformation the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers' supervision at no extra cost to the Owner.

2.06.00 **Fillets**

Fillets at junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix by volume.

2.07.00 **Waterproofing**

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with Bitumen Felts shall be done following relevant IS:1346. Bitumen felt shall conform to IS:1322 and Bitumen primer to IS:3384.

The bonding materials shall consist of blown type conforming to IS:702 or residual bitumen to IS:73 or a mixture of the two to withstand local conditions or prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples of pea sized gravel shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated in the Schedule of Items. Brief details of the various treatments shall be as follows:

a) Normal Treatment : Four courses :

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Hessian base self finished felt, type 3, grade 1

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Pea sized gravel at the rate of 0.006 mU2

b) Heavy Treatment : Six Courses :

With Hessian base felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Hessian base self-finished felt, type 3, grade 1

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Hessian base self-finished felt, type 3, grade 1.

5) Hot applied bitumen at the rate of 1.2 kg/m

6) Pea sized gravel at the rate of 0.006 mU2

Or

With fibre base felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Fibre base self-finished felt, type 2, grade 2

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Fibre base self-finished felt, type 2, grade 2

5) Hot applied bitumen at the rate of 2.5 kg/m and

6) Pea sized gravel at the rate of 0.008 mU2

c) Extra Heavy Treatment : Eight courses :

With fibre based felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Fibre-base self-finished felt type 2, grade 1

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Fibre base self-finished felt type 2, grade 1

5) Hot applied bitumen at the rate of 1.2 kg/m

6) Fibre base self-finished felt type 2, grade 1

7) Hot applied bitumen at the rate of 2.5 kg/m and

8) Pea sized gravel at the rate of 0.008 mU2.

Or

With Hessian base felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Hessian base self-finished felt, type 3, grade 1.

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Hessian base self-finished felt, type 3, grade 1

5) Hot applied bitumen at the rate of 1.2 kg/m

6) Hessian base self-finished felt, type 3, grade 1

7) Hot applied bitumen at the rate of 1.2 kg/m

8) Pea sized gravel at the rate of 0.006 mU2

However, in special cases, more courses or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the pea sized gravel or any other existing top course shall be completely removed and all damaged felts or other defects required.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that loose gravels, felt cuttings etc. do not find their way into rain water down comers.

2.08.00 **Waterproofing by epoxy resin based application**

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be throughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, light traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labours for the application. This item shall carry a guarantee as specified under the relevant item in the Schedule.

2.09.00 **Flashing**

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer, instead of being finished with pea-sized gravel, shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The metal flashing shall be done as shown on the drawings. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer.

2.10.00 **Elastromeric Membrane**

2.10.01 **Primer Coat**

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush /spray with airless spray equipment over the prepared bed as an adhesion coat with an application rate of 6-8 sq.m per litre depending on the surface porosity.

The primer shall be allowed to dry for a minimum period of 2 to 4 hours time before the successive finishing coats of P.U. liquid membrane are applied. In any case successive finishing coat shall be applied within 24 hours.

The substrate shall be properly prepared by removing all loose materials by vigourous brushings, fungal growth with proprietary fungitide as recommended. Priming coat shall not be applied to damp substrate.

2.10.02 **Finishing Coats**

The finishing coats shall consist of two successive liquid coatings of high solid content urethane pre-polymers or equivalent material to form an elastomeric membrane. Application shall be with brush or spray to form an uniform jointless elastomeric membrane. The overall dry film thickness shall be 1.5 mm subject to minimum 750 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for minimum of 150 mm over the finished roof surface or fillet with suitable tucking into the vertical wall surface. It shall be continued into rain water pipes by atleast 100 mm.

The final coat of PU liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a layer of polyscrim cloth/fabric are to be embedded between 2 finishing coats.

The entire work shall be carried out under the suspension of approved authorized agency and as per manufacturer specification.

2.10.03 **Water Proof Membrane**

One coat of Approved water proof chemicals with rubberized bituminous primer (water base) similar to EMUFAL TE manufactured by TEXSA @ 0.300 ltr/ Sq.M. shall be applied.1.5 mm thick self adhesive water proof membrane similar to Texself H.D. of Texsa or approved equivalent over chemical treatment shall be laid including flashing minimum 300 high over parapet wall and shall be secured in a groove in RCC parapet. Area of contact with RCC parapet shall also be treated with the chemical treatment similar to Roof. If specified in the General specification of Architectural Specification the water proof membrane shall be protected with 25 mm thick PCC with 0.56 dia. chicken wire mesh. The PCC shall be cast in panels of size 1.2M x1.2M size and joint shall be sealed with the same material.

The entire work shall be carried out by the Manufactutrer authorized representative and specification.

2.10.03 **Surface Finish**

Areas of roof treatment shall be provided with wearing course consisting of minimum 25 mm thick PCC 1:2.4(using 12.5 mm size aggregate) cast in panel of maximum size of 1.20 m x 1.20 m and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using polysulphide sealant or similar water proof membrane or elastomeric compound for elastromeric water proofing as per General specification of Architectural work.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided. The tiles shall be laid as per IS 1443.

3.00.00 **ACCEPTANCE CRITERIA**

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The Contractor shall give a guarantee in writing for all work executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water-proofing treatment work. The guarantee shall be for materials and workmanship for a period of minimum 10 years. The mode of execution of the guarantee shall be acceptable to the Owner.

4.00.00 **I.S. CODES AND STANDARDS**

a) IS:73 : Paving Bitumen

b) IS:702 : Industrial Bitumen

c) IS:1203 : Methods of testing tar and bitumen

d) IS:1322 : Bitumen felts for waterproofing and damp proofing

e) IS:1346 : Code of Practice for waterproofing of roofs with bitumen felts

f) IS:3384 : Bitumen primer for use in waterproofing and damp proofing.

XXIX) WATER SUPPLY

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1.00.00	SCOPE
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3.00.00	TESTING AND ACCEPTANCE
4.00.00	I.S. CODE

XXIX) WATER SUPPLY

1.00.00 **SCOPE**

This section includes supply of all materials, labour and incidentals for water supply for residential, business and industrial and other types of buildings. The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

1.01.00 **Materials**

All materials, fittings, fixtures and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence order are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

1.02.00 **Pipes and Pipe Fittings**

Under scope of this specification, pipes and pipe fittings may be any or a combination of the following types :

a) Cast Iron

b) Steel : lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanised.

c) Reinforced Concrete

d) Prestressed Concrete

e) Asbestos Cement

f) Lead (Not to be used for potable water)

g) P. V. C.

h) Copper

i) Brass

j) Wrought iron

1.03.00 **Water Reservoirs**

Water reservoirs like pressed steel tanks and G.I. tanks shall come under scope of this specification. Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

1.04.00 **Related Works**

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Specification.

1.05.00 **Regulation**

The work which is required to be carried out under the scope of this section, shall be executed by a licensed plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc. from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities. The fee paid to the Authorities shall be reimbursed by the Owner.

2.00.00 **INSTALLATION**

While basic layouts may be available in the drawings provided by the Owner, the details might have to be supplemented by the Contractor for approval of the Engineer.

Special attention shall be given by the Contractor to economy. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

2.01.00 **Pipe Lines**

2.01.01 **Laying**

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacings as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction & easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer.

2.01.02 **Back Flow**

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely water-tight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

2.01.03 **Contamination**

There shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

2.01.04 **Underground Pipings**

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.

The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.

The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

2.01.05 **Concealed Piping**

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, conduits as necessary. However, the Contractor will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

2.01.06 **Jointing of Pipes**

Jointing of pipes shall be completely leakproof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, usually recommended practices are stated below for guidance :

a) **Cast Iron**

i) **Spigot and Socket Joints**

Lead joint : The joint is made by first caulking in clean spun yarn upto half depth and filling the reminder by running in molten lead taking care that no dross enters the joint and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket. After completing the joint it shall not be allowed to move. For rectification the joint shall be completely redone.

ii) **Flanged Joints :** Flanged joints shall be made by jointing rings of good quality, smooth and hard compressed fibre board of thickness not less than 1.5 mm and of such width as to fit inside the circle of bolt. Diagonally opposite bolts shall be tightened in pairs and in stages so that degree of all bolts in a joint are similar. Damaged gaskets shall be replaced.

b) **Steel**

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove any burr from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

c) **G I Pipes**

Threads shall be cut with sharp tools, and before jointing all scales shall be removed from pipes by suitable means. The screw / threads of the pipe shall be cleaned out and the joint made by screwing the fittings after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

d) **Asbestos Cement Pipes**

Socket and spigot ended pipes shall be jointed by caulking with tarred gaskets and grouted with 1:3 cement sand mortar.

e) **Lead**

Lead and lead alloy pipes shall be jointed with wiped solder joints.

f) **Concrete**

Concrete pipes may be socket and spigot ended collar or band jointed. Joints shall be effected by caulking with 1:3 cement sand mortar.

g) **P. V. C.**

Manufacturer's instruction shall be followed. For heating approved equipment with adequate control shall be used.

h) **Tyton Joint**

The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the jont fully.

2.01.07 **Painting**

Where mentioned in the Schedule, underground steel and cast iron pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I. pipes shall be given a coat of zinc chromate primer, C.I. & M.S. pipes shall be given one coat of red lead or zinc chromate primer. Top coats shall be minimum 2 coats of best quality paint.

2.02.00 **Storage Tank - Pressed Steel Tank**

Unless otherwise mentioned, water storage tanks shall be pressed steel tanks of nominal size and capacity as mentioned in the Schedule and fabricated with all flanges external, all flanges internal, or bottom flange internal and side flanges external, as shown on drawings or schedule of items. The fabricator shall supply 6 prints of fabrication drawings to the Engineer for prior approval showing thickness of plates, method of jointing the plates, all supports, stays, gussets etc. Pads, cleats etc. required for supporting the tanks shall be supplied by the manufacturer. Inlet, overflow vent pipes, manholes etc. shall be arranged and provided as shown on drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50 mm above the bottom of the tank and there shall be a 150 mm free board at the top of the tank.

All tanks shall be supplied with mosquito-proof covered top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 Metre shall be provided with m.s. internal access ladder adjacent to the manhole. Water level indicator shall be provided if asked for. Two coats of anti-corrosive paint over a suitable primer shall be applied to both internal and external surface of tanks. Such paint if used shall not impart any taste or odour to water and be of lead free composition..

Erection of tanks shall be in accordance with detailed drawings and manufacturer's instructions. The two finishing coats of paint shall be applied to outside after erecting is complete.

2.02.01 **G. I. Water Tank**

G. I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanised iron water storage tank shall be made of minimum 2 mm thick galvanised iron sheet. Plain sheets shall be fixed at the corner to angle iron frames by means 6 mm

rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised/iron stay rods, one fixed to angle framing at top and two in the body of the tank for extra strength. Holes for rivetting shall be drilled and not punched. White lead shall be applied to the joints before rivetting.

In case it is desired by the Engineer that corners of tank should be welded instead of rivetted then the sheets shall be welded to form a tank will not have angle iron frame.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on Drawing and 25 mm dia. G.I. overflow pipe. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve permits the entry of water when the tank is empty and disconnects the supply when the tank is full. It consists of a hollow floating ball made of copper, plastic or hand Tubber, 110 mm in diameter, attached to an arm which is so pivoted that the end near the pivot closes the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution pipes. The ball valve shall be fixed to the tank independent of the inlet pipe and set in such a position that the body of the ball valve cannot submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water line. The level of the water in the tank to 75 mm below the lip of the overflow pipe. Free surface shall be about 150 mm above the maximum water filled level.

2.03.00 **Valve, Cocks, Taps**

All valves, stop cocks, taps etc. shall conform to relevant Indian Standard Specification and shall be of best quality from approved manufacturers. These shall be suitable for working pressures mentioned in the Schedule. Nominal size and material shall be as per schedule.

2.04.00 **Protection**

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets or spigot are not damaged and no foreign material can find its way into the pipe line.

Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.00.00 TESTING AND ACCEPTANCE

3.01.00 Inspection Before Installation

All pipes, fittings and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

3.02.00 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/CM^2 or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

3.03.00 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely water-tight. All pipings, fittings and appliances shall be checked for satisfactory support and protection from damage, corrosion and frost.

400.00 I.S. CODES

Important relevant IS Codes for this Specification are listed below :

Latest editions shall always be consulted.

IS:2065	:	Code for Practice for water supply in buildings
IS:1172	:	Code of basic requirements for water supply, drainage and sanitation
IS:1200	:	Laying of water and sewer lines including (Pt.XVI) appcurtnant items.
IS:1239 (Pt. I & II)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter)

IS:1536	:	Specification for Centrifugally cast (Spun) iron pressure pipes for water gas and sewage
IS:1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS:3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter)
IS:3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter)
IS:784	:	Prestressed concrete pipes
IS:458	:	Concrete pipes (with or without reinforcement)
IS:783	:	Code of Practice for laying of concrete pipes
IS:1592	:	Asbestos cement pressure pipes
IS:1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types)
IS:404	:	Lead pipes
IS:3076	:	Low density polyethylene pipes for potable water supplies
IS:4984	:	High density polythylene pipes for potable water supplies
IS:2501	:	Copper tubes for general engineering purposes
IS:407	:	Brass tubes for general purposes
IS:1230	:	Cast iron rain water pipes and fittings
IS:804	:	Rectangular pressed steel tanks

TECHNICAL SPECIFICATION
FOR
XXX) DRAINAGE AND SANITATION

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	TESTING AND ACCEPTANCE
4.00.00	CODES AND STANDARDS

XXX) DRAINAGE AND SANITATION

1.00.00 **SCOPE**

1.01.00 This section covers the layout and construction of drains for roof water, surface water and sewage together with all fittings and fixtures and inclusive of ancillary works, such as connections, manholes and inspection chambers used within the building and from the building to the connection to a public sewer or to treatment work, septic tank and soak pit dispersion trenches.

2.00.00 **INSTALLATION**

2.00.01 **General**

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipe lines, fittings and fixtures shall be installed leakproof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

2.01.00 **Rainwater Downcomers**

Rainwater downcomers shall be standard Cast Iron or PVC Pipes. In case where specifically desired, M.S. pipes, GI pipes may also be used. M.S. pipes and GI shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater downcomers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure.

All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type or perforated strap iron type and for PVC pipes as per manufacture detail and as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

2.02.00 **Gutters**

The gutters shall be made of G.I. or A.C. All gutters shall be supplied by reputable specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

2.03.00 **Soil and Drainage Pipes**

2.03.01 **Gradients**

If not specified the minimum gradients of soil and drainage pipe line shall be as follows :

100 mm nominal dia : 1 in 35

150 mm nominal dia : 1 in 65

230 mm nominal dia : 1 in 120

300 mm nominal dia : 1 in 200

2.03.02 **Relation with water supply pipe lines**

Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

2.03.03 **Laying**

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

2.03.04 **Support and Protection on Pipelines**

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooh surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows :

a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

2.03.05 **Entry into structures**

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When

openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

2.03.06 **Ducts**

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

2.03.07 **Traps and Ventilating Pipes**

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

2.03.08 **Manhole and Inspection Chambers**

The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. In addition, at every change of alignment gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise.

Manhole shall be constructed so as to be watertight under test. The bending at the sides shall be carried out in such a manner as to provide no lodgement for any splashings in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Manholes shall be provided with standard C.I. covers. The covers shall be close fittings so as to prevent gases from coming out. Suitable heavy duty covers shall be used where necessary as decided by the Engineer.

2.03.09 **Cutting of Pipes**

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

2.03.10 **Jointing**

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water-tight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes :

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centered in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leakproof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Care shall be taken to place the collar centrally over the joint.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar of 1:1 proportion. Then the socket is filled, a fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be covered with damp cloth or other suitable materials.

d) Vitrified clay pipes

These shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, Specification for Building it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1) which shall have very little water and levelled to form a splayed fillet at an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) PVC Pipes

The joints shall be thermo-welded or bolted or joints with rubber lubricant and shall be strictly as per as per manufacturer's instructions and specification.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron soil pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe or drain communicating with a sewer, the beaded spigot end of such cast iron soil pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe or drain and the joint made with mortar consisting of one part of cement and one part of clean sharp sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earthware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

2.04.00 **Trenches and other excavations**

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during handpacking with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

2.05.00 **Fixtures**

The Tenderer shall mention in his bid the type and make of the fixtures he intends to use enclosing manufacturer's current catalogues. In the absence of any such agreement, the Engineer shall be at liberty to choose any type and make.

All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear indentification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3 kg. per 25 mm dia per meter length. Where PVC or similar pipes are allowed the Contractor shall produce the test reports and convince the Engineer about their durability.

Unless specified in the contract the fixtures shall be as specified hereinafter.

2.05.01 **Water closet**

a) Raised type

It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valveless fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as desired by the Engineer.

b) Squatting type

It shall include glazed vitreous china pan with foot rests and high level cast iron flushing cistern with valveless fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The foot rests shall be made of white glazed vitreous china with chequered surface. The flushing cistern shall be painted as desired by the Engineer.

2.05.02 **Urinals**

It shall consist of wall type glazed vitreous china urinals, cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Automatic flushing shall be approximately once every five minutes. For a number of urinals located together may be served by one cistern of adequate capacity. All fittings shall be chrome plated.

2.05.03 **Wash basin**

It shall be made of glazed vitreous china. The basin shall be flat back, wall hung by painted cast iron brackets and complete with pattern with hot and cold brass faucets with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste complete with necessary fittings. All fittings including faucets shall be chromium plated.

2.05.04 **Sink**

It shall be made of glazed stoneware. It shall be wall hung by painted cast iron brackets and complete with one brass faucet with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste with necessary fittings. All fittings including faucets shall be chromium plated.

2.05.05 **Bathroom mirror**

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws and other fittings shall be chromium plated.

2.05.06 **Glass shelves**

Glass shelves shall consist of 6 mm thick clear glass with guard rails and shall be wall mounted with brackets. All brackets, guard rails and screws shall be chromium plated.

2.05.07 **Towel rail**

Towel rails shall be 20 mm dia. chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

2.05.08 **Soap holder**

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium plated screws.

2.05.09 **Liquid soap dispenser**

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

2.05.10 **Toilet roll holder**

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screws shall be chromium plated.

2.05.11 **Installation**

All plumbing fittings and fixtures shall be installed in most workmanlike manner by skilled workers. These shall be perfect in level, plumb, plane, location and symmetry. All items shall be securely anchored to walls and floors. All cuttings in walls and floors shall be made good by the Contractor.

2.06.00 **Septic tank & effluent disposal**

2.06.01 **Septic tank**

Septic tank shall consist of the tank itself with inlet and outlets therefrom complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 mm dia. whose top shall be provided with a suitable mosquito proof wiremesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

2.06.02 **Effluent Disposal**

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

2.06.03 **Soak pit**

The soak pit shall be complete as shown on drawing. It shall consist of a 900 mm dia. pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6) and filled with brick bats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

2.06.04 **Open joined SW Pipe / dispersion trenches**

Minimum dia. of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be minimum 600 x 600 mm pipes. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well graded coarse aggregate. Ordinary soil is used for filling the top of trench.

2.06.05 **Commissioning septic tank**

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.00.00 TESTING AND ACCEPTANCE

3.01.00 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

3.02.00 Testing of Pipelines

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below :

a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

b) Water test

For pipes other than Cast Iron

Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may due to one or more of the following cases:

a) Absorption by pipes and joints

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

For cast iron pipes

Cast iron sewers and drains shall be tested as for glazedware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

c) For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and

ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipe line is not straight.

3.03.00 **Testing Septic Tank**

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm.

3.04.00 **Fixtures etc.**

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

4.00.00 **CODES AND STANDARDS**

Some of the important Codes and Standards relevant to this specification shall be followed : Latest editions shall always be consulted.

IS:1172 - Code of basic requirements for water supply drainage and sanitation.

IS:1200 - Laying of water and sewer lines including appurtenant (Pt. XVI) items.

IS:1239 - Mild Steel Tubes and Mild Steel Tubulars and other (Pt.I & II) wrought steel pipe fittings.

IS:1536 - Centrifugally cast (Spun) iron pressure pipes for water gas and sewage.

IS:1537 - Vertically cast iron pressure pipe for water, gas & sewage.

IS:3486 - Cast Iron spigot & socket drain pipes.

IS:1742 - Code of Practice for building drainage.

IS:5329 - Code of Practice for sanitary pipe work above ground for buildings.

IS:2470 - Code of Practice for designs and construction of septic tank for small and large installations.

IS:3076 - Low density polythelene pipes for potable water supplies.

IS:4984 - High density polythelene pipes for potable water supplies.

IS:1537 - Vertically cast iron pressure pipes for water, gas and sewage.

IS:1538 - Cast Iron fittings for pressure pipes for water, gas & sewage.

IS:1230 - Cast Iron rain water pipes and fittings.

IS:3889 - Centrifugally cast (spun) iron spigot & socket soil waste and ventilating pipes, fittings and accessories.

IS:1729 - Sand cast iron spigot & socket soil, waste and ventilating pipes and accessories.

IS:1626 - Asbestos cement building pipes, gutters and fittings (spigot & socket types).

IS:458 - Concrete pipes (with and without reinforcement)

IS:783 - Code of Practice for laying of concrete pipes.

IS:784 - Prestressed concrete pipes.

IS:651 - Salt glazed stoneware pipes & fittings.

IS:4127 - Code of practice for laying of glazed stoneware pipes.

IS:1726 - Cast Iron manhole covers and frames intended for use in drainage works.

IS:5961 - Cast Iron gratings for drainage purposes.

IS:5219 (Part 1) - 'P' & 'S' traps.

IS:771 - Glazed earthen-ware sanitary appliance.

IS:772 - General requirements of enamelled cast iron sanitary

appliances.

IS:774 - Flushing cistern for water closets & urinals (valveless siphonic type).

IS:775 - Cast Iron brackets & supports for wash basins and sinks.

IS:2548 - Plastic water closet seats & covers.

IS:2527 - Code of Practice for fixing rain water gutters and down-pipes for roof drainage.

TECHNICAL SPECIFICATION
FOR
XXXI) BOILER DRAIN DIVERSION

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	SYSTEM DESCRIPTION
2.00.00	SCOPE OF WORK
3.00.00	DETAILED SPECIFICATION

ATTACHMENTS

ANNEXURE-I	ALTERNATE ROUTE FOR BOILER DRAIN
ANNEXURE-II	EXISTING BOILER DRAIN - SECTIONS

XXXI) BOILER DRAIN DIVERSION

1.00.00 SYSTEM DESCRIPTION

1.01.00 Existing boiler drains of unit #1 to unit #7 need to be diverted for installation of 1 x 800 MW Supercritical Unit #8.

1.02.00 The diverted drain will be connected to a Settling Tank, which shall be located near existing Cooling Tower for unit 7 (between Grids W-100 & W-200) area shown in the Plot Plan drawing of unit #8 (Dwg. No. K9213R-DWG-M-002 Rev- 4).

1.03.00 Pumping System need to be installed in Settling Tank for recirculation as well as discharge of decanted water.

2.00.00 SCOPE OF WORK

The scope of work shall include complete supply, erection, installation & commissioning of diverted boiler drain as detailed hereunder. The minimum requirement of the system have been indicated, however, EPC Contractor shall provide all items/ facilities to make the system complete & suitable for the satisfactory operation.

a) A new RCC channel shall be erected for diversion of boiler drain of Unit #1 to 7.

b) Settling Tank - One (1) no. for unit no. 1 to unit no. 7

c) 3 x 50 % drain pumps to be installed at Settling Tank.

d) Necessary piping, valves, instrumentation for recirculation as well as discharge of decanted water.

e) All Civil and Structural work associated with the scope of work described in 'a' to 'e' above.

3.00.00 DETAILED SPECIFICATION

A. Drain Channel :

Covered RCC channel shall be provided for boiler drain diversion. Tentative routing of diverted drain has been shown in the Plot Plan drawing (Dwg. No. K9213-DWG-M-002 Rev. 4). Alternate route for diverted drain has been shown in enclosed Annexure – I. Actual routing shall be finalized by the Contractor.

The capacity of diverted boiler drain shall be adequate to cater waste water discharge from unit-1 to unit-7. Waste water discharge from unit-1 to unit-7 shall be considered as approximately 475 m3/hr.

Details of existing boiler drain are attached herewith in Annexure – II. However, Contractor shall design & finalize the channel section as required.

B. Settling Tank :

A 12m x 30m x 6.2m deep Settling Tank of RCC construction shall be provided, which shall be connected with the diverted drain. Size of settling tank given here is the minimum requirement. However, EPC contractor shall provide the same of required capacity to make the system complete and suitable for satisfactory operation. Settling Tank shall be located near existing Cooling Tower for unit 7 (between Grids W-100 & W-200) area shown in the Plot Plan drawing for Unit #8 (Dwg. No. K9213-DWG-M-002 Rev. 3). This location will be nearer to the utility location of recirculation water. Settling tank should be provided with baffles and clear water sump at the end of settling tank and pre-settling chamber at shallow depth at the entry, so that heavy particles settle in pre-settling chamber.

C. Drain Pumps :

3 x 50 % capacity drain pumps shall be provided at Settling Tank for discharge of water.

The pump parameters shall be as follows :

a) Rated Capacity (Cu. M/Hr). : By Bidder.

b) Rated Head (MWC) : By Bidder

[NOTE : Capacity of pumps shall be designed considering waste water discharge from unit-1 to unit-7 as 475 m3/hr. A minimum margin of 10% shall be considered on pump capacity and 20% margin shall be considered on pump head.]

Material of Construction of Pumps :

a) Casing : 2.5% Ni-CI as per IS : 210 FG 260.

b) Impeller : Stainless Steel Grade – 316

c) Shaft : Stainless Steel Grade - 410

D. Drain Piping :

Concrete / Steel piping, valves, & instruments as required from the discharge of drain pumps upto the final discharge points (for re-use of water and/or for discharge into the river) shall be provided by the Bidder. For re-use of water piping from the discharge of drain pumps shall be connected to the existing system of re-circulation from existing settling tank to existing plant. The approximate distance is 25 to 30m. The work also includes isolation of existing line for connection. Detailed routing and terminal points shall be finalized during Detail Engineering stage.

TECHNICAL SPECIFICATION
FOR
XXXII) GEO-TEXTILE FABRIC

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	EXECUTION
4.00.00	ACCEPTANCE CRITERIA

TECHNICAL SPECIFICATION FOR XXXII) GEO-TEXTILE FABRIC

1.00.00 SCOPE

The supply, design and construction of Geo-synthetic/Geo-textile lining system with protective earth cover and turfing (or precast concrete blocks/ Brick tiles) shall be under the scope of Contractor. The design of Geo-synthetic lining system shall be done by approved manufacturer or specialized agencies and to be submitted to owner for approval. Laying of Geo-textile grid and covering the same with soil shall be done by the agencies specialized for this type of work.

2.00.00 GENERAL

2.01.00 Work to be provided by the Contractor

Work to be provided by the Contractor unless specified otherwise will include, but not limited to the following:

a) Furnish all labour, supervision, services, materials, scaffolds, equipment, tools and plant, transportation, necessary approaches etc. required for the work.

b) Prepare detail drawing, if needed, for the work, fencing of area for protective measure, provide dewatering arrangement by pumping, if required, etc.

2.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract or prior approval of the Owner is taken in this respect.

2.03.00 Conformity with Designs

The Contractor is to carry out the work as per the specification, drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or Engineer's instructions. If any deviation is likely to occur, then the Contractor should take Engineer's prior approval before starting of such work. Under no circumstances, the work to be performed should deviate from the specification or drawings unless approval of Engineer is taken.

2.04.00 **Materials to be used**

2.04.01 **General**

All materials to be used for the Work, must meet the specification requirements or the provisions of IS Code and should be of best quality available and approved by the Engineer. In case of bought-out items, certificate from the supplier or its deputed agency must be produced along with samples and approval taken from the Engineer before the items are bought.

Decision of the Engineer in cases of bought-out items shall be final.

2.04.02 **Geo-textile**

Property	**Test Method**
Non-woven Geo-textile :	
Tensile Strength	ASTM D1682
Puncture Strength	ASTM D751
Woven Geo-textile :	
Tensile Strength	ASTM D4595
Tensile Elongation	ASTM D5035
Thickness	ASTM D1777
Mass per Unit Area	ASTM D5621
Resiliency	ASTM D1777
UV Resistance at 1,000 hours	ASTM D4355

3.00.00 **EXECUTION**

The Work shall be strictly executed according to the provisions of this specification, final drawings, instructions of the Engineer at site, and/or catalogues of the approved manufacturer of Geo-textile.

All equipments necessary for the placing of Geo-textile fabric shall be approved before the work will be permitted to begin.

The installation of geo-textile shall be in accordance with the manufacturer's recommendation. Overlaps at ends of rolls and at roll widths shall be in accordance with the manufacturer's recommendations or as directed by the Engineer.

4.00.00 **ACCEPTANCE CRITERIA**

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be specifically checked :

a) Geo-textile fabric against mechanical damage if any.
b) Laying of Geo-textile fabric.
c) Method of jointing (Heat sealing).
d) End sealing or, anchoring of Geo-textile fabric.
e) Laying and joints of cover tiles/blocks.

TECHNICAL SPECIFICATION
FOR
XXXIII) LANDSCAPING WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	MATERIAL
3.00.00	LANDSCAPING WORK
4.00.00	MAINTENANCE
5.00.00	ACCEPTANCE CRITERIA
6.00.00	I.S. CODE

TECHNICAL SPECIFICATION FOR XXXIII) LANDSCAPING WORK

1.00.00 SCOPE

The work in general shall consist of preparation of earth/ground including supply & plantation of grass, saplings, plants of trees, shrubs, foliage plants, hedges and potted plants for soft landscaping work. Excavation and removal of top soil up to 300/600 mm depth and Supply and filling with Good earth, if the top soil found to be unsuitable for plantation, are included in the scope of work. Manures, sludge, oil cake, PVC Water supply pipelines & sprinklers with necessary mechanical arrangement like pump & equipment etc for irrigation systems are also included in the supply, preparation and installation work.

Scope of Work also include supply, erection, installation fitting & fixing colored concrete interlocking pavers blocks over well compacted rigid base with 50mm thick sand bed, street furniture like signage, sitting place, trellis made of MS tubes duly painted with anticorrosive paint and electrical fittings and fixtures of approved design and quality for illumination of garden and landscaped area.

Maintenance of Landscape area and landscape elements provided in the work for six(6) months from the date of completion of landscaping work are also included in the scope of work.

Approximate area for both hard and soft landscaping work will be 50,000 Sq.M of ground area spread all over the new plant area. Approximately 5% of this area shall be considered for Hard landscaping.

2.00.00 MATERIAL

i) Good Earth: The earth shall be suitable for gardening and free from kankar, moorum, shingle, rocks, stones, brickbats, building rubbish and any other foreign matter. The earth shall be free from clods or lumps of size bigger than 75 mm in any direction. It shall have PH value, ranging from 6 to 8.5.

ii) Oil cake: (neem or Castor or as available locally) The cake shall be free from husk, dust, grit and any other foreign matter. Sludge: It shall be obtained from approved disposal work.

iii) Grass : grass shall be Mexican grass /Burmese grass type and shall be procured in rolled form from approved nursery.

iv) Foliage plant: Bagonia acutifolia, Cordyline terminails (fire brand), pileas or similar widely used foliage of the region duly approved by the site in charge.

v) Ground cover: Sanscieria trifasciata (snake plant), Helxine soleiroli (baby tears), Gynura, Setecreasea purpurea, Ficus elastacia (rubber plant), Monstera pertusa. In case of non availability of these plants similar ground cover plants available in the region shall be provided with the approval of Site in charge.

vi) Climbers: Philodendron scandens, ficus pumila or similar Climbers available in the region with the approval of site in charge.

vii) Flowering plants: Begonia, impatiens petersiana, Anthuruim, Scherezranium, Hibicus rosa sinensis, Chrysanthemum (Seasonal) or locally available flowering plants with the approval of Site in charge.

viii) Hedges: Ponsettia euphorbia, Coleus (herbaceous), dadonia, duranta, clerendendron, lantana camera, Acalypha. Or available hedges of the region with the approval of site in charge,

ix) Concrete interlocked pavers tiles 60mm thick of two matching colors, for narrow walk ways in the landscaped area and terracing work in the greeneries.

x) Trees: The yellow silk cotton tree, local name kadachogund, The barna local name Varno, the temple tree local name dholo champo and other trees suitable for region like Neem, Ashoka, etc

xi) Earthen Pots with grown up plants: Plants in earthen pots shall be of ornamental variety with color foliages, flowers etc.

Earthen pots shall be made of good earth duly baked and of regular size and shape and free from any crack and defects. Sizes of earthen pot shall be approximately 300 mm high x 300 mm top dia x 200 mm bottom dia. or similar type as available locally. 500 no of pots with grown up plants shall be considered for supply and landscape work.

xii) PVC pipe lines net work shall be of required diameter with approved pop up nozzles sprinklers system at various locations for irrigation of the landscaped areas.

xiii) Electrical fittings and fixtures shall be similar to PHILIPS outdoor luminaries type HCS 370 1xPL-L 18 including lamp 1xPL-L 18 W with all electrical wiring and connections as necessary. Spacing and no of illumination fixtures shall be sufficient to illuminate the landscape area.

3.00.00 LANDSCAPING WORK

3.01.00 Suitability of the soil of the site for landscaping work shall be verified prior to start of the work. For unsuitable soil the top bad soil shall be removed and filled with good earth suitable for plantation. PH value of soil shall be between 6-8.5. Top soil fill up shall be minimum 300 for grassing and minimum 600 for plantations.

Preparation of earth shall be made by trenching of soil. Trenching shall be done to the depth of 300 for grass and 600 for plantations. Trenching of soil shall be done to loosen the soil and turn over and buried the top layer containing weeds etc, in the base and to bring up the lower layers of earth to form a proper medium for plantation.

The trenched ground shall be flooded with water to enable to soil to settle down.

Weeds or other vegetation which will appear on the ground shall be up rooted and removed and disposed off. Trenching shall be done dividing the plot in narrow strips of about, 1.5m width or as directed by the site in charge. Sludge shall be spread evenly over the surface to the required thickness of not less than 75 mm and shall be flooded with water.

After 10 days and within 15 days of flooding the weeds which will appear shall be removed.

The site shall be given fine dressing.

Beds for hedges, shrubberies, plantation shall be generally prepared to width of 750mm to 1250mm and 5 to 6 metres length or as per approved landscape design. The beds shall be excavated to a depth of 600 mm and excavated soil shall be stacked on the sides of the bed. Excavated bed then shall be re excavated for another 300mm and shall be rough dressed. The top earth shall be mixed with manure in the proportion of 8:1 (8 parts earth & 1 part manure). The mixed earth shall be refilled in to the bed and watered profusely. The surface after full subsidence shall again refilled with remaining excavated earth and manure mixture, watered and allowed to settle and finally fine dressed to the level of 50mm below the adjoining ground level. Surplus earth if any shall be removed from site as directed by the site in charge.

Stone brick bats and other foreign matter if met during these activities shall be stacked and disposed off as directed by the site in charge.

Same procedure for preparation of soil shall be made for grass lawn. Grass shall be brought in rolled form from the nursery and spread over the prepared soil.

Earth mound with a small tree at the top of mound and seasonal flowering bed/ foliage bed around the tree may be one of the general features of landscaping.

The retaining wall at coal yard side shall be provided with 750 high IRC Mesh welded to 25 x25 mm hollow steel tube frame. Hollow steel tube post shall be provided @ 1500 c/c and embedded in concrete and shall be provided with anti corrosive paint. Climbing flowering creepers shall be provided from base of the retaining wall up to the top of the Fabric net over retaining wall. This is required to stop the air borne coal dust spreading over the landscaped area.

The embankment around the site shall be landscaped with foliage, seasonal flowering bed and grass. Both sides of the internal roads shall be provided with Hedges of 500 heights and colored flowering plants and dense foliage

bed behind.

Available Spaces around the power house entrance, Service & technical building, Canteen building, fire station building, store building ND Cooling tower area, triangular vista between roads, road dividers shall be landscaped delicately with proper bio aesthetic planning. The Landscaping shall link up building masses in a harmonious whole and enhance their Architectural appeal by presenting a foil of texture, color and form by way of contrast.

Spacing of plants, trees, foliage plants etc shall be as required as per the type and character of the plants and trees. Horticultural norms of the region shall be followed in general.

4.00.00 MAINTENANCE

Details of maintenance schedule shall be as follows:

i) Regular watering of the plants, saplings, trees, grass lawn, hedges and foliages.

ii) Regular weeding of plants to keep the landscaped area free from Weeds.

iii) Supplying manure to plants, trees, shrubs, grass lawn, hedge beds, etc as and when necessary.

iv) Regular lawn mowing.

v) Replacement of dead / ill trees, plants, shrubs, on ground and in pots.

vi) Regular trimming of plants and shrubs and hedges.

vii) Regular cleaning of tree basins and pots.

viii) Earth removal and refill of plants in ground as well as in pots.

ix) Removal of dried leaves and branches of trees and plants.

x) Spraying of insecticides, pesticides as and when required/advised.

5.00.00 ACCEPTANCE CRITERIA

i) Landscaped area shall be neat, and lush green with hue. Free from any debris, scattered earth, brick bats, and any unpleasant elements.

ii) All plants, trees and potted plants shall be well blossomed and shall give a fresh pleasing appearance.

iii) Entry to all important buildings shall be inviting with sprawling greeneries.

iv) Arrangement of plants, ground cover, plant foliage, flowering plants with flower shall give a harmonious blend of hue of colors and greeneries.

v) Drainage system of Large landscaped area shall be such that there shall not be any pocket with stagnant water. The slope of the surface shall be such to drain out all rain water to near by area drainage.

vi) Landscape design work shall be entrusted to a well experienced landscape designer with architectural back ground and registered with the Council of Architecture. Specialized agency experienced in the implementation of landscaping work shall be engaged for the work. .

6.00.00 I.S. CODE

Following are some of the important I.S. Code relevant to this section;

IS : 4919 Glossary of terms applicable to landscape and horticulture work.

GUJARAT STATE ELECTRICITY CORPORATION LTD.

1x800 MW SUPERCRITICAL THERMAL POWER PROJECT WANAKBORI, GUJARAT

TECHNICALSPECIFICATION
(SECTION D)

DOCUMENT NO. PE-TS-J57-600-C001
REVISION 00

Maharatna Company

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
PPEI BUILDING, POWER SECTOR,
PLOT NO. 25, SECTOR-16A,
NOIDA -201031

Project Title	1x800 MW WANAKBORI SUPERCRITICAL TPS
Job no.	J57
Document No.	PE-TS-J57-600-C001
Subject	SECTION A, B, C & D

Rev No.	Particulars	Prepared by	Checked by	Approved by	Remarks
	Name	KN	AB	AKS	
00	Sign	-sd-	-sd-	-sd-	
	Date	15/09/2014	16/09/2014	16/09/2014	

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GENERAL

Section C & Section D of this specification cover design, preparation of general arrangement drawings, construction and fabrication drawings, supply of materials and construction of all civil, structural and architectural works.

Section-C covers specific technical & functional requirements of contract and should be read in conjunction with BOQ, Section-D and other sections of the contract. In case of any conflict between the contents of BOQ and Section-C, BOQ will prevail over Section-C. In case of any conflict between Section-C and Section-D, Section-C will prevail over Section-D. Further contract document and clarifications given by BHEL to Bidder will prevail over Section C and D in case of any conflict. During the detailed engineering if there is some change in requirements, which is agreed by customer, consultant and BHEL, the same shall prevail over all.

SECTION D

STANDARD SPECIFICATION

SECTION - D
(PART I)

SUB-SECTION – D I

EARTHWORK IN EXCAVATION AND BACKFILLING

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	CODES AND STANDARDS
3.00.00	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA
5.00.00	RATES AND MEASUREMENTS
6.00.0	INFORMATION TO BE SUBMITTED BY THE BIDDER

STANDARD TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING

1.00.00 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

1.01.00 Work To Be Provided By The Contractor

The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision services including as required under statutory labour regulations, materials, scaffolding, equipments, tools and plants, transportation etc required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

1.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.00.00 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes

unless specified otherwise.

IS-1200	Method of measurement of building and civil engineering works, Part-I: Earthwork
IS-2720	Method of test for soils (Relevent parts)
IS-3764	Excavation work - Code of safety
IS-4081	Safety code for blasting and related drilling operations
IS-4701	Indian Standard Code of Practice for earthwork on Canals
IS:6922	Criteria for safety and design of structures subject to underground blasts

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.02.00 Materials

2.02.01 General

All materials required for the work shall be of the best commercial variety and approved by the engineer.

2.02.02 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, the following classification are to be followed.

a) Soil

It include all type of soil including laterite and moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under clause 2.02.02 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers

or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It include the rocks which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

2.02.03 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.03.00 Quality Control

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor

shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

3.00.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms and compaction etc within 15 days of award of the contract to the engineer for approval.

3.01.00 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

3.02.00 Clearing and Grubbing

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as

instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

3.03.00 Excavation for Foundations and Trenches

3.03.01 General

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. All excavation in open cuts shall be made true to the line, slopes and grades as shown on the drawings and/or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum

shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.03.02 Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades etc, the work shall be got checked and approved by the engineer. In cases where detoriation of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.03.03 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.03.04 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside

the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting.

The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

f) Restrictions in Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.

d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

3.03.05 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

a) By using it straightway for backfilling.

b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.

c) i) By either spreading
or
ii) By spreading and compacting at designated disposal areas.

d) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.03.06 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer. All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.03.07 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the

underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.03.08 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer's prior approval on the method of pumping to be adopted shall be taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.03.09 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

a) Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the collapse of

the pit or trench. It shall be started from one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

b) Open Timbering

In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

3.03.10 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.04.00 Backfilling

3.04.01 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

3.04.02 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material

during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.04.03 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.

3.04.04 Filling in Trenches for Water Pipes and Drains

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.04.05 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.05.00 Approaches and Fencing

The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as around the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.06.00 Lighting

Full scale area lighting is to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Excavation

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.02.00 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS:4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall

include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

e) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.02.00 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall

be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

6.00.00 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.01.00 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.02.00 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.

SECTION D
SUB-SECTION D II

CEMENT CONCRETE(PLAIN & REINFORCED)

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	INSTALLATION
4.00.00	SAMPLING AND TESTING
5.00.00	ACCEPTANCE CRITERIA
6.00.00	RATES AND MEASUREMENTS
7.00.00	LIST OF I.S.: CODES AND STANDARDS FOR REFERENCE

SUB-SECTION – D II

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 ACI:318 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Prepare working drawings of formworks, scaffolds, supports, etc.

d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.
e) Prepare detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and submit for approval concrete mix designs required to be adopted on the job.

h) Furnish samples and submit for approval results of tests of various properties of the following:

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of batching plant and equipments to be used for batching, transportation, compaction, ice handling, testing at site & laboratory.

c) Names of firms with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

i) Coarse and fine aggregates, cement (if supplied by contractor).

ii) Admixtures.

iii) Plywood for Formwork.

iv) Embedded and anchorage materials as may be desired by the Engineer.

v) Joint sealing strips and other*waterproofing materials.

vi) Joint filling compounds.

vii) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per specification giving proportions of the ingredients, sources of aggregates and cement, along with test results of trial mixes as per relevant I.S 10262 (latest), is to be submitted to the Engineer for his approval before it can be used on the works.

d) Bar Bending Schedules

Bar Sending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under

Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00 Conformity with Design

The Contractor will prepare checklists in approved Performa, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to

IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

a) TG foundation top deck and sub structures including raft.

b) Spring Supporting decks of all machine foundations.

c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.
For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will

be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

a) Accelerating admixture

b) Retarding admixture

c) Water reducing admixture

d) Air entraining admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTMC-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars above 10 mm dia. shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

a) Admixture: Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete.

For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.

b) Aggregate: Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.

c) Water: Impurities tests.

d) Cement: Tests to satisfy relevant IS Specifications.

e) Formwork: Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.

f) Reinforcement: Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.

Material tests or Certificates to satisfy relevant IS Specification.

g) Grades of Concrete: Usage and mix design, testing of all properties.

h) Batching & Mixing: Types and capacity of plant, concrete mixers and transportation equipment.

i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.

j) Embedded and Anchorage Items: Material, shape, location, setting.

k) Placing: Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.

l) Compaction: Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.

m) Setting of base &

Bearing plates: Lines, elevations, and bedding mortar.

n) Concrete Finishes:Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.

o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

"Design Mix Concrete" and "Nominal Mix Design" is defined as follows for use in this specification:

a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".

Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.

The mix design shall have required workability and characteristic strength as

per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS: 456. All other relevant clauses of IS: 456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.

b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.

c) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on:-

a) The requirement of strength.

b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

3.07.02 Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience

and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS: 1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as

follows unless otherwise directed by the Engineer

Very narrow space	- 12 mm
Reinforced concrete Except foundation	- 20 mm
Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm
Lean concrete	- 40 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles

80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.09.01 Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills):

The temperature of fresh concrete shall not exceed 25°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 25°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 25°C.

3.09.02 Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00 Mixing of Concrete

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or

loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in-spite of all precautions, segregations does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

Earth foundation

b) Rock foundation

Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer.

Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.

c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth shape.

c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

9) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out defective concrete.

i) Grouting with cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortars.

k) Polymer modified patching and adhesive repair& mortar for beams & columns.

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common

cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beans, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with

such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive 'Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. Welded mesh fabrics conforming to IS: 1566 may also be used if specified in the Drawings. Welding of cold twisted High yield strength deformed bar shall not be allowed.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by –volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by

the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its

acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be

allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

3.20.04 Inspection of Forms

Casting of' Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he

considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

For - a) Sectional dimension - ± 5 mm
b) Plumb - 1 in 1000 of height
c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in .the finished concrete surface & should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

a) **Ordinary:** These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.

c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer.

Items to be embedded

a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be left embedded for future extension, special connection etc.

d) Dowel bars, etc. for concrete work falling under the scope of other contractors.

e) Lugs or plugs for door and window frames occurring in concrete work.

f) Flashing and jointing in concrete work.

g) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer.

The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to SOA
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.

3.25.00 Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soffit

former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully, so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting. In case of walls, the above bonding agent will be mixed with water, which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two-component epoxy resin-bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days

Compressive strength - 55 to 60 N/Sq.mm

Flexural strength - 5 to 30 N/sq.mm

Tensile strength - 15 N/Sq.mm (approx.)

Bonding strength to concrete - 3 N/Sq.mm (approx.)

Bonding strength to steel - 20 N/Sq.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

Method 2: One row of threaded nozzles at regular intervals not exceeding l.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls

and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasiticizer will be preferable.

a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.

b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer’s satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Structural waterproofing

a) Nozzles spaced as required after the concrete is completed shall be drilled into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

b) External Treatment

Two layers of (1 : 4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.

ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m

minimum

iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,

v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250-micron polyethylene film as second layer similar to

vii) above.

viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.

ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the teat results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to IS: 456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.

5.04.00 Load Test

Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required strength.
If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall also include the cost of using curing compound, whenever used.

b) The unit rates shall include for all working conditions including in or under water, liquid, mud, in or under foul positions, under tides, and extreme weather conditions.

c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.

d) The unit rates shall include for maintaining stability of structure during execution.

e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.

f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity tests or other relevant tests to ascertain grade and quality, etc. of the concrete, if required. In case of any defects,

the Contractor shall rectify the same by cement/epoxy grout at his own cost.

g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.

h) The quoted rate shall include the cost of making additional trial mixes, using the super plasticizer and mixing in concrete etc.

6.01.02 Measurements

a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres.

b) No deductions shall be made for the following:

i) Opening upto 0.1 sq.m.

ii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.

iii) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.

c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.

d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 250C.

6.02.00 Reinforcement

6.02.01 Rates

a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.

b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if

required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc.

c) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).

d) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.

b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.

b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.

c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.

d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.

Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.

If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.\

6.03.02 Measurements

a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.

b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

c) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.
d) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.
e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

a) The unit rate for erection of embedded steel parts, supplied by Engineer shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.

b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.

c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts.

6.04.02 Measurements

a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.

b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.

c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.

d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.

e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.

f) The expansion fasteners shall be measured in number according to tension capacity.

g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:

a) Measurement shall be in cubic decimeters.

b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.

c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.

d) No deduction shall be made for shims, bolts, shear keys and such other embedments.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete

6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/ stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

6.07.02 Measurements

a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be on the same basis as that employed for construction work.

b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).

c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.

7.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard

Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

IS: 73 - Indian Standard Specification for Paving Bitumen

IS: 216 - Indian Standard Specification for Coal Tar Pitch

IS: 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete

IS: 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement

IS: 455 - Indian Standard Specification for Slag Cement

IS: 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete

IS: 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures

IS: 516 - Indian Standard Specification for Methods of Test for Strength of Concrete

IS: 702 - Indian Standard specification for industrial bitumen.

IS: 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete

IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing

IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement

IS: 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.

IS: 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felt

IS: 1786 - Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.

IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.

IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type.

IS: 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks

IS: 2210 - Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates

IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII

IS: 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

IS: 2505 - Indian Standard Specification for Concrete Vibrators, Immersion Type

IS: 2506 - Indian Standard Specification for Screed Board Concrete Vibrators

IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables

IS: 2571 - Code of practice for laying in-situ cement concrete floors.

IS: 2645 - Integral cement water proofing compound

IS: 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)

IS: 2750 - Indian Standard Specification for steel scaffoldings.

IS: 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction

IS: 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete

IS: 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry

IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.

IS: 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses

IS: 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids

IS: 3414 - Code of practice for design and installation of joints in buildings.

IS: 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry

IS: 3558 - Code of Practice for use of Immersion vibrators for Consolidating Concrete

IS: 3696 - Safety Code for Scaffolding and Ladders

IS: 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete

IS: 4014 - Code of practice for steel tubular scaffolding.

IS: 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement

IS: 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site

IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches

IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes

IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete

IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant

IS: 4926 - Indian Standard Specification for Ready Mixed Concrete

IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work

IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground

IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials

IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.

IS: 5256 - Code of practice for sealing joints in concrete lining on canals.

IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials

IS: 5513 - Indian Standard Specification for vacate Apparatus.

IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.

IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.

IS: 5624 - Indian Standard Specification for foundation bolts.

IS: 5751 - Indian Standard Specification for Precast Concrete Coping Blocks.

IS: 5816 - Indian Standard Specification for Method of Test for Splitting Tensile strength of Concrete Cylinders.

IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers.

IS: 5892 - Indian Standard Specification for transit mixer and agitators.

IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use

IS: 6909 - Indian Standard Specification for Super sulphated Cement

IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.

IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.

IS: 7242 - Indian Standard Specification for Concrete Spreaders.

IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.

IS: 7251 - Indian Standard Specification for Concrete Finishers.

IS: 7293 - Safety code for working with construction machinery.

IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.

IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.

IS: 7969 - Safety Code for Storage and Handling of Building Materials.

IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.

IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.

IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.

IS: 8989 - Safety Code for Erection of Concrete Framed Structures.

IS: 9012 - Recommended method for shortcreting.

IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.

IS: 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.

IS: 9103 - Indian Standard Specification for Admixtures for Concrete.

IS: 10262 - Recommended Guidelines for Concrete Mix Design.

IS: 13311 - Non-destructive testing of concrete.

SP: 34 - Handbook of concrete, reinforcement and detailing.

SECTION - D

SUB-SECTION – D3

CARPENTRY AND JOINERY

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODES
5.00.00	RATES AND MEASUREMENTS

CARPENTRY AND JOINERY

1.00.00 SCOPE

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, panelled, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION

2.00.01 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number or joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is

BWP grade phenol formaldehyde synthetic resin conforming to IS: 848. The thickness shall be as specified.

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close - fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc., which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M.S. grills or guard bars shall be provided to windows where called for in the drawings.

2.02.02 Finish

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.00.01 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

All doors and window shutters shall be of proper size, shape, and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Partitions, Paneling, Pelmets, Furniture, etc.

3.03.01 General

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 848	-	Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)
IS: 1003	-	Timber panelled and glazed shutters.
IS: 2191	-	Wooden flush door shutter (Cellular and hollow core type).
IS: 2202	-	Wooden flush door shutters (solid core type).
IS: 4021	-	Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall include of all activities mentioned in “Schedule of Item” for

completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges, holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00 Measurement

Measurement shall be done in Sqm for door shutters, window shutters, ventilators shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.

SECTION – D

SUB-SECTION – D4

ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA AND GUARANTEE
4.00.00	I.S. CODES AND STANDARDS
5.00.00	RATES AND MEASUREMENTS

ROOF AND UNDERGROUND WATER PROOFING, INSULATION AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION

2.01.00 GRADING UNDERBED

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Cement Concrete Underbed

The undebed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12 mm down stone chips and coarse sand. The aggregate shall be mixed dry and

minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expended Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor

shall secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two lavers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

3) Hessian base self finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Hessian base self-finished felt, type 3, grade I.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fiber base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Fiber base self-finished felt, type 2, grade 2.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Fiber base self-finished felt, type 2, grade 2.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fiber based felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Fiber-base self-finished felt type 2, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)

5) Fibre base self-finished felt type 2, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

7) Fibre base self-finished felt type 2, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

5) Hessian base self-finished felt, type 3, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

7) Hessian base self-finished felt, type 3, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02 Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTMC836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70^0C minimum, 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkalies and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.

b) Primer coat

It shall consists of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane are applied.

c) Finishing coats :

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish :

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

2.04.03 Waterproofing By Epoxy Resin Based Application

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at leas 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

a) 2 layers - for depths up to 5m below ground level

b) 3 layers - for depths beyond 5m below ground level

2.05.01 Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level

is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.

For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

i) Primer (For vertical faces only), as per I.S. 3384.

ii) Hot applied blown bitumen at the rate of 1.2 Kg/m2

iii) Hessian base, bitumen felt type 3 grades 2

iv) Hot applied blown bitumen @ 1.2 Kg/m2

v) Hessian base, bitumen felt type 3 grade 2

vi) Hot applied blown bitumen @ 1.2 Kg/m2

B) Extra Heavy treatment (Three layers of felt)

i) Primer (for vertical faces only) as per I.S. 3384

ii) Hot applied bitumen at the rate of 1.2 Kg/m2

iii) Hessian base bitumen felt type 3 grades 2

iv) Hot applied bitumen at the rate 1.2 Kg/m2

v) Hessian base bitumen felt type 3 grades 2

vi) Hot applied bitumen at the rate of 1.2 Kg/m2

vii) Hessian base bitumen felt type 3 grades 2

viii) Hot applied bitumen at the rate of 1.2 Kg/m2

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship for 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.

4.00.00 I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

a)	IS: 73	-	Paving Bitumen
b)	IS: 702	-	Industrial Bitumen
c)	IS: 1203	-	Methods of testing tar and bitumen
d)	IS: 1322	-	Bitumen felts for waterproofing and damp proofing.
e)	IS: 1346	-	Code of practice for waterproofing of roofs with bitumen felts.
f)	IS: 1609	-	Damp-proofing Treatment using Bitumen Felts – Code of Practice
g)	IS: 3067	-	Code of practice for General design details and preparatory work for Damp-proofing and water-proofing of buildings
h)	IS: 3384	-	Bitumen primer for use in waterproofing and damp proofing.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for complete work, including the cost of all materials and labour, as detailed in the specification unless any portion is specifically excluded in the "Schedule of Items".

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.

SECTION - D

SUB-SECTION – D5

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	INFORMATION TO BE SUBMITTED
5.00.00	I.S. CODES
6.00.00	RATES AND MEASUREMENTS

ATTACHMENT

ANNEXURE – A SCHEDULE OF FIXTURES

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

1.00.00 SCOPE

This section covers supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. The scope of work shall also include the assembly and erection of all doors, windows, louvers, glazed partitions, etc. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS:733 or IS:1285 or as manufactured by Indian Aluminium Company Limited or approved equivalent. Aluminium door, windows and ventilator shall be fabricated as per IS:1948 and IS:1949. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified and the best quality from approved manufacturers shall only be used. The tenderer shall specifically state the particular manufacturer's materials he proposes to use. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closures shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or shall be replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance Requirements and endurance test stated in IS: 3564 - Appendix-A. The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards end for incorporation in the job. The mastic for caulking shall be of best quality from a manufacturer approved by, the Engineer. In

general, mastic for fixing of metals frames shall be as per IS: 1081 or as approved by the Engineer.

2.02.00 Fabrication

2.02.01 Steel Doors, Windows, Ventilators, louvers etc.

a) Door Frames

Frames shall be fabricated from 16 gauge (G) sheets. They shall, be mortised, reinforced, drilled, and tapped for hinge lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered Corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be installed. Frames shall be brought to site with floor ties/weather bars installed in, place.

b) Double or Single Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of tw0 outer sheets of 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres including void filled with mineral wool (64kg/cum density).

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs of double doors shall have meeting-stile edges bevelled or rebated. Where shown in drawings, or called for in the schedule of items. The doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled, and tapped in shop for hinges, locks, and bolts. They shall also be reinforced for closers, push-plates, and other surface hardwares where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown in drawings, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 18G sheets.

c) Single or Double Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G (mild) steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi tubular edge and central stiffening rail, which shall convey the lock and other fixture. The frames shall be made from best quality, 16 G mild steel sheets.

Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

The manufacturing shall be done as specified in 2.02.01 (b) "Double Plate Flush Door Shutters."

d) Sliding Door

Sliding doors shall be either double plate or single plate Construction made out of 18 gauge steel sheets with adequate stiffeners. The contractor shall specify the weight of the door in his shop drawings and submit the manufacturer's catalogue of the sliding gear proposed to use. Where called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Door Threshold

Door threshold shall be provided. Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361, IS: 7452 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, and pivot arrangements for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specified. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) /hindalco /jindal unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.02.02 Aluminium Door, Windows, and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating and electro color coating of required shade as per IS 1868 (minimum anodized coating of grade AC15)of minimum 15 micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce an uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 Shop Coat or Paint

The shop Paint for steel doors, windows etc. shall be best lead or zinc chromate primer paint from, approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1½ - 2 oz. per sqft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame, which come in contact with masonry construction shall be (before shipment from workshop) protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before dispatch, to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Contractor shall satisfy himself that the items supplied are up to the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.

2.05.00 Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper "Lines and levels", and in approved workmanlike manner, to give trouble free and leak-proof installations. Installation shall be done according to instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take all precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation, without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the cement in original sealed containers of manufacturer and shall apply it as per the instruction. For all frames supplied by either the owner or the Contractor, mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metres from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

2.06.0 Fire proof Door

Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings whether from internal fire or from external fire. The construction details of door shall conform to the requirements stipulated in

IS:3614(Part-1). Doors shall comply with the testing requirement mentioned in IS:3614 (Part-2). The doors shall be approved by Tariff Advisory Committee(TAC) and shall have minimum 2 hrs. fire rating.

Metal covered (on both sides) Doors having insulating core filled up with mineral wool shall be used at all fire exit points and shall open out side.

All necessary accessories and hardware ,panic bars shall also be supplied along with doors. Fire proof door shall be provided with zinc silicate primer (minimum DFT 75 micron) after blast cleaning the surface to near white metal surface and shall be finished painted with epoxy based painting.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 For fabricated Items

a) Overall dimensions shall be within ±1.5 mm of the size shown on drawings.

b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ±1.5 mm from the axis of the member.

c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm for double leaf doors; the gap at the meeting stiles shall not be more than 1.5 mm.

d) Door leaves shall be undercut where shown on drawings.

e) Doors, windows, frames, etc. shall be on a true plane, free from warp or buckle.

f) All welds shall be dressed flush on exposed and contact surfaces.

g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures

h) Provision for hardware and fixtures to be installed at site.

i) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed aluminum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces shall present a uniform and pleasing look.

3.02.00 For installed Items

a) Installations shall be at correct location, elevation and in general, on a true vertical plane.

b) Fixing details shall be strictly as shown in drawings.

c) Assembly of composite units shall be strictly, as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.

d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.

e) All open able section shall operate smoothly without jamming.

f) Locks, fasteners etc. shall be engage positively. Key shall, be non-interchangeable.

g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

h) Aluminium doors, windows, etc. shall be free from scratches stain or discoloration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

a) Names of manufacturers for Doors, windows etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

b) He shall submit a programme of work to be done for the approval of the Engineer.

c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall by retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

d)

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733
Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow Section (for general engineering purpose)	-	IS: 1285
Steel doors, windows, and ventilators	-	IS: 1038
Steel windows for industrial, building	-	IS: 1361
Aluminium doors windows, and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.	-	IS: 1081
Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614
Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking

and jamming of frames, including cutting/drilling/welding, grouting, grinding, making good of the structure for installing the unit etc. complete as per "Schedule of Items".

Rates shall also include cost of surface preparation, application of primer, enamel painting or anodizing as applicable.

Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.

6.02.00 Measurement

Supply and installation of doors, windows, and ventilators shall be measured in Sqm in net outer to outer (excluding frame) area of doors, windows, and ventilators of each type used as described in "Schedule of Items". Frame for steel or aluminium shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminium partition shall be from net outer to outer area of frames i.e., frames are part of partition.

Measurement for fire proof door shall be in SqM in net area outer to outer of the door.

ANNEXURE-A

SCHEDULE OF FIXTURES

A. TIMBER DOORS

1. For single leaf panel/flush doors

   i) 100 mm brass butt hinges with screws - 3 Nos.

   ii) 150 mm brass tower bolts with screws - 1 No.

   iii) 100 mm x 225 mm clear plastic push Plate with counter sunk brass screws - 1 No.

   iv) 30 mm brass ring pull handle with Plates and screws - 1 No.

   v) 150 mm brass coat hook with screws - 1 No.

   vi) Heavy duty, cylinder looks on active leaf - for flush door. For door-closure, see "Door Schedule".

B. ALUMINIUM DOORS

1. For double leaf door

   i) Concealed hanging arrangement for door leaves.

   ii) Concealed two points bolt encasing simultaneously at head and threshold on inactive leaf, operable from inside.

   iii) Heavy duty, cylinder look on active leaf.

   iv) Pull handle of approved design on both leaves.

   v) Doors stoppers for both leaves.

   vi) Overhead hydraulic door closure for both leaves.
   vii) Floor mounted hydraulic door closer

ANNEXURE-A

C. STEEL DOORS AND WINDOWS

1. Doors

a) Double leaf doors

i) 100 mm butt hinges - 3 Nos. on each leaf.

ii) 300 mm aluminium tower bolt - 2 Nos. (top and bottom) On inside of inactive Leaf. 1. No. (Top only) On inside active leaf.

iii) 200 mm anodized aluminium Pull handle - 1 No. of each leaf.

iv) Door stopper of approved design - 1 No. of each leaf.

NOTE: For locks, door closure and threshold, see "Door Schedule".

b) Single leaf doors

i) 100 mm butt hinges - 3 Nos.

ii) 300 mm aluminium tower bolt - 2 Nos. top & bottom of Inside face

iii) 200mm anodised aluminium Pull handle - 1 No.

iv) Door stopper of approved design - 1 No.

NOTE: For locks, door closures and threshold, sec “Door Schedule".

2. Windows, Ventilators, etc.

a) Side Hung Windows

i) Hinges - As per standard Practice of the Manufacturer, but minimum two Hinges Per leaf.

ii) 12" peg stays - 1 No. per leaf

ANNEXURE-A

iii) 2 point handles - 1 No. per leaf

b) Top Hung Ventilators (Projecting Out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two Hinges Per leaf.

ii) Adjustable sliding fabrication Assembles - 2 Nos. per leaf.

iii) 2 point handles - 1 No. per leaf.

c) Bottom Hung Ventilators (Projecting in)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two Hinges Per leaf.

ii) Concealed side arms for Opening adjustment. - 2 Nos. per leaf.

iii) Spring Catch - 1 No. per leaf.

ANNEXURE-A

D. ALUMINIUM WINDOW, VENTILATORS, ETC.

(As per 1.S-1948 latest editions)

a) Side Hung Windows

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) 300 mm peg stays - 1 No per leaf

iii) 2 point handles - 1 No per leaf

b) Top Hung Ventilators (Projecting out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Adjustable sliding fabrication assembles - 2 Nos. per leaf

iii) 2 Point handles - 1 No. per leaf

c) Bottom Hung Ventilation&(Projecting In)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment - 2 Nos. per leaf

iii) Spring Catch - 1 No. per leaf

SECTION - D

SUB-SECTION – D6

GLASS AND GLAZING

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODES
5.00.00	RATES

GLASS AND GLAZING

1.00.00 SCOPE

This section covers supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as per specifications.

2.00.00 INSTALLATION

2.01.00 General

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, from approved manufacturer like Hindustan Pilkinton or equivalent, having uniform refractive index and free from flaws, specks, and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

a) Glare reducing or beat absorbing glass shall be "Calorex" of Hindustan Pilkinton or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

b) Clear glass shall be flat draw sheet glass and shall be at least 4 mm thick. Sheet glass for doors shall be minimum 5.5 mm thick.

c) Wired glass shall be thick- rolled glass with centrally embedded 42g wire mesh of Georgian type. This may be of clear or coloured glass, as required.

d) Obscure glasses shall have a cast surface in one side.

e) Coloured and figured glass shall be as per approved sample.

f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing.

g) Neoprene gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

h) Polycarbonate sheet multi (twin) wall fire retardant and ultra violet resistant with sealed open edges. as per IS: 14443.

i) Patterned, figured or rolled glass :-It is a decorative and translucent glass with figures or patterns on one face. In addition to diffusing light and obstructing

visibility from the outside, the figures soften the interior lighting. This type of glass is usually more fragile and less convenient to clean

j) Ground Glass :- Ground glass surface has been ground to produce a flat but rough (matte) finish. Glass surface has been ground or etched to create a roughened non transparent surface. this are similar as figured glass, obstructing visibility from the outside.

k) heat-reflecting type float glass:

A metallic coating is applied to one side of the glass in order to significantly increase the amount of reflection by the glass of both the visible and infra-red (light and heat) range of the electromagnetic spectrum. This metallic coating can be applied to clear or body tinted glass. The reflective glass imparts a mirror like appearance to the exterior of buildings under most daytime conditions. Due to the coating of metal oxides on the glass, they are widely applied in buildings for its highly reflective surface and its wide palette of colours. It reduces heat gain and glare from the exterior and allows optimum visible light transmission to the interior. An exceptional property of solar reflective glass is that the coating of metal oxides on the glass can be achieved without affecting the transparency of the glass.
Density : 2.4 – 2.5 g/cm3

l) Laminated glass:

Laminated glass is composed of two or more layers of glass with one or more layers of a transparent/ pigmented and specially treated plastic Polyvinyl Butyral [PVB] sandwiched between the glass layers. The glass panes (layers) can be either normal glass or tempered glass. When the glass is broken, fragments tend to adhere to the plastic [PVB] interlayer thereby reducing the risk of injury and helping to resist further damage by weather.
Laminated glass retains its colour and strength for the life of the building and is as easily cleaned as any conventional glass.
When exposed to heat, laminated glass breaks but stays in place longer. The risk of thermal breakage is avoided only when heat strengthened / tempered laminated glass is used.
Density (approximate) : 2.42 – 2.52 g/cm3
Tensile strength : 32 N/sq. M
Compressive strength : 1000 N /mm2
Modulus of elasticity : 70 GPa
Coefficient of linear expansion: 9 x 10–6 m / mK
U value : 2.84 W/sq. m. K for 3 mm thick clear to 5.96 W/sq. m. K for 6 mm thick clear
UV transmittance : 30% for bronze 6 mm thick to 80% for 6 mm thick clear.

Shading co-efficient : 0.5% for 6 mm thick gray to 0.9% for 6mm thick clear.

Visible light transmittance : 25% for 6mm thick bronze to 90% for 6mm thick clear
(product specific information to be referred)

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2.03.00 Glazing, Setting, and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glass pane, except for large panes were six or more clips shall be used as per engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by, the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where mouldings or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Where owner will supply glass, the Contractor shall cut it to size and fix them in the same as specified above.

The Contractor shall supply necessary glazing clips, putty, mastic cement etc.

After completion of glazing, the Contractor shall remove all dirt stains, excess putty etc. clean glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the contractor's own cost.

3.00.00 ACCEPTANCE CRITERIA

a) All installation shall be free from cracked, broken, or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked, or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak

proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00 I.S. CODES

Following are some of the important I.S.Codes relevant to this Section:

IS: 3548 - Code of practice for glazing in building.

IS: 1081 - Code of practice' for fixing and glazing metal doors, windows ventilators.
IS: 2553 PART-I- Code of practice for safety glass, toughened or laminated glass.
IS: 2835 – 1987-Code of practice for sheet glass, flat transparent sheet glass.
IS: 14443-Code of practice for polycarbonate sheet specification.
IS: 5437- Code of practice for figured rolled and wired gla

5.00.00 RATES

Rates of glass and glazing are included in respective items for supply and installation of window, ventilator, and partitions. No separate payment shall be made for glazing clips, mastic cement, putty, screws; rails, etc. nor for drilling holes in frames for inserting glazing clips.

SECTION - D

SUB-SECTION – D7

ROLLING STEEL SHUTTERS AND GRILLS

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA & GUARANTEE
4.00.00	I.S. CODES
5.00.00	RATES AND MEASUREMENTS

ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 SCOPE

This Section covers the design and supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 Components

a) Slats for rolling shutters shall be made from tested bright hot rolled double dipped galvanised steel lath section of 18 swg tested mild steel strips at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

b) Rolling grills shall be constructed out of 6mm rods at 35 mm on centers running horizontally flexible connected with vertical links spaced not more than 200 centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm dia rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor. Bottom lath shall be coupled to a lock plate fabricated from 3mm thick galvanized steel plate and securely riveted with stiffening angles.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.m.

f) Shafts shall be of steel pipe of sufficient size to carry the tensional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as prescribed by the Engineer.

i) Power unit shall be suitable for 3 phase, 50 cycles, 400-volt A.C. power supply and be either floor or wall mounted unit. The motor shall be of sufficient capacity, to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

j) Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.

2.02.00 Manually Operated Shutters/Grills (self coiling type or push pull down)

Self-coiling type rolling shutters shall be raised or lowered manually by means of a puffing hook applied to the pulling handles fixed on the bottom lock plate. The length of the pulling hook shall be adequate to push the bottom lock plate to the topmost position with ease. Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for opening up to 8 Sq. metres in area. It shall be used up to a maximum of about 8 m^2 clear area without ball bearings and up to a clear area of about 12 m^2 with ball bearings, as per IS 6248. Larger shutters shall, be either chain or gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer.

2.03.00 Mechanically or Gear Operated Shutters/Grills

It shall be fitted with ball bearings. It shall be used up to ‘a maximum of about 25 m^2 clear area, if the rolling shutter is operated by a bevel gear-box and crank handle and up to a maximum of about 35 m^2 clear area ,as per IS 6248.
All shutters shall be lockable from one or both sides as desired by the Engineer.Gear-operated type rolling shutters ordinarily employ a worm drive arrangement, the worm driving the worm wheel attached to one end of the roller. Worm drive is preferred in view of its irreversible nature, which provides a safeguard against any accidental downward descent of the curtain due to failure of the springs.

2.04.00 Power operated Shutters/Grills

Electrically operated rolling shutters shall be operated by an electric motor operating on 400/440 V, 3 phase, 50 cycles ac supply. The electric motor shall drive the worm shaft by chain or Vee-belt drive or through a reduction gear box. The reduction gear box shall have a control lever within easy reach from the floor so that the motor may be disengaged and the auxiliary chain gear operating mechanism may be engaged instantly in the event of power failure. The motor unit shall be so mounted that the motor may be completely removed without interfering with the operation of the rolling shutter or the auxiliary drive. The electric drive shall be so designed as to limit the speed of movement of the curtain in either direction to not more than about 10 cm/s

The controls provided for the electric motor shall include push

The controls provided for the electric motor shall include push button control through the medium of a 3-phase reversing starter with Interlocking contractors and overload protection. The reversing starter shall be wall-mounted and fitted adjacent to the shutter in a convenient position. A minimum of 3 phase buttons marked 'Forward ', 'Reverse & 'Stop ' or ' Up ', Down ', ' Stop ' shall be provided with a mechanical locking arrangement to prevent unauthorized or irregular operation of the push buttons. Limit switches shall be provided to cut off current to the motor when the rolling shutter reaches the limit of its travel in the' Up ' and ' Down ' directions.

Arrangement shall also be provided for emergency mechanical Operation of the rolling shutter in the event of failure of electricity or electrical equipment. The emergency mechanical operation shall be by an auxiliary chain wheel and hand chain drive on the worm shaft.

2.05.00 Shop Coat

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, shutters shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat and shop paint as per specification.

2.06.00 Erection

Shutters shall be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The shutters shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS: 6248 - Metal rolling shutters and rolling grills.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor.

5.02.00 Measurement

Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in “Schedule of Items”.

SECTION - D

SUB-SECTION – D8

MISCELLANEOUS METAL

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	IS CODES
5.00.00	RATES AND MEASUREMENTS

MISCELLANEOUS METAL

1.00.00 SCOPE

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION

2.01.00 Fabrication/casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundary shop.

2.01.02 Shop Connections

a) All shop connections shall be riveted or welded except when noted otherwise on drawings.

b) Welding of steel shall be done in accordance with IS: 816.

c) Welding of aluminium shall be done accordance with IS: 2812, “Arc welding of Aluminium and Alloys.” Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied be brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.

2.02.00 Erection

2.02.01 Bracing

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.

2.02.02 Temporary Bolting-Up

As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.02.03 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 Welding

Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.

2.02.05 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings, holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.

2.02.06 Drifting

Correction minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakens the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount of reaming and slight chipping and

cutting shall immediately be called to the attention of the Engineer-and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1:2 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. for masonry works and for concrete works. The expansion sleeves are different for masonry type anchor fastner and concrete type anchor fastener. Depending upon the safe tensile load capacity of each fastener, size of anchor fastener varies. The Contractor shall submit the Manufacture's literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturer's instructions and as approved by the Engineer.

Anchor fastener is considered as light duty for carrying safe tensile load up to 0.5MT per fastener and as heavy duty for carrying safe tensile load above 0.50MT per fastener.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

a) Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
b) Capacity of the anchor shall be established after considering the effect of concrete

grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.

c) The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.

d) The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as nut version are acceptable. The bolt version anchors consist of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.

e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, and expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING

2.03.01 Galvanised Chain Link Fencing

The material requirement shall conform to IS: 2721 latest edition. The galvanised chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm unless otherwise specified. The mesh wire shall not vary from specified dia. by more than $\pm$0.05mm. All steel wire shall be hot dipped galvanised wire. The dia shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. GI wire. The stirrup wire for securing the line wire to the intermediate post (RCC/structural steel)

shall be GI wire 2.5 mm diameter. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter GI wire. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of GI flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:
Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill 25mm below the chain link fencing to a depth of 150mm.

2.03.02 PVC coated Galvanised Chain Link Fencing

The PVC coated galvanized chain link fencing shall be woven from minimum 8 gauge PVC coated wire (including PVC coating) with mesh size of 75mmX75mm. The diameter of the hot dip galvanized steel wire for chain link fencing excluding PVC coating shall not be less than 12 gauge. The mesh wire shall not vary from specified dia. by more than +0.05mm. Other fixing details shall be as provided under sub head Galvanised **Chain Link Fencing** above.

2.03.03 Barbed Wire Fencing

The barbed wire shall be conform to IS: 278 latest edition. The barbed wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two line wires and two point wires. The barbs shall have four points and shall be formed by twisting two point wires, each two turns, tightly around both or one line wire (Type A - around both line wire, Type B - around one line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four evenly spaced row of line wire in all. The top line wire shall be doubled, making five line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less then 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

2.03.04 Concertina Fencing

Concertina shall be from high tensile serrated galvanized wire (HTSW) made with wire diameter of 2.5 mm which will be stretched to 6m and attached on two strands of galvanized HTSSW (high tensile spring steel wire) of 2.5mm dia by means of clips at 1m interval. These two HTSSW strands will be attached to the fence posts/ angles with 12mm security fasteners.

3.00.00 ACCEPTANCE CRITERIA

a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.

b) For installed items, the tolerances shall be as follows

   i) Permissible deviation from, straightness – 1 in 1000.

   ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.

c) All castings shall be free from blowholes, cracks, and other blemishes.

d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00 IS CODES

IS:278 Specification for Galvanised Steel Barbed wire for fencing.

IS:816 Code of practice for use of Metal Arc welding for general construction in mild steel.

IS:1367 Industrial Fasteners – Threaded steel fasteners - Technical supply condition.

IS:2721 Specification for Galvanised Steel Chain Link fence fabric.

IS:2812 Arc welding of Aluminum and Alloy

5.00.00 RATES AND MEASURMENTS

5.01.0 Rates

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items.

Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded in the schedule of items.

5.02.0 Measurements

Measurement for MS gates shall be in MT.

Measurement for fencing shall be in Sqm unless otherwise specified in schedule of item.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.

SECTION - D

SUB-SECTION – D9

MASONRY AND ALLIED WORKS

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	MATERIALS
3.00.00	INSTALLATION
4.00.00	I.S. CODES
5.00.00	RATES AND MEASUREMENTS

MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

Fly ash lime bricks shall be as per the requirements of IS:12894 and clay ash bricks shall be as per the requirements of IS: 13757.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky, or earthly appearance. Stone showing mottled colours shall not be

used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.

Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine

joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry

3.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified

otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean, and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.03.07 Exposed Stone work

Stonework, which is to be kept exposed, shall be as shown on approved drawing. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 Sq.M. area shall be built and approved by the Engineer and all works shall match with this sample.

3.03.08 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

3.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

3.03.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

3.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc., and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.05.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly overbumt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus

earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.

Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other paftem as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

4.00.00 I.S. CODES

Some of the important relevant codes for this section are:

IS: 1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Damp proof treatment using bitumen felts.

IS: 2212: Code of Practice for Brickwork.

IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.

IS: 12894: Pulverized Fuel Ash-Lime Bricks - Specification

IS: 13757: Specification for burnt clay fly ash building bricks

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

Unit rate for masonry work shall include the following:

a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.

b) Preparing top sand sides of existing wall for joining old with new work.

c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00 Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.

b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.

c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.

SECTION - D

SUB-SECTION – D10

FINISH TO MASONRY AND CONCRETE

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE
5.00.0	RATES AND MEASUREMENTS

FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.
For sand cement plaster, sand and cement in the specified proportion shall be mixed dry, on a watertight platform and minimum water added to achieve working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish
Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

2.02.04 Curing

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punting shall be applied by skilled workman and given a smooth and ever finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall. not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

SECTION - D

SUB-SECTION – D11

PAINTING, WHITEWASHING, POLISHING

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA AND TESTING
4.00.00	I.S. CODES AND STANDARDS
5.00.00	RATES AND MEASUREMENTS

PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 Installation

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer’s test certificate. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as snellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 litres of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and share conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacture. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic based weather coat paint

Providing and applying two or more coats of **Acrylic based weather coat paint** of approved brand and manufacture and required shade over one coat of primer after necessary cleaning/ washing, preparing the surface using coir brush/ wire brush, sand paper, including filling of cracks with putty wherever required etc. all complete to give smooth, hard, durable & glossy finish over a coat of primer over prepared plaster surface as per manufacturers guidelines. The final finished coating shall be fungus resistant, UV resistant, water repellent and extremely durable with colour fastness as per specification.

f) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

g) Acrylic Distemper

Two or more coats of **acrylic distemper o**f approved brand and manufacture to give an even shade including a priming coat with distemper primer complete.

h) Acid/Alkali Resistant Paint

Providing and applying 2 or more coats of **acid/alkali resistant paint** of approved brand and colour to floors, walls and ceiling including preparation of surface to receive paint, providing and applying bitumen primer confirming to IS 158 complete all as per manufacturer's recommendations and as approved by engineer, at all heights above or below grade level, complete as per specifications.

i) Fire Resistant Transparent Paint

Two or more coats of **fire resistant transparent paint** as per IS 162 on all woodwork over French polish as per IS 348 or flat oil paint as per IS 137 of approved grade and manufacture to give an even shade as per specifications.

j) Anti-Corrosive Bitumastic paint

Two or more coats of black **anti-corrosive bitumastic** painting of approved brand and manufacture to give an even shade complete.
Bitumen paint (black bituminous anti-corrosive paint)
Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

k) Resin Bonded Granular Textured

Providing and applying **resin bonded granular textured finish, for external applications** shall consist of crushed stone/quartz chips of .5 mm to 2.5 mm size and of approved natural colour/shade and bonded with synthetic resins, adhesives and additives altogether in a single pack mix, applied on cured and dried plaster surface with a dry film thickness of minimum 2 mm. The final finish shall have UV resistance, fungus, bacterial resistance properties all complete with grooves filled with poly

sulphide sealant of matching colour and shade as per specification/drawing/approval of engineer in charge.

l) Epoxy Paint

Providing and applying ready made **Epoxy Paint** over areas other than steel structure with suitable pigments of approved shade as per specification and direction of Engineer. The epoxy paint shall be a two pack material and shall be resistant to water, splash, spillage & acidic environment. The epoxy paint coating shall be of 150micron thickness over epoxy primer.

m) Synthetic plaster for external applications

Providing and applying **Synthetic plaster for external applications** composed of synthetic fibre and petroleum based chemical similar to RENOVO or equivalent and of approved natural color/shade applied on cured and dried plaster surface. The final finish Paint shall have UV resistance, fungus, bacterial resistance properties all complete with grooves filled with poly sulphide sealant of matching color and shade as per specification/drawing/approval of engineer in charge.

n) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

o) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

p) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

q) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat

on wood after the woods pretreated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

2.00.02 Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00 Preparation of surface

Before starting the work the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.

2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477(Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.

2.02.00 Application

2.02.01 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered

property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conform to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint

Shall be applied on properly primered surface. Subsequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white

the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted .The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.

Testing

a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.

b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.

c) Material/workmanship unsuitable for acceptance shall he removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348	Specification for French polish
IS: 427	Specification for Distemper, dry colour as required.
IS: 428	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	Code of Practice for painting of ferrous metal in buildings.
IS: 2338 (I & II)	Code of Practice for finishing of wood and wood based materials.
IS: 2339	Specification for Aluminium, Paints for general purposes in dual containers.
IS: 2395	Code of Practice for painting concrete, masonry, and Plaster surface.
IS: 2932	Specification for enamel, exterior type-1.
IS: 5410	Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rates for complete items described in the “Schedule of Items”.

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these

openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. unless specified otherwise.

SECTION - D

SUB-SECTION – D12

FLOOR FINISH AND ALLIED WORKS

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODES
5.00.00	RATES AND MEASUREMENTS

FLOOR FINISH AND ALLIED WORKS

1.00.0 SCOPE

This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below

a) In Situ Finishes

i) Integral finish to concrete base

ii) Terrazzo finish

iii) Granolithic finishes

iv) Patent Stone

v) Metallic Hardener like “Ironte”/Hardonate Finish

vi) Mastic Asphalt finishes

vii) Chemical Resistant finish

b) Tiled Finishes

i) Terrazzo tile

ii) Chequered tile

iii) Glazed tile

iv) Vitrified Tiles Finish

v) Tesserae (Mosaic etc.)

vi) Chemical Resistant

vii) Rubber, Vinyl etc.

viii) Stone Slab including Kota Stone.

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.01.01 Sequence

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered elsewhere under the Specification. In general, all such materials shall be as per relevant Codes where available. In all cases these materials shall be of the best quality available indigenously unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialized manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirts, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.
The surface shall be bone dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish To Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still `green' thick slurry, made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per SqM. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 Terrazzo Finish in Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the 'finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the under bed may very in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to acc ate the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 parts cement, 1½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from White marble and shall be finer than IS Seive No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M. long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbeds plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat “green” but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled f or horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the

underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polish

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. A suitable machine shall do the grinding. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried, and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.

2.01.03 Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1 part cement: 1 part coarse sand 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface ' of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then the lightly trowelled to remove all, marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

e) Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

g) Finishing

Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.04 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1 part cement and 2 part stone aggregate 6mm nominal size by volume.

c) Laying

The Patent Stone finish including the underbed shall be laid in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.05 Metallic Hardener Like 'Ironite'/ `Hardonate' Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is `green'.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials when desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification 'Cement Concrete' and levelled upto required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brash as soon as possible.

The finish shall be laid while the concrete underbed is still very `green' within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigoursly and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing.

b) Materials

Bitumen shall be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly, and incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.07 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles: Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness ± 3 mm. Face of the tile shall be plane, free from pinholes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (b).

The tile shall be cured at the shop for at last 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix: Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.01.02(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02 Chequered Tile Finish

The finish shall consist of manufactured gray or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01 (a).

b) Tiles: Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm. c/c. Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain gray cement or colour pigment added to cement.

c) Under-bed
As per clause 2.02.01 (c).

d) Laying
As per clause 2.02.01 (d).

e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an under bed laid over a concrete or masonry base.

a) Thickness

The total thickness shall be between 20mm and 25mm including the underbed.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) Tiles: Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) Mix: Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

d) Laying
Same as clause 2.02.01 (d).

e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.03 Vitrified Tiles Finish

Vitrified tile is a tile which has been processed in such a way that it has extremely low porosity (and water absorption) which make it stain resistant and very strong. Vitrified tiles have a water absorption of < 0.5%.thickness of tile as per manufacturer specification. This may be glazed or unglazed. Vitrified tiles are made by mixing silica and clay to form a non porous tile with glassy texture.

Vitrified tiles are resistant to chemicals, abrasion, fire & staining, acid resistance easy to maintain and ensures hygienic surroundings. Vitrified tiles have strength greater than 300Kg/square cm. Size : 600 MM X 600 MM.

a) Mix: Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

b) Laying
Same as clause 2.02.01 (d).

d) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04 Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) Thickness

The total thickness including the underbed shall be between 16 mm & 25 mm.

b) Tesserae Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass, or similar hard wearing, strong, and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) Mix: Underbed
Same as clause 2.02.03 (c)

d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be made with white cement to fix the panels. The paper-mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.05 Chemical Resistant Tiled Finish

This shall include all verities of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm^2. The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed these tiles shall be durable, strong and chemical resistant epoxy mortar. The grout, which shall be to the full depth of tile, shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be as incorporated in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trademark, the thickness, sizes, batch number, and date of manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty:1 part cement: 3 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried, and polished

with an approved type of polish just before handing over.

2.02.07 Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.

b) Stone Slab

The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix: Underbed
Same as clause 2.02.01 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form a inverted 'Y'.

3.00.00 ACCEPTANCE CRITERIA

The finish shall be checked specially for:

a) Level, Slope, Plumb as the case may be

b) Pattern and Symmetry

c) Alignment of joints, dividing strip etc.

d) Colour, texture

e) Surface finish

f) Thickness of joints

g) Details at edges, junctions etc.

h) Performance

i) Precautions specified for durability

4.00.00 I.S. CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 777 : Glazed earthenware tiles

IS: 1196 : Code of practice for laying bitumen mastic flooring.

IS: 1197 : Code of practice for laying of rubber floors

IS: 1237 : Cement concrete flooring tiles

IS: 1443 : Code of practice for laying and finishing of cement concrete flooring tiles.

IS: 2114 : Code of practice for laying in situ terrazzo floor.

IS: 3461 : PVC asbestos floor tiles

IS: 4860 : Specification for acid resistant bricks

IS: 5518 : Code of practice for laying of flexible PVC Sheet and tile flooring.

IS: 5491 : Code of practice for laying in situ granolithic floor topping.

IS: 13712 : Code of practice for ceramic tile.

IS: 4457 : Code of Practice Unglazed Vitreous Acid Resisting Tile.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for the complete work (including dividing strips, ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc.

Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.

5.02.00 Measurement

The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.

SECTION - D

SUB-SECTION – D13

SHEET WORK IN ROOF AND SIDING

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODES
5.00.00	RATES AND MEASUREMENTS

SHEET WORK IN ROOF AND SIDING

1.00.00 SCOPE

This section covers supply, cutting & fabrication and erection of corrugated/plain asbestos, corrugated galvanized iron, aluminum, permanently colour coated troughed zinc-aluminium alloy coated M.S. sheet or other sheet for covering to roof and sides at various elevations as specified.

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a watertight finish to the satisfaction of the Engineer. Fixing of gutters and down pipes shall be according to IS: 2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as specified shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification. Hook bolts or J-bolts shall be 8 mm dia. at 305 mm centres. Six (6) mm dia. galvanized iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stiching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used, the end laps shall be minimum 100 mm. Holes in C.G.I. sheets shall preferably be made on the ground. The sheets should be placed on purlins/trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum spacing of the bolts shall be 305 mm. The length of the hook or J-bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanized iron seam bolts and G.I. flat washers and bituminous washers.

2.02.03 Fibre Glass Reinforced Plastic Sheeting

This shall be of thickness and profile as specified. Colour and light transmittance shall be as mentioned. Where used in conjunction with C.G.I. or asbestos sheeting, the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.

2.02.04 PERMANENT COLOUR COATED SANDWICHED INSULATED METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 275 gm/sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF_2) of Dry Film Thickness (DFT) 20 microns (minimum) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

ii. Troughed zinc-aluminium alloy coated (both sides) M.S. sheets of minimum 0.6mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (minimum) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The weight of coating shall not be less than 275 gm/sqm.

iii. The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.

iv. Inner sheet shall be fixed directly to side runners and Z spacers made out of at least 2 mm thick galvanized steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50M centre to centre to hold the insulation and external sheeting. The fasteners shall be of high quality corrosion resistant grade of self tapping / self drilling type provided with suitable cap.

v. The insulation shall be of bonded mineral wool of minimum thickness 50mm conforming to IS:8183, having a density of 32 Kg/cu.m. for glass wool & 48 Kg/cu.m. for rock wool.

2.02.05 PERMANENT COLOUR COATED (NON-INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated not less than 275 gm/sq.m M.S. sheets having 0.6 mm minimum thickness (or High tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF_2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.

ii. **FLASHING, CAPS, TRIM CLOSURES ETC.**

All flashings, trim closures caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 3007 : Code of practice for laying of asbestos cement sheets.

IS: 2527 : Code of practice for fixing rainwater gutters and down

pipes for roof drainage.

IS: 1626 : Specification for asbestos cement building pipes, gutters and fittings.

IS: 277 : Specification for galvanized steel sheets (plain and corrugated).

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rate for complete item described in "Schedule of Items" and shall include all wastage.

5.02.00 Measurement

Sheeting work in roof & sides shall be measured in Sq.M. for net area of the work done. Profiled sheeting shall be measured flat and not girthed. Opening less than 0.40 Sqm shall not be deducted. No extra shall be paid for extra labour in cutting and for wastage etc. No payment shall be made for laps in sheeting works.

SECTION - D

SUB-SECTION – D14

SUSPENDED CEILING

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	SAMPLES
4.00.00	SHOP DRAWINGS
5.00.00	ACCEPTANCE CRITERIA
6.00.00	RATES AND MEASUREMENTS

SUSPENDED CEILING

1.00.00 SCOPE

This section covers supply and installation of suspended ceiling together with the suspension system as shown on drawing or specified in schedule of item with all materials, labour and equipments. The work shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers etc. as shown on drawings or as instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural works, slabs and beams.

All members of the suspension system shall be of sufficient strength and rigidity to carry, the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angles. Angle moulds where shown on drawings shall be securely fixed to walls. All drillings of structural concrete and installation of suitable anchoring device for installation including welding of the suspension system shall be included in the rate. All M.S. sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be “Bead lock” as manufactured by W A Beard shell and Co. Pvt. Ltd. or Ajit India Limited or approved equal. Steel grid ceiling system shall be 'Jolly Snap Grid' as manufactured by Jolly Board Limited or approved equal.

Steel tees as intermediate members and steel channels, as end pieces will be assembled in the form of grid. Size of tees and channels shall be as required.

The cross-tees shall intersect main tee runners in pattern shown on drawing and positively locked together with intersection members. All perimeter areas shall have tee runners fixed to vertical wall surfaces and end channels shall be fixed to runners leaving return air space between vertical wall and channels, unless otherwise shown on drawings. Angle cleats or other suitable fixing device shall be fixed to the structural

beams above for fixing of hangers. Main runners shall be hung by M.S. flats, angles, rods or 12G or heavier galvanized tie wire hangers at maximum 1.2 metre centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings(as per shop drawings).Turnbuckles shall be provided in M.S. rods for adjustment in levels.

2.02.00 Ceiling Panels

2.02.01 Material

Ceiling panels shall be best quality material in thickness and properties called for in the "Schedule of items". The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of following type:

a) Plaster of Paris ceiling (decorative).

b) Gypsum board plain and perforated false ceiling (decorative)

c) Expanded polystyrene insulation board with plastic fascia.

d) Mineral fibre tile false ceiling.

e) Bonded wooden particle board (Plain and decorative)

f) Glass fibre reinforced gypsum plaster board ceiling(GRG)

g) Flat asbestos sheets (with plastic fascia).

2.02.02 Installation of Ceiling Panels

Installation of Ceiling panels shall be strictly as per manufacturer's instruction.

For concealed grid system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.02.03 Aluminium Lineal Ceiling System

Aluminium lineal ceiling (permanently colour coated) system shall be "Luxalon 84C " or approved equal and the installation shall be strictly as per manufacturer's instruction/ specification subject to approval of the Engineer.
Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick corrosion resistant aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 'J' hooks and nylon inserts. 50 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation (density48 kg/cum) conforming to is 8183 bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

2.02.04 Providing, fixing and laying **permanently colour coated aluminium false ceiling** of approved colour with stove enamel finish of approved make in LINEAR and SQUARE type with corrosion resistance aluminium alloys panels of minimum thickness 0.5mm including 50mm thick mineral wool insulation (as per IS:8183) bound in polythene bags on top of panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures. A.C. ducts etc. suitable M.S. channel (minimum MC 75) grid 1200 c/c maximum shall also be provided above the false ceiling level for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.The work to be complete as per specifications, drawings and direction of engineer.

2.02.05 Providing, fixing and laying a**nodised** natural colour matt finished **aluminium false ceiling** of Jindal/Hindalco make with corrosion resistance aluminium alloys panels of minimum thickness 0.5mm including 50mm thick mineral wool (density 48kg/cum insulation (as per IS:8183) bound in polythene bags on top of panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures. A.C. ducts etc. suitable M.S. channel (minimum MC 75) grid shall also be provided above the false ceiling level for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.The work to be complete as per specifications, drawings and direction of engineer.(Materials for structural platform grid for movement made up of MS Channels/ Beams / Angles shall be supplied by BHEL and shall be paid under ST No 2301).

2.02.06 Providing and Fixing **12mm thick Gypsum board plain/perforated false ceiling tiles (600x600mm)** of India Gypsum or equivalent make in plan or elevation with aluminum grid, metal suspension system, anchor fastener adjustable hangers etc. including two or more coats of acrylic emulsion paint of approved colour to give an even shade with smooth finish all complete as per architectural design and detail. metal

suspension system as per ASTM C-635 shall be hot dipped M.S.galvanized (grade 180 as per is :277) nominal size of T-section shall be 24 x 38 mm or 24 x 25 mm cross runners. 24mm wide exposed flange surface shall be permanently color coated. suspension system shall be as per manufacturer's specification supported over movement platform. The work to be complete as per specifications, drawings and direction of engineer.(Materials for structural platform grid for movement made up of MS Channels/ Beams / Angles shall be supplied by BHEL and shall be paid under ST No 2301)

2.02.07 Providing, fixing and laying light weight **mineral fiber tile false ceiling** of minimum thickness 15 mm and exposed surface semi-perforated with depth of perforation as 4 mm and humid resistance of 95% RH and fire performance of class 0/1 as per BS 476 with metal suspension grid system with galvanized Tees of section 24 X 38 mm for main runners of approved color and make as per specification including 50mm thick mineral wool insulation (density48kg/cum) as per IS:8183 bound in polythene bags on top of panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures. A.C. ducts etc. suitable M.S. channel (minimum MC 75 @ 1.2m) grid shall also be provided above the false ceiling level for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc. complete with cut-outs etc.The size of tiles shall be 600 X 600 mm or
600 X 1200 mm. Required MS channel shall be measured & paid extra under respective item unit rate.

2.02.08 Providing and fixing **glass fiber reinforced gypsum plaster board (GRG) ceiling** (having gypsum core mixed with glass fiber) system consisting of metal supporting grid system forming panels of specified size, suspended from RCC slab/structural steel or catwalk way grid above with 4 mm (minimum) galvanized wires (rods) with special height adjustment clips, including preparation of working drawing, providing openings for AC ducts, return air grills, light fixtures etc (but excluding the cost of catwalk way grid) all complete as per drawings, specification and instructions of the engineer.

3.00.00 SAMPLES

Samples of Ceiling panels and metal suspension system components as noted below shall be submitted for Engineer's approval:

Panels : 3 samples approximately 300 mm square/long each

Suspension System : 3 samples of short length : each of main and secondary system

4.00.00 SHOP DRAWINGS

Shop drawings shall be submitted for approval as required and approval shall be obtained prior to delivery of suspended ceiling components. Shop drawings shall be co-coordinated with all related work and shall show the following information:

a) A reflected ceiling plan of areas indicated to receive the ceiling showing electrical and mechanical features.

b) Typical Intermediate framing for support where required.

c) Hanger fastening details.

d) Panels - unit support at ceiling penetrations.

e) Details of splicing method for main and cross runners.

f) A table indicating load bearing capacity of main and cross runner

g) A note stating that the suspension system member furnished will not deflect more than 1/360 of the span under the indicated loading.

5.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from, sags, warps, disfigured, or damaged board. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be for the complete item called for in the “Schedule of Items”. No extra payment will be made for alignment and adjustment of lighting fixtures, air-conditioning diffusers, access panels etc. The rate shall include all cutting and wastage from standard size sheets, runners/carries etc.

6.02.00 Measurement

Actual area of work shall be measured in Sqm correct to second place of decimal. However, no deduction will be made for opening upto 0.25 Sqm. each in area.

SECTION - D

SUB-SECTION – D15 (PART – I)

WATER SUPPLY

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3.0.0	TESTING AND ACCEPTANCE
4.0.0	I.S. CODES

STANDARD TECHNICAL SPECIFICATION FOR WATER SUPPLY

1.0.0 SCOPE

This section includes supply of all materials, labour and incidentals for water supply for residential, business and industrial and other types of buildings. The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

1.0.1 Materials

All materials, fittings, fixtures and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence order are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

1.0.2 Pipes and Pipe Fittings

Under scope of this specification, pipes and pipe fittings may be any or a combination of the following types :

a) Cast Iron

b) Steel : lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanised.

c) Reinforced Concrete

d) Prestressed Concrete

e) Lead (Not to be used for potable water)

f) P. V. C.

g) Copper

h) Brass

i) Wrought iron

j) G.I

1.0.3 **Water Reservoirs**

Water reservoirs like pressed steel tanks and G.I. tanks shall come under scope of this specification. Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

1.0.4 **Related Works**

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply systems shall come under scope of the Contractor unless specifically excluded.

1.0.5 **Regulation**

The work which is required to be carried out under the scope of this section, shall be executed by a licensed plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc. from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

2.0.0 **INSTALLATION**

While basic layouts may be available in the drawings provided by the Owner, the details might have to be supplemented by the Contractor for approval of the Engineer.

Special attention shall be given by the Contractor to economy. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

2.1.0 **Pipe Lines**

2.1.1 **Laying**

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacings as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer.

2.1.2 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely water-tight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

2.1.3 Contamination

There shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

2.1.4 Underground Pipings

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.

The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.

The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

2.1.5 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, conduits as necessary.

However, the Contractor will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

2.1.6 **Jointing of Pipes**

Jointing of pipes shall be completely leakproof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, usually recommended practices are stated below for guidance :

a) **Cast Iron**

i) **Spigot and Socket Joints**

Lead joint : The joint is made by first caulking in clean spun yarn upto half depth and filling the reminder by running in molten lead taking care that no dross enters the joint and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket. After completing the joint it shall not be allowed to move. For rectification the joint shall be completely redone.

ii) **Flanged Joints :** Flanged joints shall be made by jointing rings of good quality, smooth and hard compressed fibre board of thickness not less than 1.5 mm and of such width as to fit inside the circle of bolt. Diagonally opposite bolts shall be tightened in pairs and in stages so that degree of all bolts in a joint are similar. Damaged gaskets shall be replaced.

b) **Steel**

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove any burr from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

c) **GI Pipes**

Threads shall be cut with sharp tools, and before jointing all scales shall be removed from pipes by suitable means. The screw / threads of the pipe shall be cleaned out and the joint made by screwing the fittings after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

d) **Lead**

Lead and lead alloy pipes shall be jointed with wiped solder joints.

e) **Concrete**

Concrete pipes may be socket and spigot ended collar or band jointed. Joints shall be effected by caulking with 1:3 cement sand mortar.

f) **P. V. C.**

Manufacturer's instruction shall be followed. For heating approved equipment with adequate control shall be used.

g) **Tyton Joint**

The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the joint fully.

2.1.7 **Painting**

Where mentioned in the Schedule, underground steel and cast iron pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I. pipes shall be given a coat of zinc chromate primer, C.I. and M.S. pipes shall be given one coat of red lead or zinc chromate primer. Top coats shall be minimum 2 coats of best quality paint.

2.2.0 **Storage Tank - Pressed Steel Tank**

Unless otherwise mentioned, water storage tanks shall be pressed steel tanks of nominal size and capacity as mentioned in the Schedule and fabricated with all flanges external, all flanges internal, or bottom flange internal and side flanges external, as shown on drawings or schedule of items. The fabricator shall supply 6 prints of fabrication drawings to the Engineer for prior approval showing thickness of plates, method of jointing the plates, all supports, stays, gussets etc. Pads, cleats etc. required for supporting the tanks shall be supplied by the manufacturer. Inlet, overflow vent pipes, manholes etc. shall be arranged and provided as shown on drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50 mm above the bottom of the tank and there shall be a 150 mm free board at the top of the tank.

All tanks shall be supplied with mosquito-proof covered top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 Metre shall be provided with m.s. internal access ladder adjacent to the manhole. Water level indicator shall be provided if asked for. Two coats of anti-corrosive paint over a suitable primer shall be applied to both internal and external surface of tanks. Such paint if used shall not impart any taste or odour to water and be of lead free composition..

Erection of tanks shall be in accordance with detailed drawings and manufacturer's instructions. The two finishing coats of paint shall be applied to outside after erecting is complete.

2.2.1 G. I. Water Tank

G. I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanised iron water storage tank shall be made of minimum 2 mm thick galvanised iron sheet. Plain sheets shall be fixed at the corner to angle iron frames by means 6 mm rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised / iron stay rods, one fixed to angle framing at top and two in the body of the tank for extra strength. Holes for rivetting shall be drilled and not punched. White lead shall be applied to the joints before rivetting.

In case it is desired by the Engineer that corners of tank should be welded instead of rivetted then the sheets shall be welded to form a tank will not have angle iron frame.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on Drawing and 25 mm dia. G.I. overflow pipe. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

2.2.2 PVC Water Tank

PVC water shall be of Syntex or approved reputed manufacturer.

Tanks shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on Drawing and 25 mm dia. G.I. overflow pipe or as shown on Drawing. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve permits the entry of water when the tank is empty and disconnects the supply when the tank is full. It consists of a hollow floating ball made of copper, plastic or hand Tubber, 110 mm in diameter, attached to an arm which is so pivoted that the end near the pivot closes the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution pipes. The ball valve shall be fixed to the tank independent of the inlet pipe and set in such a position that the body of the ball valve cannot submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water line. The level of the water

in the tank to 75 mm below the lip of the overflow pipe. Free surface shall be about 150 mm above the maximum water filled level.

2.3.0 Valve, Cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian Standard Specification and shall be of best quality from approved manufacturers. These shall be suitable for working pressures mentioned in the Schedule. Nominal size and material shall be as per schedule.

2.4.0 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets or spigot are not damaged and no foreign material can find its way into the pipe line.

Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.0.0 TESTING AND ACCEPTANCE

3.1.0 Inspection Before Installation

All pipes, fittings and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

3.2.0 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/CM^2 or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

3.3.0 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working

conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely water-tight. All pipings, fittings and appliances shall be checked for satisfactory support and protection from damage, corrosion and frost.

4.0.0 I.S. CODES

Important relevant IS Codes for this Specification are listed below :
Latest editions shall always be consulted.

IS:2065	:	Code for Practice for water supply in buildings
IS:1172	:	Code of basic requirements for water supply, drainage and sanitation
IS:1200 (Pt. XVI)	:	Laying of water and sewer lines including appcurtnant items.
IS:1239 (Pt. I & II)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter)
IS:1536	:	Specification for Centrifugally cast (Spun) iron pressure pipes for water gas and sewage
IS:1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS:3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 nominal diameter)
IS:3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter)
IS:784	:	Prestressed concrete pipes
IS:458	:	Concrete pipes (with or without reinforcement)
IS:783	:	Code of Practice for laying of concrete pipes
IS:1592	:	Asbestos cement pressure pipes
IS:1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types)
IS:404	:	Lead pipes
IS:3076	:	Low density polyethylene pipes for potable water supplies
IS:4984	:	High density polyethylene pipes for potable water supplies
IS:2501	:	Copper tubes for general engineering purposes

IS:407 : Brass tubes for general purposes

IS:1230 : Cast iron rain water pipes and fittings

IS:804 : Rectangular pressed steel tanks

SECTION - D

SUB-SECTION – D15

DRAINAGE AND SANITATION

TABLE OF CONTENT

CLAUSE NO.	DESCRIPTION
1.0.0	SCOPE
2.0.0	INSTALLATION
3.0.0	TESTING AND ACCEPTANCE
4.0.0	CODES AND STANDARDS

STANDARD TECHNICAL SPECIFICATION FOR DRAINAGE AND SANITATION

1.0.0 SCOPE

1.1.0 This section covers the layout and construction of drains for roof water, surface water and sewage together with all fittings and fixtures and inclusive of ancillary works, such as connections, manholes and inspection chambers used within the building and from the building to the connection to a public sewer or to treatment work, septic tank and soak pit dispersion trenches.

2.0.0 INSTALLATION

2.0.1 General

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipe lines, fittings and fixtures shall be installed leakproof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

2.1.0 Rainwater Downcomers

Rainwater downcomers shall be standard Cast Iron Pipes. In case where specifically desired, M.S, UPVC, GI and HDPE pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater downcomers shall run along and be secured to walls, columns etc. where desired by the Engineer these may have to be installed in chases cut in the structure.

All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

2.2.0 Gutters

The gutters shall be made of G.I. All gutters shall be supplied by reputable specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

2.3.0 Soil and Drainage Pipes

2.3.1 Gradients

If not specified the minimum gradients of soil and drainage pipe line shall be as follows :

100 mm nominal dia : 1 in 35
150 mm nominal dia : 1 in 65
230 mm nominal dia : 1 in 120
300 mm nominal dia : 1 in 200

2.3.2 Relation with water supply pipe lines

Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

2.3.3 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

2.3.4 Support and Protection on Pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows :

a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

2.3.5 Entry into structures

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

2.3.6 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

2.3.7 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

2.3.8 Manhole and Inspection Chambers

The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. In addition, at every change of alignment gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise.

Manhole shall be constructed so as to be watertight under test. The bending at the sides shall be carried out in such a manner as to provide no lodgement for any splashings in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Manholes shall be provided with standard C.I. covers. The covers shall be close fittings so as to prevent gases from coming out. Suitable heavy duty covers shall be used where necessary as decided by the Engineer.

2.3.9 **Cutting of Pipes**

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

2.3.10 **Jointing**

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water-tight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) **Cast Iron Pipes**

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centered in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leakproof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) **Concrete Pipes**

Care shall be taken to place the collar centrally over the joint.

2.4.0 **Trenches and other excavations**

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during handpacking with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

2.5.0 **Fixtures**

The Tenderer shall mention in his bid the type and make of the fixtures he intends to use enclosing manufacturer's current catalogues. In the absence of any such agreement, the Engineer shall be at liberty to choose any type and make.

All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear identification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3 kg. per 25 mm dia per

meter length. Where PVC or similar pipes are allowed the Contractor shall produce the test reports and convince the Engineer about their durability.

Unless specified in the contract the fixtures shall be as specified hereinafter.

2.5.1 **Water closet**

a) **Raised type**

It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level 12.5 litre PVC flushing cistern (same colour of wc) with valveless fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, wc, cistern, seat and cover shall be as desired by the Engineer.

b) **Squatting type**

It shall include glazed vitreous china pan with foot rests and low level 12.5 litre PVC flushing cistern with valveless fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The foot rests shall be made of white glazed vitreous china with chequered surface. Colour of basin, wc, cistern, shall be as desired by the Engineer.

2.5.2 **Urinals**

It shall consist of wall type glazed vitreous china urinals, photo voltaic control flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. All fittings shall be chrome plated.

2.5.3 **Wash basin**

It shall be made of glazed vitreous china. The basin shall be flat back, wall hung by painted cast iron brackets and complete with pattern with hot and cold brass faucets with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste complete with necessary fittings. All fittings including faucets shall be chromium plated. Colour of wash basin shall be as desired by the Engineer.

2.5.4 **Sink**

It shall be made of vitreous china. It shall be wall hung by painted cast iron brackets and complete with one brass faucet with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste with necessary fittings. All fittings including faucets shall be chromium plated.

2.5.5 **Bathroom mirror**

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws and other fittings shall be chromium plated.

2.5.6 **Glass shelves**

Glass shelves shall consist of 6 mm thick clear glass with guard rails and shall be wall mounted with brackets. All brackets, guard rails and screws shall be chromium plated.

2.5.7 **Towel rail**

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

2.5.8 **Soap holder**

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium plated screws.

2.5.9 **Liquid soap dispenser**

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

2.5.10 **Toilet roll holder**

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screws shall be chromium plated.

2.5.11 **Installation**

All plumbing fittings and fixtures shall be installed in most workmanlike manner by skilled workers. These shall be perfect in level, plumb, plane, location and symmetry. All items shall be securely anchored to walls and floors. All cuttings in walls and floors shall be made good by the Contractor.

2.6.0 Septic tank & effluent disposal

2.6.1 **Septic tank**

Septic tank shall consist of the tank itself with inlet and outlets therefrom complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 mm dia whose top shall be provided with a suitable mosquito proof wiremesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

2.6.2 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed CI pipes laid in a trench filled with broken bricks.

2.6.3 Soak pit / Chlorination Chamber

The soak pit shall be complete as shown on drawing. It shall consist of a 900 mm dia pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6) and filled with brick bats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

2.6.4 Joining C.I. Pipes / dispersion trenches

Minimum dia of the CI pipe shall be 150 mm nominal. The trench for laying the pipes shall be minimum 600 x 600 mm pipes. The joints of the pipes shall be made with lead. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well graded coarse aggregate. Ordinary soil is used for filling the top of trench.

2.6.5 Commissioning septic tank and Soak pit/Chlorination Chamber

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.0.0 TESTING AND ACCEPTANCE

3.1.0 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

3.2.0 Testing of Pipelines

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below :

a) **Smoke test**

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

b) **Water test**

For pipes other than Cast Iron

Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may due to one or more of the following cases :

a) Absorption by pipes and joints

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

For cast iron pipes

Cast iron sewers and drains shall be tested as for glazedware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

c) **For straightness**

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and

ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipe line is not straight.

3.3.0 **Testing Septic Tank**

The septic tank shall be tested for watertightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm.

3.4.0 **Fixtures etc.**

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

4.0.0 **CODES AND STANDARDS**

Some of the important Codes and Standards relevant to this specification shall be followed : Latest editions shall always be consulted.

IS:1172 - Code of basic requirements for water supply drainage and sanitation.

IS:1200 (Pt. XVI) - Laying of water and sewer lines including appurtenant items.

IS:1239 (Pt. I & II) - Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings.

IS:1536 - Centrifugally cast (Spun) iron pressure pipes for water gas and sewage.

IS:1537 - Vertically cast iron pressure pipe for water, gas & sewage.

IS:3486 - Cast Iron spigot & socket drain pipes.

IS:1742 - Code of Practice for building drainage.

IS:5329 - Code of Practice for sanitary pipe work above ground for buildings.

IS:2470 - Code of Practice for designs and construction of septic tank for small and large installations.

IS:3076 - Low density polythelene pipes for potable water supplies.

IS:4984 - High density polythelene pipes for potable water supplies.

IS:1537 - Vertically cast iron pressure pipes for water, gas and sewage.

IS:1538 - Cast Iron fittings for pressure pipes for water, gas & sewage.

IS:1230 - Cast Iron rain water pipes and fittings.

IS:3889 - Centrifugally cast (spun) iron spigot & socket soil waste and ventilating pipes, fittings and accessories.

IS:1729 - Sand cast iron spigot & socket soil, waste and ventilating pipes and accessories.

IS:1626 - Asbestos cement building pipes, gutters and fittings (spigot & socket types).

IS:458 - Concrete pipes (with and without reinforcement)

IS:783 - Code of Practice for laying of concrete pipes.

IS:784 - Prestressed concrete pipes.

IS:651 - Salt glazed stoneware pipes & fittings.

IS:4127 - Code of practice for laying of glazed stoneware pipes.

IS:1726 - Cast Iron manhole covers and frames intended for use in drainage works.

IS:5961 - Cast Iron gratings for drainage purposes.

IS:5219 (Part-I) - 'P' & 'S' traps.

IS:771 - Glazed earthen-ware sanitary appliance.

IS:772 - General requirements of enamelled cast iron sanitary appliances.

IS:774 - Flushing cistern for water closets & urinals (valveless siphonic type).

IS:775 - Cast Iron brackets & supports for wash basins and sinks.

IS:2548 - Plastic water closet seats & covers.

IS:2527 - Code of Practice for fixing rain water gutters and down-pipes for roof drainage.

IS:2556 - Vitreous sanitary appliances.

SECTION - D

SUB-SECTION – D16

ROAD AND DRAINAGE

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	CODES AND STANDARDS
a.	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA
5.00.00	MEASUREMENT

Standard Technical Specification For Road And Drainage

1.00.00 Scope

The scope include all works required for the construction of road including construction of embankment, sub-base course, base course, tack coat, bituminous macadam, wearing course, liquid seal coat, shoulder and all incidental items of work specified or not shown but reasonably implied or necessary for the completion of the work etc.

The scope also include all works required for the construction of drainage including construction of road side drains, RCC culverts, pipe culverts, drainage pipes, manholes and all other incidental items necessary for the completion of the work etc.

1.01.00 Works To Be Provided By The Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all required for the completion of the work.

b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work To Be Provided By Others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

1.03.00 Conformity With Designs

The contractor shall carryout the work as per the construction drawings, specification and as directed by the engineer.

1.04.00 Materials To Be Used

All materials required for the work shall be the best commercial variety and as approved by the engineer.

2.00.00 Codes and Standards

All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise.

a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC

b) IRC: 19 - Standard specification and code of practice for Water bound Macadam

c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways

d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.

e) IS:2212 - Code of Practice for Brick work

f) IS: 783 - Code of Practice for Laying of Concrete Pipes

g) IS: 1201 - Methods of testing tar and bituminous materials to 1220

h) IS: 73 - Specification for paving bitumen

i) IS: 215 - Specification for Road tar

j) IS: 216 - Coal tar pitch

k) IS: 217 - Specification for cut-back bitumen

l) IS: 454 - Specification for cut-back bitumen from waxy crude

m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete

n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non extruding and resilient type
Part I Bitumen impregnated fibre

Part II CNSL Aldehyde resin and coconut pith

o) IS : 334 - Glossary of terms relating to bitumen and tar

p) IS: 1077 - Common burnt clay building bricks

q) IS : 3117 - Specification for bitumen emulsion roads (anionic type)

r) IS : 1200 - Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements

s) Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Quality Control

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be ± 40mm.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.

Sub-grade ± 25 mm
Sub-base ± 20 mm
Base course ± 15 mm
Wearing course ± 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance on base course if the thickness of the wearing course is thereby reduced by more than 6 mm.

c) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of the completed sub-base, base course and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table - I. The longitudinal profile shall be checked with a 3m long straight edge at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8

6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6
8.	Semi-dense carpet	10	-	-	-	20***	6
9.	Asphaltic Concrete	8	-	-	-	10***	4

Notes:

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 Execution

3.01.00 Setting Out

Within 15 days of the award of contract, the contractor shall prepare and submit to the Engineer detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dimensions as per construction drawings and specification adding his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. On receiving the approval from the Engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the contractor shall proceed with the work. It should be noted that this checking by the Engineer prior to the start of the work will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. Profiles of the embankment made with Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen.

3.02.00 Clearing and Grubbing

Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below ground level or 300mm below formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the Engineer. The trees shall be cut into suitable pieces as instructed by the Engineer. Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to the approved disposal areas as may be specified. Useful materials, saleable timbers, firewood etc shall be the property of the Owner and shall be stacked properly at the work site in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, moorum, gravel or a mixture of the above or any other material approved by the Engineer. The material shall be free from lumps and clods, boulders and rock pieces, roots and vegetation, harmful salts and chemicals, organic materials, loose silts, fine sands and expansive clays in order to provide a stable embankment. The filling and compaction operation should be such that the best available materials are saved for the top portion and will result in an acceptable and uniform gradation of material and provide impermeability and stability to the embankment when compacted. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm. However the Engineer may at his discretion permit the use of material coarser than the specified if he is satisfied that the same will not present any difficulty as regard to the placement and compaction of the fill material are concerned. Ordinarily, only the materials satisfying the density requirements as given below in Table-II shall be employed for embankment construction.

Table - II

Density Requirements of Embankment Materials

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skews/curves. The actual profile of the embankment shall be made at every third centre line peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.

3.03.03 Stripping and Storing top soil

The construction of the earthen embankment by filling shall conform to the dimensions, slopes and other details shown in the approved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grubbing shall be stripped off to a minimum depth of 150mm or more as directed by the Engineer in order to remove all perishable materials and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. In localities where most of the available embankment fill materials are not conducive to plant growth or when so directed by the Engineer, the top soil suitable for plant growth existing over the embankment foundation areas shall be stripped to specified depths not exceeding 150mm and stored for covering the embankment slopes where revegetation is desired.

3.03.04 Compacting Original Ground

In all cases, the original ground after stripping shall be compacted by rolling with a minimum six passes of 8-10 tonne roller and as directed by the Engineer.

Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall be made good either at the source or after spreading

the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06 Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.
Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III

Compaction Requirements For Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing With Sods

3.04.01 General

This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds and other undesirable matters. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris.

Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and top soiling (if required), fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

3.04.04 Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

3.04.05 Top Dressing

After the sods have been laid in position, the surface shall be cleaned of any loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.

3.04.06 Watering and Maintenance

The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.

3.05.00 Shoulder Construction

3.05.01 Description

This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.

3.05.02 Materials

Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.

3.05.03 Construction Operations

Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials before proceeding with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface

shall be immediately removed without any damage to the pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water.

3.06.00 Kerb

3.06.01 Material

Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02 Laying

The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm.The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00 Sub-base (Granular Sub-base)

3.07.01 Description

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer.

3.07.02 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV
Grading for Granular Sub-base Material

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm 63 mm 4.75 mm 75 micron	100 90 - 100 35 - 70 0 - 20	100 90 - 100 40 - 90 0 - 25	100 90 - 100 50 - 100 0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetations and other extraneous matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.

Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water

has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water, laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

Sl.No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS : 2386 (Part IV) or IS : 5640**	40 percent maximum
2.	Base	a) Loss Angeles Abrasion value*	IS : 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS : 2386 (Part IV) or IS : 5640 **	40 percent maximum
		b) Flakiness Index ***	IS : 2386 (Part I)	15 percent maximum

* Aggregates shall satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS : 5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-1 shall be restricted to sub-base courses only.

Table - VI
Grading Requirements of Coarse Aggregates

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.

Table - VII
Grading For Screenings

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS : 2720,Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03 Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading shall be done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time

of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregates are thoroughly keyed, well bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding

material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.09.00 Tack Coat

3.09.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.09.02 Materials

The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.

3.09.03 Construction Operations

a) Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder.

b) Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.

3.10.00 Bituminous Macadam Binder Course

3.10.01 Description

This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawin

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table – VIII
Physical Requirements of Aggregates For Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.

Table-IX
Aggregates Grading For 75mm Compacted Thickness Of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

Table-X
Aggregates Grading For 50mm Compacted Thickness Of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 -100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportio-

ning of materials and producing a uniform mix. A variation in binder content upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03 Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit

manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, the rolling shall be done with 8 to 10 tonne power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as early as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C.

Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it.

3.11.00 Open Graded Premix Carpet

3.11.01 Description

This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification.

3.11.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable.

b) Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set forth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30.

c) Proportioning of Materials

The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet.

Table - XI

Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick Open Graded Premix Carpet

Aggregates for Carpet		
i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total	0. 27 Cu.m
Binder for premixing (quantities in terms of straight run bitumen)		
i)	For 0. 18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
	Total	14.6 Kg

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat

A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material are laid, rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of approved binder before the new mix is placed against it.

f) Seal Coat

A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.12.00 Seal Coat

3.12.01 Description

This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber.

Type-A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type-B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.12.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS : 73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type-A and Type-B seal coat respectively.

b) Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table-VIII except that the upper limit for flakiness Index shall be 30.

c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter

or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03 Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary the surface shall be broomed to ensure uniform spread of chippings. Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present an uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be

rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type- A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.

Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown on approved drawing, drains shall be of R.C.C. construction with necessary slopes.

3.15.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As described in the "Specification for Earthwork in Excavation and Backfilling", backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable.

3.16.00 Pipe Culverts and Drainage Pipes

3.16.01 Materials

The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings. Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of IS : 458 and shall be procured from approved manufacturers with collars as per manufacturer's specification. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383.

3.16.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS:783 and as per the specification given below.

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.

Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per "Specification for Earthwork in Excavation and Backfilling" to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the "Specification for Earthwork in Excavation and Backfilling". When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc as specified on the drawings and as instructed by the Engineer.

e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.

3.16.03 Relation With Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00 Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide a smooth flow. Connection to the existing pipelines shall be through a manhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00 Testing And Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the "Specification for Roads and Bridge Works, 1983" published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

5.00.00 MEASUREMENT

Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.

SECTION - D

SUB-SECTION – D17

FABRICATION OF STRUCTURAL STEEL WORK

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	WORKMANSHIP
4.00.00	INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY
5.00.00	INFORMATION TO BE SUBMITTED
6.00.00	RATES AND MEASUREMENTS

SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and. connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle, and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

i) Maintain a fully equipped workshop at site for fabrication, modification and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.

2.02.00 Work by others

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed:

IS : 226 - Structural steel (Standard Quality)

IS : 800 - Code of Practice for general construction in steel.

IS : 806 - Code of practice for use of steel tubes in general building construction.

IS : 808 - Rolled steel beams, channels, and angle sections

IS : 813 - Scheme of symbols for welding

IS : 814 - Covered electrodes for metal arc welding of structural steel

IS : 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.

IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel

IS : 817 - Code of practice for training and testing metal arc welders

IS : 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations

IS : 822 - Code of practice for inspection of welds

IS : 919 - Recommendations for limits and fits for Engineering
IS : 961 - Structural Steel (High Tensile)

IS : 1148 - Rivet bars for structural purposes

IS : 1149 - High tensile rivet bars for structural purposes

IS : 1161 - Steel Tubes for structural purposes

IS : 1200 - Method of measurement of steelwork and ironwork (Part 8)

IS : 1239 - Mild Steel Tubes

IS : 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (dia 6 to 24 mm)

IS : 1364 - Precision and semi-precision hexagon bolts, screws, nuts and l locknuts (dia, range 6 to 39 mm)

IS : 1367 - Technical supply conditions for threaded fasteners

IS : 1442 - Covered electrodes for the metal are welding of high tensile structural steel

IS : 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube

IS : 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.

IS : 1731 - Dimensions for steel flats for structural and general engineering purposes

IS : 1852 - Rolling and cutting tolerances for hot-rolled steel products

IS : 1977 - Structural steel (ordinary quality) St-42-0

IS : 2062 - Steel for General Structural Purposes

IS : 2074 - Ready mixed paint, red oxide Zinc chromate priming

IS : 2595 - Code of Practice for Radiographic Testing

IS : 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel

IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles
IS : 3757 - High strength structural bolts

IS : 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products

IS : 7205 - Safety Code for Erection of Structural Steelwork

IS : 7215 - Tolerances for fabrication of steel structures

IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels.

IS : 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric.

With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural steel High Tensile

c) IS : 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

a) IS : 1148 - Rivet Bars for structural purpose

b) IS : 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04 Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture and shall comply with any of the following Indian Standard Specifications as may be applicable

a) IS : 814 - Covered electrodes for metal arc welding of structural steel

b) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel

c) IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel

d) IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels

2.05.05 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 _/A, where "A" is the cross sectional area of the test specimen

i) IS: 1367: Technical supply conditions for threaded fasteners

ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural Steel (High Tensile Quality)

c) IS : 1977 - Structural steel (Ordinary Quality) St-42-0

d) IS : 6649 - Hardened washers

2.05.07 Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS: 2074 - Ready mixed Paint, Red oxide Zinc Chromate Priming.

2.06.00 Coal Bin

2.06.01 Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have be conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

2.06.02 For general requirements, fabrication and construction details IS: 9178 (Pt.l & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.

2.06.03 The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.

2.06.04 Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.

2.06.05 Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.

2.07.00 New Erection Marks

2.07.01 Additional structures involving new erection marks may be required to be added at any stage of work.

2.07.02 All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.

2.07.03 All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

2.08.00 ELECTRO FORGED STEEL GRATINGS

2.08.01 Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.

2.08.02 All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.

2.08.03 The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.

2.08.04 The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.

2.08.05 Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.

2.08.06 The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.

2.08.07 Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.

2.08.08 Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.

2.08.09 Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

2.08.10 Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.

2.08.11 The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.

2.08.12 Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.

2.08.13 All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two:

(a) Two coats of red lead primer and two coats of black enamel finish paint.

(b) Hot dipped galvanization at 610 gm/sq.m.

in the shop prior to erection at site, as the approved drawing.

2.08.14 Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.

2.08.15 Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.

2.09.00 GALVANIZATION OF GRATINGS

2.09.01 Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15

2.09.02 After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).

2.09.03 The weight of the zinc coating shall be at least 610 gm/m² - unless noted otherwise.

2.09.04 The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, bare spots, unevenness

of coating, spelter that is loosely attached to the steel, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633.

2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.

2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection.

2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.

2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to the redone in the similar manner as stated above at no extra cost to the Owner.

2.10.00 STAINLESS STEEL HOPPERS

2.10.01 Material

Stainless steel hopper of grade SS 304/409 M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper.

2.10.02 Fabrication

The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

2.10.03 Fabrication Drawings

a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel

plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also required adjustment in the size of the each element of hopper plate and also additional weld joints.

b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store will call for the penal recovery at three (03) times the maximum procurement rate for the weight of stainless steel pieces not returned to the store.

c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the welded structure joints and the test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS

2.11.01 PTFE (Poly tetra fluorethylene) slide bearing

a) General

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm².

c) Installation

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

2.12.00 Storage of material

2.12.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.12.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.12.03 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The

electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.12.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length, and quality.

2.12.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.13.00 Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work

a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

b) Rivets, Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.

c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.

d) Welders : Qualifying Tests

e) Welding sets : Performance Tests

f) Welds : Inspection, X-ray, Ultrasonic tests

g) Paints : Manufacturer's certificate, physical inspection reports

h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.14.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.15.00 Fabrication Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The fabrication drawings shall include but not limited to the following:

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolts location etc.

c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.

d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of the various components of the steelwork, including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks,

bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

Shearing, cropping, or sawing shall affect cutting. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction

3.02.01 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as specified in IS: 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02 Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection .The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with he holes. Rivets shall be heated uniformly to a temperature not exceeding 1 125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not

be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project trough the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 Welded Construction

3.03.01 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.

3.03.02 Preparation of material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shod splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 m thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material, as the base metal shall have the weld metal thoroughly fused with the backing material.

Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.
To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03. 12 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03. 13 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03. 14 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole

section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3. 12.00 Lacing bars

The ends of lacing bars shall be neat and free from burns.

3. 13.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.14.00 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.15.00 Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes,

ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00 Chequered Plates

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

3.11.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.11.00 Shop connections

a) All shop connections shall be otherwise riveted or welded as specified on the Drawings.

b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection.

c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.

3.13.00 Castings

Steel castings shall be annealed.

3.14.00 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in

place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.

3.15.00 Shop painting

3.15.01 General

Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.

3.15.02 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, Positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.15.03 Contact surfaces

Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.

3.15.04 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.15.05 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.16.00 Galvanizing

3.16.01 General

Structural steelwork for switchyard or other structures as may be specified in the contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.16.02 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.16.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS: 4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport, handling, and erection. Damages, if

occur, shall be made good in accordance or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.

4.02.02 Welding

a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.

b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:

i) 10% at random on fillet-joints.

ii) 100% on all butt-joints.

c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs.

d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

4.02.04 Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02. 12 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially -

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores
e) A schedule of parts or pieces, giving the parts or piece number with reference to

assembly drawings and the quantity of each.

The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information is required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

i) Preparation and approval of fabrication drawing

ii) Procurement of Materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork.

v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable.

vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.

vii) Final date of completion of all shipments.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following:

a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.

d) Results of any test as and when conducted and as require by the engineer.

e) Manufacturer’s mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications

including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary operations described in the Specifications.

6.01.02 The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.

6.01.03 The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.

6.01.04 No claims shall be entertained, if the details shown on the `Released for Construction' drawings differ from those shown on the bid/tender drawings.

6.01.05 Rates shall be inclusive of all leads and lifts/elevation.

6.01.06 The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of materials not issued by the Owner.

6.01.08 The bidders rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning

and abrasives used, and getting approval of the specialized agency supplying the zinc silicate primer.

6.01.09 The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.

6.01.10 The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint.

6.01.11 The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.

6.01.12 The bidder’s rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.

6.01.13 The bidder’s rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.

6.01.14 The bidder’s rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unublized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.

6.01.15 The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.

6.01.16 The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.

6.01.17 The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

6.01.18 The bidders rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.

6.01.19 The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner for this item of work shall supply no material.

6.02.00 MODE OF MEASUREMENT

6.02.01 The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.

6.02.02 The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.

6.02.03 For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the

extreme points of the section.

6.02.04 Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds the area shall be assumed as the minimum circumscribed rectangle.

6.02.05 For bunker wall plates the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).

6.02.06 For all other plates, where the area of any notch/skew cut in the plate is less than 0.2 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.2 sq.m. the actual profile of the plate shall be considered for the purpose of payment.

6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.2 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.2 sq.m.

6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.

6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.

6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for welding/bolting.

6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.

6.02.12 The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne,

corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.

6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.

6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.18 The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below

6.02.19 For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.

6.02.20 For the work of addition to, alteration in and / or modification of 'erection marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.

6.02.21 For re-erection the weight of the modified erection mark shall only be measured.

6.02.22 The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.

6.02.23 The measurement for the item of PTFE bearings shall be based on the actual weight in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load

carrying capacity, for all bearings.

6.02.24 The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.

6.02.25 The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.

6.02.26 The measurement for the item of Stainless Steel Hand Railing shall be based in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.

SECTION - D

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	WORKMANSHIP
4.00.00	TESTING AND ACCEPTANCE CRITERIA
5.00.00	INFORMATION TO BE SUBMITTED

SUB-SECTION – D XVIII

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.

b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, leveling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures.

g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size rivet or bolt if required.

iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.

v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS: 800 - Code of practice for general construction in steel.

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in

accordance with the provisions of this Specifications and/or the instructions o the Engineer.

2.05.00 Material

2.05.01 General

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

2.05.02 Materials to conform to Indian standards

All materials required to be supplied by the Contractor under this contract shall conform to the relevant Indian Standard specifications.

2.06.00 Storage of Materials

2.06.01 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.

The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 Covered Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 Quality Control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the Following items of work :

i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.

iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 Taking Delivery

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and Equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erecrtion shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The requirement of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.
No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight" is defined as the

tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times dia or 200 mm	Bolt length exceeding 8 times dia or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30° over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) for bolt class 8.8 of IS:1367	Torque to be applied (Kg.M)
20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14. 7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.08 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer.

The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, “ironite” or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required

flowability and compressive strength may also be used with Engineer's approval.

3.04.00 Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Wherespecified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved “Schedule of Painting”. The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found

to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the “Strength Test” as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below:

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	

	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and other member connection levels:	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more than ±7 mm per 30m length.
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	± 9.0 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating	3.0 mm
Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or greater than 10mm whichever is the least.
Trusses	b) Lateral displacement of top chord at center of span from vertical plane	1/250 of depth of truss or 20 mm which ever is the -

	running through center of supports.	least.
Crane Cirders	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm.
	b) Deviation to crane rail-gauge	± 3.0 mm
	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.	1.0 mm.
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.	

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ±3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list Of all constructional plant and equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection Yard

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00 After award of the Contract

After award of the contract, the Contractor shall submit the following:

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

SECTION - D

SUB-SECTION – D19

ROOF DECKING

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	MATERIALS
3.00.00	INSTALLATION
4.00.00	ACCEPTANCE CRITERIA
5.00.00	IS CODES
6.00.00	RATES AND MEASUREMENTS

ROOF DECKING

1.00.00 Scope

This section of the specification covers the supply, fabrication and erection of profiled light gauge Metal Decks (coated and painted) as roof decking to the main plant building and any other area as indicated in the drawings.

2.00.00 Material

2.01.01 Roof of main plant TG, Deareator bay, bunker building,cw pump house consists of permanently colour coated (on exposed face) galvanized MS trough metal sheet decking plate of approved colour over roof purlins for cast-in-situ roof slab as per IS: 14246 and conform to class 3. Thickness of deck plate shall be minimum 0.7mm and minimum trough depth of 44 mm and centre to centre of the valley shall be 130mm with minimum yield strength of 250 Mpa. Silicon modified polyester paint shall be used for permanent coating over galvanized surface with minimum rate of galvanization 275 gm/sqm. DFT of permanent colour coating shall be 20 microns on exposed surface and minimum 7 micron on other face. It shall serve as permanent shuttering for cast-in-situ roof slab. It should have adequate strength to support weight of green concrete and imposed load during construction. The thickness of the deck plate shall however be designed suitably according to the spacing of roof purlins.

3.00.00 INSTALLATION

The Contractor shall furnish all labour, equipment and materials as required for the design, fabrication, coating, erection and fixing of the decking over purlins, painting and for the complete performance of the work in accordance with the construction drawings and as described herein.

The description, which follows, gives a general indication of the nature and extent of the work but is not necessarily exhaustive and does not purport to cover all the details/operations which will be necessary in order to carry out the work.

3.01.00 Detailed Design of Roof Decking

The Contractor, in conjunction with the manufacturer, shall be responsible for the detailing of the profiled decking, fittings and fixtures and shall submit with his tender particulars of the proposed manufacturer and of the particular product proposed for use. The detailing is to be based on typical details furnished by the Engineer. The Contractor shall submit to the Engineer, two copies of the general arrangement and detailed working drawings for the proposed design, together with all calculations necessary to verify the adequacy and completeness of the design & detailing of decking sheets, fixtures, flashings and trims. After approval he shall supply further eight copies.

The Engineer will verify the correct interpretation of his requirements but may not necessarily check the design and details, and the Contractor shall be entirely responsible for the accuracy of the drawings and the correctness of the design and the suitability of the details. Manufacture of roof decking sheets shall not commence until the necessary approval of the Engineer has been obtained.

3.02.00 Erection & Fixing

3.02.01 Sequence of Manufacture/Erection

Cutting Schedules, delivery to site and stacking arrangements in store shall ensure that sheets are erected in a sequence which follows that for the manufacture. The decking sheets shall be erected using an arrangement of sheets and joints to conform with the requirements of this specification. Decking erection for each elevation or feature shall commence at one end only and proceed towards the other end, in order to ensure tight fitting laps.

3.02.02 Position and Location of Laps

Side and end laps of roof decking sheets shall be located and positioned in such a manner as to provide the maximum weather protection taking into account the direction of the prevailing wind.

The lines formed by horizontal laps and fixing shall where possible, be continuous and coincide with the edges of large openings in the roof.

3.02.03 Alignment of Sheets and Fixings

All roof decking sheets shall be fixed plumb and level with all fixings evenly spaced and accurately lined. All dirt and grease shall be removed from the surfaces of the sheets as the work proceeds.

3.02.04 Site Cutting

Approval must be obtained before the roof decking sheets are cut at site. Generally cutting of sheets to length will not be permitted, only special cutting and trimming for small openings shall allowed. Where possible, site cut edges shall be concealed at laps.

3.02.05 Damaged Sheets

Distorted, blemished or water stained sheets and any other fittings shall not be used.

3.02.06 Laps

End laps and side laps to roof decking sheets shall be sufficiently large to ensure that the decking complies with the weather tightness and other requirements of this specification. The length of each decking sheet shall be adjusted so that the end laps shall bear on the purlins. In no case end laps shall not be less than 150 mm and side laps shall not be less than 53 mm.

3.02.07 End Lap Fixings

End lap fixings shall be located at least 25 mm from the end of each sheet.

3.02.08 Side Lap Fixings

The spacing of side lap fixings shall ensure compliance with this specification regarding tightness. The spacing of these fixing screws shall not exceed 500mm. The fixing shall be located in the bottom flat of the corrugation.

3.02.09 Holes

Holes in MS decking sheets shall be punched. In case holes are drilled holes, it is to be ensured that the holes do not go oversize due to the small thickness of the sheeting. All drilling swarf shall be removed from the surfaces of decking, supporting steel work, purlins etc.

3.02.10 Location and Spacing of Fixings

Fixings shall be accurately located in position in the centre of the corrugations to ensure that the heads of bolts, nuts and washers bear squarely down on the surface of the sheeting and are not located at the edge or on the joints in supporting purlins.

3.02.11 Fixings

The tenderer shall submit with his tender details of the proposed method for securing the roofing sheets to the metal purlins. The roof decking sheets are to be fixed to the roof purlins with hex washer head white zinc plated heat treated carbon steel self drilling / self tapping screws of minimum thread diameter of 5.6mm. These self drilling screws shall be drilled through the roofing sheets and purlins supporting the roofing sheets. These purlins shall be suitably spaced as per the requirement of roofing sheets and the roofing sheets shall not sag more than span/250 for the loads likely to be imposed during concreting and in future. The self-drilling screws are to be spaced at a maximum distance of 390mm centre to centre along the length of the purlins and top chord of truss. The screws are to be located preferably in the valley only and shall

be installed in accordance with the manufacturer's recommendations using tools approved by the manufacturer which do not damage the coating of the decking sheets.

3.03.00 Protection during Construction

Precautions shall be taken during the erection of the roof decking to ensure that partially erected decking are protected during inclement weather and damage at all times.

3.04.00 Damage

Any damage to coating & primer during transportation is to redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

4.00.00 Acceptance Criteria

The installation shall present a neat appearance and shall be checked for water tightness. The following shall be checked :

a) Side and end laps

b) Absence of damage in the sheeting.

c) Conformity of fixings with the approved design.

5.00.00 IS Codes

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS : 513 - Specification for cold rolled carbon steel sheets.

IS : 3618 - Specification for phosphate treatment of iron and steel for protection against corrosion.

IS : 4431 - Specification for carbon & carbon manganese free cutting steel.

IS : 1573 - Electroplated Coatings of zinc on iron and steel.

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include all wastage.

6.02.00 Method of Measurement

Roofing shall be measured for net area of the work done. Profiled sheeting (coated & painted) shall be measured in plan area of sheets and not girthed. No deduction shall be made for openings measuring up to 0.1 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

No payments shall be made for laps.

SECTION - D

SUB-SECTION – D20

FALSE FLOORING

C 0 N T E N T

CLAUSE NO.	DESCRIPTION
1.00.00	GENERAL
2.00.00	MATERIALS
3.00.00	INSTALLATION
4.00.00	ACCEPTANCE CRITERIA
5.00.00	IS CODES
6.00.00	RATES AND MEASUREMENTS

FALSE FLOORING

1.00.00 General

This section of the specification covers the supply, fabrication and installation of removable type false flooring system having PVC top finish fire particle board, GI supporting system, aluminium foil lining etc. as per schedule of items in the main plant building and any other area as indicated in the drawings.

The scope of contractor covers supply of all materials, fabrication & installation works required to be carried out for completion of false flooring in the area specified in the drawings.

2.00.00 MATERIAL

2.01.00 Supporting structure

Supporting pedestals shall be made of steel and will be of height as required. Supporting pedestal shall be truly vertical and located at distances to conform with size of floor panels and shall be equipped with locking devices to prevent disturbances of finished elevation. Base of pedestal shall have integral load dispersion plate of size 100x100x8mm to transmit the load evenly to the base floor. Adjustment of pedestal shall be provided by threaded vertical rod of 25mm diameter and elevating nut. The pedestal head shall provide positive interlocking of the steel grid channels supporting system and shall prevent lateral shifting.

The grid channels shall be made of galvanised steel of 40mm x 40mm x 3.15mm thick and shall be placed at 605mm centre to centre both ways to support floor panels in uniform levelled elevations. Nominal height of the false flooring system shall be 600 mm unless otherwise indicated. Pedestal head shall be equipped with conducting grounding pad if so desired by the Engineer

2.02.00 Floor Panels

The floor panels shall be made of fire resistant particle board, phenol formaldehyde bonded. Size of each panel shall be 600mm x 600mm with all panel edges finished to a tolerance of $\pm$ 0.2mm. Floor panel shall have 2mm thick non-static PVC on top, 2mm thick hard PVC strip lipping on four edges and 26 G aluminium sheet fixed with araldite at bottom. Minimum thickness of the panel shall be 35mm, unless otherwise noted. All panels shall be completely interchangeable and easily removable with a suction lift tool. Panels shall be square within a tolerance of $\pm$ 0.25 mm on the diagonal. The floor panels shall be cut, wherever required for providing suitable outlets for cables and edges shall be lipped with hard PVC sheets.

2.02.01 Strength

Each 600mm x 600 mm floor panel must be capable of withstanding the designed service load. The ultimate strength shall provide a safety factor of 3. The false flooring shall be capable of carrying a axial load of 800 kg and uniform load of 2000 kg/sq.m with maximum deflection of 1/350. If required by the Engineer, the samples shall be accepted only after carrying out load tests. The Engineer may relax the test requirements with concentrated load in case cabinets are not handled with castor fitting arrangement.

One additional pedestal shall be provided under floor stringer along front panel area of each control board for taking possible additional load that may occur from time to time.

2.02.02 Surface finish

All removable panels shall have the top surface finished with 2 mm thick flexible PVC flooring conforming to IS:3462 and shall be fixed to the surface with compatible high-creep resistant adhesive. The PVC floor tile shall be in single piece for each floor panel. Under side of panels shall also be painted with suitable epoxy or oil based paint.

2.02.03 Damaged Floor Panels

Distorted, blemished or stained floor panels shall not be used.

2.03.00 Skirting

Skirting shall be 150 mm high and 2 mm thick, completely matching with false flooring surface finish materials and shall be fixed to the wall surface as per manufacturer's installation instructions.

3.00.00 INSTALLATION

3.01.00 Base

The system shall be placed over a base of RCC floor slab and beams. Any grouting etc. that is necessary to fix the supporting structure shall be done.

The concrete sub floor shall be sealed with two coats of polyurethane paint to prevent moisture from coming in contact with cables and to minimise dust problem.

The floor panels and channels shall be completely interchangeable and remain in position without screwing or bolting under working/imposed loadings.

Any damage to the sub floor during installation of the false flooring system shall be

made good by the contractor without any extra cost to the Owner. All steel surfaces are to be protected by two coats of polyurethane paint over a compatible primer and any damage to the paint during installation shall be made good. In case the loads exerted by the weight of machines are above the stated characteristics of floor finish material, the floor shall be protected by overlaying hard board during installation of machine or equipment.

All installation work of the false flooring system shall be supervised by the manufacturer's authorised representative.

3.03.00 Painting

After fixing the false flooring supporting system the sub floor shall be given a coat of polyurethane paint.

3.04.00 Protection during Construction

All precautions shall be taken during the erection of the false flooring to ensure that partially erected flooring are protected and shall not be damaged before handing over to owner.

3.05.00 Damage

Any damage of coating to supporting system caused during transportation is to be redone with the similar type of coating as per the manufacturer’s specification at no extra cost to the Owner.

4.00.00 ACCEPTANCE CRITERIA

The false flooring system shall only be accepted after completion of following checks :

a. Level

b. Alignment of joints

c. Thickness of joints

d. Surface finish

e. Colour and texture

f. Details of edges, junctions etc.

g. Performance

h. Criteria specified for strength.

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS:5318 Laying of flexible sheet and flooring.

IS:3462 Flexible PVC flooring

IS:3087 Wood particle boards (medium density) for general purposes.

6.01.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include, but not limited to, supply & installation of floor panels, supporting systems, paintings atc.

6.02.00 Method of Measurement

False flooring shall be measured in Sq.M for net area of the work done. No deduction shall be made for openings measuring up to 0.4 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

SECTION - D

SUB-SECTION – D21

BORED CAST IN - SITU PILES

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL REQUIREMENTS
3.00.00	MATERIALS
4.00.00	PILE INSTALLATION
5.00.0	SAMPLING, TESTING, AND QUALITY ASSURANCE
6.00.00	PILE TESTING
7.00.00	CODES AND STANDARDS
8.00.00	RATES AND MEASUREMENT
	ANNEXURE-A
	ANNEXURE-B
	ANNEXURE-C
	ANNEXURE - D
	TABLE - 1

TECHNICAL SPECIFICATION FOR INSTALLATION OF BORED CAST-IN-SITU PILES

1.00.00 SCOPE

This specification covers the installation of bored cast-in-situ reinforced concrete vertical piles of specified load carrying capacity and diameter for various structures. This specification also covers carrying out initial and routine load tests on piles to assess their vertical, horizontal and pull out load carrying capacities.

2.00.00 GENERAL REQUIREMENT

2.01.00 This specification along with specific requirements under Annexure-A covers the technical requirements for piling work.

2.02.00 The work shall include supplying and providing necessary materials, mobilization of all necessary equipments (Annexure-B), providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carryout the complete piling work, and submission of records as per schedule.

2.03.00 The Contractor shall carryout all works as mentioned in Scope above. All works shall be executed to the satisfaction of the Engineer.

2.04.00 Pile capacities in vertical compression, horizontal, pullout loads for various pile diameters are given in Annexure-A.

2.05.00 The Contractor shall confirm and guarantee the "Safe Load" capacities by conducting both initial and working load test on piles as mentioned in the specific requirements.

2.06.00 The Contractor shall submit along with tender documents his tender design of piles based on soil data furnished by the Owner along with this specification. The ultimate load capacity of a pile may be estimated using suitable static formula and the minimum factor of safety shall be 2.5. However, safe load carrying capacity shall be conformed and guaranteed by conducting initial and routine load tests.

2.07.00 In case of initial or routine load test piles, if the Contractor fails to establish the safe load capacity as per his design, the Owner has the right to either derate the pile capacity on prorata basis or insist the Contractor to modify the pile design, to achieve the desired safe load capacity at no extra cost to the Owner.

2.08.00 Derating is acceptable up to 90 percent. In such case, additional piles shall be installed as per the design requirements.

2.09.00 The Owner shall decide whether to derate or modify the design based on the design considerations such as providing additional piles in the designed pile cap, provision for extending the pile cap size, etc.

2.10.00 In case the Owner decides to modify the design instead of derating the pile, the contractor shall carry out the same and install separate test piles and test the same to guarantee the safe load at no extra cost to the Owner. However no extra shall be charged for the additional test piles as well as testing of these piles as per agreed contract conditions.

2.11.00 In case of working piles, if the pile does not meet the guaranteed capacity or rejected due to any other reason, the Contractor shall install extra piles at no extra cost to the Owner. Further, the extra cost, due to the increase in the pile cap size if any, on account of extra piles, shall be borne by the Contractor.

2.12.00 It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the completion of tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer. If the Engineer so desires the Contractor shall arrange for having the instruments tested at an approved laboratory at no extra cost to the Owner and the test report shall be submitted to the Engineer. If the Engineer desires to witness such tests Contractor shall arrange to conduct the test in his presence.

2.13.00 The Contractor shall make his own arrangements for locating the coordinates and position of piles as per drawings supplied to him and for determining the Reduced Levels (RL) of these locations with respect to the benchmark indicated by the Engineer. Two established reference lines in mutually perpendicular direction shall be indicated to the Contractor. The Contractor shall provide at site all the required survey instruments to the satisfaction of the Engineer so that the work can be carried out accurately according to specifications and drawings.

2.14.00 The contractor shall assure the quality of piling work including cleaning of pile bore, quality of concrete, integrity of piles, etc.

2.15.00 AVAILABLE SUB-SOIL DATA

An abstract of the sub soil data is furnished in the tender document. However, the detailed soil investigation report shall be made available for reference of the bidder, if so required, at the office of the Owner. The soil data furnished is in good faith and only for the guidance of the Bidder, to arrive at design parameters and construction methods.

3.00.00 MATERIALS

3.01.00 General

All materials viz cement, steel, aggregates, water, etc. which are to be used for pile construction shall conform to relevant IS codes for properties, storage and handling of common building materials. However, aggregates more than 20 mm size shall not be used.

3.02.00 CONCRETE

Concrete shall be manufactured either by central batching plant or Ready Mix concrete. However, for initial test piles suitable method as approved by the Engineer may be used. Concrete shall conform to IS: 10262 & IS: 456.

3.02.01 Technical Specification for Cement Concrete (Plain and Reinforced) works along with IS: 2911 Part I/Sec 2 shall be followed for concrete works of piles. Use of plasticiser to control the water cement ratio shall be permitted on specific approval from the Engineer. Water cement ratio shall not be greater than 0.5.

3.02.02 Grade and minimum cement content
Minimum grade of concrete shall be as per Annexure-A conforming to IS: 456. Minimum cement content of 400 Kg/M³ of concrete shall be used for M-20 grade concrete.

3.02.03 Slump of concrete
The slump of concrete shall vary between 150 to 180 mm.

3.03.00 REINFORCEMENT

3.03.01 Longitudinal reinforcement in pile shall be high strength deformed steel bars conforming to IS: 1786 unless specified otherwise. Lateral reinforcement in pile shall be of mild steel conforming to IS: 432 Part-1 or HYSD bars as per IS: 1786.

3.03.02 The longitudinal reinforcement shall be provided considering the combination of vertical (compression and tension) and horizontal loads. However, the minimum longitudinal reinforcement shall be 0.4 percent of the sectional area calculated on the basis of nominal pile diameter. Minimum six numbers of bars shall be provided for longitudinal reinforcement. The diameter of longitudinal reinforcement bars shall not be less than 12mm. The stipulated minimum reinforcement shall be provided for the full length of pile.

3.03.03 The longitudinal reinforcement shall project 50 times its diameter above cut off level unless otherwise indicated.

3.03.04 The laterals shall be tied to the longitudinal reinforcement to maintain its shape and spacing. The laterals may in the form of links or spirals. The minimum diameter of the links or spirals shall be 6 mm and the spacing of the links or spiral shall not be less than 150 mm and in no case more than 250 mm.

3.03.05 Reinforcement cage shall be sufficiently rigid to withstand handling and installation without any deformation and damage. As far as possible number of joints (laps) in longitudinal reinforcement shall be minimum. In case the reinforcement cage is made up of more than one segment, these shall preferably be assembled before lowering into casing tube/pilebore by providing necessary laps as per IS: 456.

3.03.06 The minimum clear distance between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage.

3.03.07 The laps in the reinforcement shall be such that the full strength of the bar is effective across the joint and the reinforcement cage is of sound construction.

3.03.08 Laps shall be staggered as far as practicable and not more than 50% bars shall be lapped at a 'particular section. Lap joints shall be staggered by at least 1.3 times the lapped length (Centre to Centre).

3.03.09 Proper cover and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers, cast specifically for the purpose.

3.03.10 Minimum clear cover to the longitudinal reinforcement shall be 50 mm, unless otherwise mentioned.

3.03.11 Bundling of bars is not permitted.

4.00.00 PILE INSTALLATION

Installation of piles shall be carried out as per pile layout drawings, installation criteria, and the direction of the Engineer.

4.01.00 Equipment and Accessories

4.01.01 The equipment and accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the sub soil conditions, ground water conditions and the method of casting, etc. These shall be of standard type and shall have the approval of the Engineer.

4.01.02 List and details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.

4.01.03 The capacity of the rig shall be adequate so as to reach the specified founding level.

4.01.04 Provision shall be kept for chiselling within the pilebore, as specified elsewhere in this specification. Chiselling shall be carried out only with the approval of Engineer.

4.02.00 Installation Criteria

4.02.01 For determining the founding level of piles in soil as specified elsewhere, the Contractor shall have to perform Standard penetration test (SPT) as per IS: 2131 in a separate bore hole. The SPT shall be conducted at 1.0 m interval between the depths covering 5 metres each above and below the specified founding level. The bore shall be 100 mm diameter and method of boring shall conform to IS: 1892.

4.02.02 For determining founding level of piles in rock, as specified elsewhere socketing horizon shall be established by the Contractor by collecting rock cores of NX size in a separate borehole, and testing the same for uniaxial compressive strength (UCS). Cores shall be collected by double tube core barrel attached with diamond bit. Coring shall be done upto a depth as indicated in the "specific requirements." Coring in rock shall conform to IS: 6926.

4.02.03 In case it is not possible to test the cores so obtained for uniaxial compressive strength, cores shall be tested for point load strength index and correlated to obtain uniaxial compressive strength.

4.02.04 Number of boreholes for carrying out SPT in soil or uniaxial compressive strength in rock, shall vary from one in 100 to 150 piles or pile group of 150 Sqm depending on the site condition and as decided by the Engineer. However, at the location of initial load test piles, one such borehole shall be done.

4.02.05 A protocol between contractor and BHEL site shall be maintained regarding the strata at founding level. SPT value and UCS from the nearest borehole shall be indicated therein.

4.02.06 The founding level of the pile shall be decided based on the criteria elaborated in the specific requirements under Annexure-A. Concreting shall not be done until the above conditions for founding level are satisfied.

4.02.07 Approval of founding level by the Engineer shall in no way absolve the Contractor of his responsibility to guarantee the Safe load capacity of the piles as indicated in this document.

4.03.00 Control of position and alignment

4.03.01 Piles shall be installed as accurately vertical as possible. The permissible limits for deviation with respect to position and (inclination) alignment shall conform to IS: 2911 Part I/Sec. 2, which is reproduced below for ready reference.

a) The maximum deviation of vertical piles shall not exceed 1.5 per cent in alignment.

b) Piles shall not deviate more than 75 mm or D/4 whichever is less (75mm or D/10 whichever is more in case of piles having diameter more then 750mm) from their designed position at the working level.

4.04.00 Boring

4.04.01 Boring operations shall be done by rotary or percussion type drilling rigs using reverse mud circulation (RMC) method. Rotary hydraulic pulley shall be preferred.

4.04.02 The Contractor shall satisfy himself about the suitability of the method to be adopted for site. If DMC (direct mud circulation) or RMC is used Bentonite slurry shall be pumped through drill rods by means of high-pressure pumps. The cutting tool shall have suitable ports for the bentonite slurry to flow out at high pressure. If on mobilisation, the Contractor fails to make a proper bore for any reason, the Contractor has to switchover to other boring methods as approved by the Engineer at no extra cost to the Owner.

4.04.03 Working level shall be above the cut off level. After the initial boring of about 1.0m a temporary guide casing of suitable length shall be lowered in the pile bore. The diameter of guide casing shall be of such diameter, so as to give the necessary finished diameter of the concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum of 1.0m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc.

4.04.04 Use of drilling mud (bentonite slurry) for stabilizing the sides of the pile bore is necessary wherever subsoil is likely to collapse in the pile bore. Drilling mud to be used shall meet the requirement as given in Annexure-C.

4.04.05 The bentonite slurry and the cuttings, which are carried to the surface by the rising flow of the slurry, shall pass through settling tanks of adequate size to remove the sand and spoils from the slurry before the slurry is recirculated to the boring. The bentonite slurry mixing and recirculation plant shall be suitably designed and installed.

4.04.06 The bentonite slurry shall be maintained at 1.5m above the ground water level during boring operations and till the pile is concreted. When DMC or RMC method is used the bentonite slurry shall be under constant circulation till start of concreting.

4.04.07 The size of cutting tools shall not be less than the diameter of the pile by more than 75mm. However, the pile bore shall be of the specified size.

4.05.00 Chiselling

4.05.01 Chiselling may be resorted to with the permission of the Engineer below the socketing horizon. The chiselling tool or bit shall be of adequate size and weight so as to reach the desired depth.

4.06.00 Cleaning of Pile bore

4.06.01 On completion of the pile bore upto the required depth, the bottom of the hole shall be cleaned very carefully before concreting work is taken up. Cleaning shall ensure that the pile bore is completely free from sludge/bored materials, debris of rock/boulder etc. Necessary checks shall be made as given in clause 5.0 to confirm the thorough cleaning of the pile bore.

4.06.02 Pile bore shall be cleaned by fresh drilling mud through tremie pipe after placing reinforcement and just before start of concreting.

4.06.03 Pile bore spoil along with used drilling mud shall be disposed off from site as directed by the Engineer.

4.06.04 Pile bore bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before and after placing the reinforcement cage.

4.07.00 Adjacent Structures

4.07.01 When working near existing structures care shall be taken to avoid any damage to such structures.

4.08.00 Concreting

4.08.01 The Contractor shall carry out concrete mix design in accordance with IS: 10262 and submit mix design calculations and get them approved from the Engineer well in advance for installation of piles. Adequate number of tests on cubes, etc. shall be carried out as mentioned in clause 5.0 to ensure concrete of the minimum specified strength in accordance with IS: 456 at requisite workability (slump).

4.08.02 Concreting shall not be done until the Engineer is satisfied that the bearing strata (soil/rock) met with at the termination level of pile.

4.08.03 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs the pilebore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile

bore by 0.5 m beyond the proposed depth, and clean the pilebore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

4.08.04 Proper placement of the reinforcement cage to its full length shall be ensured before concreting.

4.08.05 Concreting shall be done by tremie method as specified by IS: 2911 (Part I /Sec.2). The level of drilling mud shall be maintained sufficiently above the ground water level.

4.08.06 The concreting operations shall not be taken up when the specific gravity of bottom slurry is more than 1.2 and sand content more than 7%. The drilling mud sample shall be collected from the bottom of pilebore as mentioned in clause 5.

4.08.07 Consistency of the drilling mud suspension shall be controlled throughout the concreting operations in order to keep the bore stabilized as well as to prevent concrete getting mixed up with the thicker suspension of the mud.

4.08.08 It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.

4.08.09 The temporary guide casing shall be withdrawn cautiously, after concreting is done upto the required level. While withdrawing the casing concrete shall not be disturbed.

4.09.00 Cut off level (COL)

4.09.01 Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer.

4.09.02 The top of concrete in pile shall be brought above the COL to remove all laitance and weak concrete and to ensure good concrete at COL for proper embedment in to pile cap.

4.09.03 When the pile cut off level is less than 1.0 metre below the working level, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection. In case COL of pile is more than 1.0 metre below working level then concrete shall be cast to a minimum of one metre above COL.

4.10.00 Sequence of Piling

4.10.01 Each pile shall be identified with a reference number.

4.10.02 The convenience of installation may be taken into account while scheduling the sequence of piling in a group. This scheduling shall avoid piles being bored close to other recently constructed piles.

4.11.00 Building up of Piles

4.11.01 If any pile, already cast as per construction drawing, requires any extra casting due to any change in cut off level or the cast pile top level is less than the specified level or for any other reason, then the pile shall be built-up by using atleast one grade higher concrete than that used for concreting of the same pile, ensuring proper continuity with the existing concrete and to the satisfaction of the Engineer. Necessary reinforcement as per design requirement and suitable shuttering shall be provided before casting the concrete. Surrounding soil shall also be built up to the required level by proper compaction to ensure lateral capacity of the pile.

4.12.00 Breaking off of Piles

4.12.01 If any pile already cast, requires breaking due to lowering in cut off level or for any other reason, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile such as loosening, cracking etc. and to the satisfaction of the Engineer.

4.13.00 Preparation of Pile head

4.13.01 The soil surrounding the piles shall be excavated upto the bottom of the lean concrete below the pile cap, with provision for working space, sufficient enough to place shuttering, reinforcement, concreting and any other related operations.

4.13.02 The exposed part of concrete above the COL shall be removed/chipped off and made to a uniform level at COL, but not before seven days of casting of pile.

4.13.03 The projected reinforcement above COL shall be properly cleaned and bent to the required shape and level to be anchored into the pile cap.

4.13.04 The pile top shall be embedded into the pile cap by 50mm or clear cover to reinforcement, whichever is higher.

4.13.05 All loose material, like debris due to chipping/breaking of pile head to the desired level, shall be removed and disposed off as directed by the Engineer.

4.14.00 Rejection and Replacement of Defective Piles

4.14.01 The Engineer reserves the right to reject any pile which in his opinion is defective on account of load capacity, structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the Engineer, at no extra cost to the Owner.

4.15.00 Recording of Piling Data

4.15.01 The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as shown in Appendix D of IS: 2911 Part I/Sec.2. The pile data shall also include all the details as in Annexure-D. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer within two days of completion of concreting of the pile.

5.00.00 SAMPLING, TESTING AND QUALITY ASSURANCE

5.01.00 Facilities required for sampling and testing of materials, concrete, etc. in field and in laboratory should be provided by the Contractor. The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and this Specification. Where no specific testing procedure is mentioned the tests shall be carried out as per the prevalent accepted engineering practice and as per the directions of the Engineer. Tests shall be done in the presence of the Engineer or his authorized representative. In case the Engineer requires additional tests, the Contractor shall arrange to get these tests done and submit to the Engineer the test results in triplicate within three days after completion of any test.

5.02.00 The Contractor shall maintain records of all inspection and testing, which shall be made available to the Engineer. The Engineer at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.

5.03.00 Materials found unsuitable for acceptance shall be removed and replaced by the Contractor. The work done by this unsuitable material shell be redone as per specification requirements & and to the satisfaction of the Engineer at no extra cost to the Owner.

5.04.00 Quality Assurance Programme

a) The Contractor shall submit and finalize a detailed Field Quality Assurance Programme within 30 days from the date of award of the contract, according to the requirements of this specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of field quality plan, etc. On finalized field quality plan, the Owner shall identify, customer hold points, beyond which work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated/ corrected by the qualified persons as frequently as possible to give accurate testing results.
b) Frequency of sampling and testing, etc. and Acceptance Criteria are given in Table - 1. The testing shall be done at field laboratory or any other laboratory approved by the Engineer. However, the testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the

appropriate specifications. The materials shall be tested to meet all the specified requirements before acceptance at manufacturers premises or at independent government approved laboratory. Tests indicated in the table are for cross checking at site the conformity of the materials to some of the specifications.

5.05.00 Testing of Concrete

5.05.01 Concrete and other materials shall be tested for quality, strength and other properties. Details of testing shall be as specified under technical specification for Cement concrete (Plain and Reinforced).

5.05.02 One sample consisting of six test cubes shall be made from the concrete used in each test pile, three to be tested after 7 days and three after 28 days.

5.05.03 For working piles, minimum one sample consisting of six test cubes shall be made from the concrete for the first ten piles, three to be tested after 7 days and three after 28 days. Thereafter, minimum one sample consisting of three test cubes for every 10 piles shall be tested for the 7-days & 28-days cube strength.

5.05.04 In preparation of test cubes or specimens vibrators shall not be used.

5.05.05 Concrete shall be tested for slump at every 1-hour interval during concreting of piles.

5.05.06 The frequency of sampling and testing of concrete and materials shall be done as per technical specification for cement concrete (Plain & Reinforced).

5.05.07 The acceptance criteria shall be as mentioned in Table-1.

5.06.00 Testing for position and alignment

5.06.01 Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.

5.06.02 Permissible limits for deviation shall be as specified under clause no. 4.03.

5.07.00 Properties of Drilling mud

5.07.01 Properties of drilling mud shall be checked as per requirement under Annexure C. Prior to the commencement of piling work and thereafter minimum once in a week or as found necessary by the Engineer, one sample consisting of 3 specimens shall be tested. Acceptance criteria applicable are as specified else where with 5% variation. This relaxation is not applicable for properties of drilling mud before concreting.

5.07.02 Density of the drilling mud shall be checked in each pile before concreting.

5.08.00 Check for Pile bore

5.08.01 On completion of boring and cleaning the bottom of each pilebore shall be checked from the sample collected from near the bottom of pile bore or by any other methods as approved by the Engineer, to ensure that it is free from pilebore spoil/debris and any other loose material, before concreting. Concreting shall be done only after the approval of the Engineer.

5.08.02 For sampling of drilling mud from the pilebore the following method or any other suitable method shall be adopted.

a) A solid cone shall be lowered by a string to the bottom of pilebore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, and then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimize the leakage while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.

b) Use of borehole camera for checking the pile bore spoil and strata is acceptable on approval of the Engineer.

5.09.00 Pile Integrity test

5.09.01 Low strain integrity test shall be conducted on 50% of the jobs piles and on all test piles or as directed by Engineer. The system shall have the computer readout facility and report on the findings of this shall be furnished to the Owner. This test shall be used to identify the job piles for routine load test.

Piles shall be trimmed to cut off level or sound concrete level. No pile cap blindage work should be undertaken prior to this test. The cast in-situ piles should not be tested before 14 days of casting.

5.09.02 The test shall be undertaken by persons trained and experienced and capable of interpreting the results with specific regard to piling. This test is limited to testing the integrity of the shaft and is not intended to replace the use of static load testing.

5.09.03 Low Strain Integrity Test Methodology:

a) In this test, a low stress wave is set up in the pile shaft and is also known as Sonic Integrity or Sonic Echo test.

b) A small metal/hard rubber hammer is used to produce a light blow on top of the pile. The shock wave travelling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/ accelerometer in a computer for subsequent analysis.

c) The primary shockwave, which travels down the length of the shaft, is reflected from the toe by the change in density between the concrete and sub strata. However, if the pile has any imperfections or discontinuities within its length these will set up secondary reflections, which will be added to the return signal.

d) By analysis of the captured signal and knowledge of the conditions of the ground, age of concrete, etc. a picture of the locations of pile shaft defects can be built up. The observed signals are amplified into digital display as velocity versus length records providing information on structural integrity of piles.

e) The stress wave velocity and approximate pile lengths are provided as input for the integrity testing. The stress wave velocity is dependent on the Young's Modulus and mass density of pile concrete.

f) More than one recording of signals shall be done until repeatability of signals is achieved on the same pile.

g) The tests shall be conducted at 3-6 locations to cover the entire cross section of the pile.

6.00.00 PILE TESTING

Pile load test shall be carried out as per IS:2911 Part-4 (latest edition) or as directed by Engineer.

6.01.00 INITIAL LOAD TEST

Initial load test shall be carried out on separately cast piles for confirmation of estimated pile capacities and to fix a more accurate driving criteria viz. set/bow, total number of blows and approximate depth etc. of founding level. At least 2 nos. of tests shall be conducted for each mode (vertical compression, pull out and lateral). The maximum test load shall be as mentioned in bill of quantities.

6.02.00 ROUTINE LOAD TEST

Routine load tests shall be carried out on job (working) piles for 0.5% of total no. of piles (for each mode and type). Maximum test load shall be 1.5 times the design safe load capacity. Piles showing unsatisfactory results as per load test results shall be treated as defective piles. Defective piles shall be removed or left in place and replaced

by additional piles as directed by Engineer at no extra cost to the owner. Any additional cost towards design implications, if any, due to above shall be born by the contractor.

7.00.00 CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 432 (Part 1 & 11) - Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.

IS: 456 - Code of practice for plain and reinforced concrete.

IS: 1200 (Part 23) - Measurement of Building and Civil Engineering works Piling.

IS: 1786 - Code of practice for twisted steel high strength deformed bars for concrete reinforcement.

IS: 1892 - Code of practice for Subsurface Investigation for foundation.

IS: 2131 - Method of Standard Penetration Test for Soils

IS: 2911 Part I/Sec 2 - Code of practice for design and construction of pile foundations - Bored cast-in-situ concrete piles.

IS: 2911 Part IV - Code of practice for design and construction of pile foundation - Load test on piles.

IS: 6926 - Code of practice for Diamond core Drilling for Site Investigation for River Valley Projects.

IS: 10262 - Recommended guidelines for concrete mix design.

8.00.00 RATES AND MEASUREMENTS

The clauses below shall apply for item rate contracts only. They shall not be applicable to turnkey/lump sum Contracts.

8.01.00 Rates

8.01.01 The items of work in the schedule of items, describe the work in brief. The various items in schedule of items shall be read in conjunction with the corresponding sections in the Technical Specifications, including amendments, and additions, if any. For each item in schedule of items, the unit rate shall include for the activities covered in the description of the item as well as for all necessary operations described in the specification and specific requirements.

8.01.02 The unit rates shall include for minor details which are obviously and fairly intended, and which may not have been included in the description in these documents, but are essential for the satisfactory completion of the work. Unit rates shall also include for all safety measures as required by codal provisions, local regulations, acts, bye-laws, etc. and for execution of work to the satisfaction of the Engineer.

8.01.03 The quoted rate for each item shall be inclusive of mobilization of all plant, equipment, scaffolding, labour, materials, skilled and unskilled labour, and demobilization after completion of work, supervision, establishing the level and coordinates at each work.

8.01.04 The quoted rate for piling for a particular diameter and capacity of pile shall remain valid for the actual lengths provided /to be provided irrespective of the minimum length specified elsewhere in this specification.

8.01.05 The quoted rate for piling as per description of item works shall be inclusive of providing all plant equipment, labour, materials, skilled and unskilled labour, making observations, establishing the ground level and coordinates at each location of pile by carrying levels from one established bench mark and distances from one set of grid lines furnished by the owner.

8.01.06 The quoted rate for piling shall be inclusive of bailing out all the pile bore spoil from the pilebore, keeping the borehole free from bored material/debris etc. and disposing the bored/chiselled material along with the drilling mud upto 2 Km. beyond plant boundary or as directed by Engineer, flushing the pile bore by fresh bentonite before concreting, collection of samples from bottom of pilebore, transporting to laboratory, testing and reporting of results.

8.01.07 The quoted rate for piling shall include shifting of plant and equipment from one pile location to another pile locations, providing temporary casing pipe and removal of the same after completing, concreting, supply of necessary materials, equipment and manpower, cost of boring by approved method as specified, circulation of bentonite slurry and cleaning of borehole free from sludge, as specified, etc.

8.01.08 The quoted rate for piling shall also include chiselling, if any, required for socketing the pile in rock.

8.01.09 The quoted rate for the piling shall include concreting by termite method, length of pile above COL, withdrawal of guide casing, cost for preparation of pile head and disposal of debris etc., resulting from breaking off of pile upto COL, upto a distance of 2 Km from the plant boundary or as directed by Engineer.

8.01.10 The quoted rate for piling shall also include providing reinforcement and its cleaning, straightening, cutting, bending, binding with annealed wire, welding, tackwelding, providing concrete cover blocks, spacers, placing the reinforcement cage in pile casing/bore and other cost of tools and plants, materials, labours, carting the steel from store to piling site and return of unused steel to the Owners storage point, etc.

8.02.11 Plasticiser/Admixture when used as directed by the Engineer shall be included in piling rates.

8.01.12 The quoted rate for piling shall include for all quality assurance requirements, but not limited to providing for technical inspection, transportation of samples to laboratory, testing samples, maintaining and submitting all test records, etc.

8.01.13 The quoted rate for boring in separate borehole shall be inclusive of performing of SPT at regular intervals as specified and collecting rock cores from boreholes, upto the depth as specified shall be inclusive of transporting to laboratory, testing and reporting of the results.

8.01.14 Unit rate for low integrity test shall be inclusive of mobilization of the entire set of equipment, computer readout, printer, and equipment which may not lave been included in the description but are essential for the satisfactory completion of the work as per internationally accepted practice. The rate quoted shall be inclusive of repeatability of test, preparation of pile top surface etc.

8.02.00 Measurement

8.02.01 Piling length shall be measurement by linear measurement from pile cut-off level to the tip of pile in meters upto second place of decimal separately for each diameter and capacity of pile. The length of pile to be cast above cut off level, as per specification, and as approved by Engineer, shall be considered for cement reconciliation only. Theoretical diameter of piles shall be considered for reconciliation of cement consumption. No extra payment shall be made for the length from existing ground to cut-off level.

8.02.02 Reinforcement steel shall be measured for reconciliation purpose only and the measurement shall be done for providing and placing reinforcement in piles, by weight in tones, up to third place of decimal in the following manner:

i) The weight shall be arrived at by multiplying the actual length measured alongwith standard hooks, rings or spirals, spacers, cranks, bends, authorized laps, etc. by sectional weight. These shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS code's sectional weight. Nothing extra shall be payable to the contractor on account of difference in weight, if any, due to different methods adopted for issue and measurement.

ii) Standard hooks, cranks, bend, authorized laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tones.

iii) Dowels, neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured.

8.02.03 Breaking off of piles, due to subsequent change in design cut off level, shall be measured separately. This shall be measured in cubic metres upto second place of decimal. This will be payable only when the pile is cast and on the basis of written instruction of the Engineer for lowering of COL.

8.02.04 Measurements for the item of boring in a separate borehole shall be measured in metres from ground level upto the depth as specified, upto second place of decimal. Item of work of boring in soil and coring in rock shall be measured separately for the actual length of boring in soil and coring in rock.

8.02.05 The item for pile integrity test shall be measured in terms of no. of piles tested.

ANNEXURE-A

Specific Requirements for Bored Cast-in-situ RCC Piles

A1.0 Minimum cement concrete grade M-25

Minimum cement content 400 Kg/M³

A1.1 Safe load

Diameter of Pile

Diameter of Pile (mm)	Vertical/ Compression (MT)	**Horizontal/ Lateral (MX)**	**Pul lout/Tension (MT)**
*	*	*	*
*	*	*	*

A2. Installation criteria

The installed pile(s) shall satisfy the following criteria.

A2.1 In Soil/weathered Rock

a) Minimum length of the pile shall be _____* m below COL.

b) The pile shall be terminated after penetrating through the strata having SPT penetration less than __* cm for ____* blows, for a minimum length of _____* times the diameter of the pile.

A2.2 In Rock

a) Piles shall be installed and socketed into the rocks for a length (socketing length) equal to _____* times the pile diameter subject to a minimum of _____* meter below the socketing horizon.

b) Socketing horizon shall consist of rock strata having minimum uniaxial compressive strength of _____* kg/sq.cm.

A3. Average cut-off level for tender design and initial load test can be assumed as _____* m below ground level.

A4. A protocol shall be signed between BHEL site and contractor regarding,

Strata at the founding depth

Installation criteria

Socketing depth

Density of bentonite before concreting

Slump of concrete.

Time interval between end of boring and start of concreting,

* Values shall be indicated separately depending upon subsoil strata of the site.

ANNEXURE-B

List of Equipments

SI.No	Description	Capacity No.
1.	Piling Rigs	
2.	Chisel	3 T min 6 T max
3.	High pressure Mud Pumps	10 HP min 25 HP max
4.	Bentonite mixing plants	
5.	Concrete batching plant	
6.	Soil testing equipments	

Note:

1. The no. and capacity of the piling equipment varies for each work.

2. Additional equipments shall be mobilized if required as per the directions of the Engineer to match the work schedule at no extra cost to the Owner.

ANNEXURE-C

Bentonite suspension used for piling work shall satisfy the following requirements

a) Liquid limit of bentonite when tested in accordance with IS: 2720(Part V) shall be more than 300 percent and less than 450 percent.

b) Sand content of the bentonite powder shall not be greater than 7 percent.

c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.034 and 1.10 gm/ml depending upon the pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite suspension after mixing with deleterious materials in the pilebore may be upto 1.25 gm/ml.

d) The Marsh viscosity when tested by a Marsh cone shall be between 30 to 60 seconds.

e) The differential free swell shall be more than 540 percent.

f) The pH value of the bentonite suspension shall be between 9 and 11.5.

ANNEXURE-D

PILE DATA

1. Reference No. Location (Co-ordinates) _____area.
2. Sequence of Piling
3. Pile diameter & Type
4. Working level (Platform level)
5. Cut off level (COL)
6. Actual length below COL
7. Pile termination level
8. Top of finished concrete level
9. Date and time of start and completion of boring.
10. Depth of Ground water table in the vicinity.
11. Type of soil at pile tip
12. Method of boring operation
13. Details of drilling mud as used:

    i) Freshly supplied mud
    Liquid limit -

    Sand content -

    Density -

    Marsh viscosity -

    Swelling index -

    pH value -

    ii) Contaminated mud
    Density -

Sand content -

14. SPT* N values in soil (from the nearest bore hole).
+UCS** value in rock (from the nearest bore hole).

* Standard penetration Test
** Unconfined compression strength

15. Chiseling if any, from..…... m to …..... m

16. Date and time of start and completion of concreting.

17. Method of placing concrete

18. Concrete quantity
Actual

Theoretical

19. Ref. Number of test cubes

20. Grade and slump of concrete

21. Results of test cubes

22. Reinforcement details:

Main Reinforcement	Stirrups: Type
No._____	No._____
Dia. _____	Dia._____
Depth _____	Spacing _____

23. Any other information regarding obstructions, delay and other interruption to the sequence of work.

TABLE -1

FREQUENCY OF SAMPLING AND TESTING

SI. No	Type of material work	Nature of Test/ characteristics	Method of Test & frequency	No. of test	Acceptance Criteria
1.	Pilebore size a) diameter b) length		Physical measurement	each pile	as per specification
2.	Founding level	to establish socketing horizon/ and or founding level & upto depth 5m below founding level.	in separate borehole meant for the purpose a) SPT in soils/ weathered rock b) Core & UCS value of rock	1 borehole for 100-150 piles or group of 150 Sqm	Annexure - B
3.	Bentonite (Mud) properties. a) Basic properties of bentonite before use. b) Contaminated mud from pile bore bottom before concreting	Liquid Limit, Marsh Viscosity, Specific gravity, sand content, swelling index, pH value. Density, sand content	in lab in lab	As per Cl. 5.7 Each Pile	As per Annexure C As per annexure C
4.	Position and Alignment	-	Physical or any Approved method	Each Pile	As per Cl. 4.3
5.	Cleaning of pilebore	-	As per Cl. 5.8	Each Pile	Pilebore be free from bored materialcuttings debris/sludge
6.	Reinforcement (R/F) Spacing of longitudinal R/F cover laps binding of laterals		Physical inspection and measurement	each cage	As per approved design
7.	Concrete a) Workability b) Cubes	 Slump cone test Compressive Strength test	 Each pile As per spec.	 As per Cl. 5.5 As per Cl. 5.5	 As per specification. As per IS: 456
8.	Materials like aggregate, sand etc.	As per technical specification for concrete and relevant IS codes			
9.	Pile head		Physical	each pile	

SECTION - D

SUB-SECTION – D22

SITE LEVELLING AND GRADING

C O N T E N T

CLAUSE NO	DESCRIPTION
1.00.00	GENERAL
2.00.00	SCOPE
3.00.00	MATERIALS
4.00.00	QUALITY CONTROL
5.00.00	EXECUTION
6.00.00	RATES AND MEASUREMENTS

TECHNICAL SPECIFICATION
FOR
SITE LEVELLING AND GRADING

1.00 GENERAL

This specification cover the works to be carried out for "Site Levelling and Grading Works including Slope Protection" etc for the entire plant and associated areas. The specified formation level(s) shall be achieved either by excavation or by raising with controlled fill with excavated/borrowed earth as the case may be.

2.00 SCOPE

2.01 The scope include all works involved in levelling the site to the lines, grades, cross sections and dimensions as shown on the approved drawings and/or as directed by the engineer including site clearance, setting out, earth work in excavation, stacking, loading, transportation, unloading, dewatering, drainage, filling, watering, compaction, turfing on slopes (if required), lighting, disposal of residual/surplus earth etc. It also include supplying and providing all labour, materials, supervision, services, equipments, tools and plants, testing and all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work etc.

2.02 All tools and plants, equipments and machineries to be used in this work shall be of standard quality and manufactured by reputed concerns conforming to Indian Standard (IS) codes or equivalent thereof.

2.03 Work to be provided by the Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision, services including as required under statutory labour regulations, materials, equipments, tools and plants, approaches, transportation etc required for the completion of the work.

b) Preparation and submission of detailed scheme of all operations required for executing the work (material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

2.04 Work to be provided by others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.05 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) codes unless specified otherwise.

IS: 1200	Methods of measurement of building and civil engineering works, Part-1: Earth work
IS: 2720	Method of test for soils (Relevant parts)
IS: 3764	Excavation work- Code of safety
IS: 4081	Safety code for blasting and related drilling operations
IS: 4701	Code of practice for earth work on canals
IS: 6922	Criteria for safety and design of structures subject to underground blasts

In case of conflict between this specification and those (IS codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by the specification or/and by the IS codes, any other standard practice as may be specified by the engineer shall be followed.

2.06 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

3.00 MATERIALS

All materials required for the work shall be of best variety and approved by the engineer.

3.01 Materials for Excavation

For the purpose of identifying the various strata met during the course of excavation, the following classification are to be followed.

a) Soil

It include all type of soil including laterite, moorumetc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall underclause 3.01 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However,the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

3.02 Materials for Filling

Any coarse grained or fine grained low plastic soil free from vegetation, roots, shingle, salts, organic matters, sod and any other harmful chemicals shall be used for filling. The contractor shall test the fill material to establish its suitability and submit the results to the engineer for approval. Fill material shall be got approved by the engineer. The following type of materials shall not be used for filling.

a) Materials from swamps, marshes and bogs
b) Expansive clays
c) Peat, logs, sod and perishable materials
d) Materials susceptible to combustion
e) Any material or industrial and domestic produce which will adversely affect other materials of work
f) Materials from prohibited areas

The earth available by cutting the high grounds within the project site and the materials (if) available from the road excavation or any other excavation under the same contract shall be used for filling depending upon its suitability as fill material. Filling with excavated rock (in the project site) shall be done only with the written permission of the engineer in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling. In case the earth required for filling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. He shall obtain and submit the necessary clearances/permissions from the concerned authorities to the engineer for the borrow areas/materials acquired.

4.00 QUALITY CONTROL

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Filling	(a) On quality of fill material (b) On moisture content of fill material (c) On degree of compaction achieved

5.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of approaches, dewatering (if any), drainage and compaction etc within 15 days of award of the contract to the engineer for approval.

5.01 Site Clearance

Before the commencement of earthwork, the entire area of cutting and filling shall be cleared of all trees, stumps, bushes, grasses, vegetation etc with their roots, fences, logs, rubbish, water, slush etc. It is not necessary to remove all the soil containing fine hair

like roots but only the rather heavy mats are to be removed. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below the existing ground level or 300mm below the formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed off to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timbers, fire woods etc shall be the property of owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

5.02 Setting Out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for the ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost. The contractor shall take spot levels of the area (with respect to the bench mark/ available source as provided by the engineer) to be excavated or to be filled at an interval of not more than 10m or as directed by the engineer before starting any earth work and shall be submitted to the engineer for prior approval.

5.03 Excavation

Levelling by excavation shall be carried out where the existing ground levels are higher than the specified formation level. Excavation shall include removal of all materials whatever nature as may be and whether wet or dry shall be carried out exactly in accordance with the line, levels, grades and curves shown on the approved drawings and/or as directed by the engineer. All excavations shall be done to the minimum dimensions as required. The contractor shall obtain prior approval of the engineer for the method he proposes to adopt for excavation in different types of strata including dimensions, side slopes and dewatering if any, stacking or disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. **Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**

The rough excavation may be carried up to a maximum depth of 150mm above the final formation level. The balance shall be excavated with special care and the final surface shall be compacted by rolling with 6 passes of 8 to 10 tonne roller. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The contractor shall be paid for the extra excavation and filling at the appropriate items of work.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the engineer due to the contractor's fault, the excess depth shall be filled up to the required level with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer at the own risk and cost of the contractor.

Suitable slope in cutting as per the requirements and as directed by the engineer shall be adopted to withhold the face of earth. The contractor shall be held responsible for any damage to any part of the work caused by the collapse of the side of excavations.

5.03.01 Excavation in Hard Rock

Excavation in hard rock shall normally be done with blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces.

5.03.02 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well asfor obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his

authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.
The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefullyexamined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicleconveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation

connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect

carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole.The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

5.03.04 Restrictions on Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

5.04 Sorting of Excavated Materials

The excavated material shall be carefully sorted for use in filling the areas in the project site by removing roots, grasses, organic matters and other objectionable materials and be sorted out into different types of materials for use and as directed by the engineer. The excavated material which is not considered fit for filling purpose shall be immediately removed and disposed at such a place and in such a manner as will be directed by the engineer. The material found unusable should be got approved by the engineer before actually disposing it off. The useful materials that cannot be used directly shall be heaped in separate area as stock piles. Stockpiles shall be of regular size as for as possible for ease of measurement. The materials heaped shall be utilised as and when required and as directed by the engineer. The cost of complete item of earthwork includes the cost of rehandling of the materials and temporarily heaped and reused.

5.05 Disposal of Surplus/ Waste Materials

Surplus and other waste materials shall be removed and disposed of from the construction site to the area demarcated by the engineer. No material shall be wasted unless approved by the engineer.

5.06 Earth Work in Filling

Levelling by raising with controlled fill of approved excavated/borrowed earth shall be carried out where the existing ground levels are lower than the specified formation level. After clearing site as per clause 5.01, the original ground shall be compacted by rolling subject to a minimum 6 passes of 8 to 10 tonne roller. The approved earth/fill material shall then be spread in horizontal layers not exceeding 300mm in compacted thickness. Each layer shall be watered and thoroughly compacted with proper moisture content and such equipments as may be required to obtain a minimum of 95% of its maximum dry density as determined by standard Proctor's test as per IS: 2720, part-VII. Moisture content of the fill material shall be controlled near optimum moisture content during compaction

The fill material shall be tested for its optimum moisture content and maximum dry density as per IS: 2720, part-VII. Moisture content shall be checked at the source of supply in accordance with IS: 2720 part- II and if found less than that required for proper compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from the hose line or from the truck-mounted water tank etc making due allowance for evaporation losses and the fill material be thoroughly mixed by means of harrows, rotary mixers or by any other suitable approved method until the layer is uniformly wet. **Flooding shall not be permitted for watering purpose under any circumstances.** If the material delivered is too wet, it shall then be dried by aeration and exposure to the sun till the moisture content is suitable for compaction. Should circumstances arise owing to wet weather the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended. Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the layers before compaction. For each of the above tests on the fill material, one sample for every 10,000cu.m shall be tested. Additional samples shall be tested whenever there is a change of source or type of material.

Before start of filling, the contractor shall submit the engineer his proposal for the methodology to be adopted for compaction. The compaction equipments as approved by the engineer shall only be employed to compact the different type materials encountered during construction. If directed by the engineer, the contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The compacted layer shall be tested for its dry density as per IS: 2720**,** part-XXVIII or XXIX as directed by the engineer. Samples shall be taken at the rate of one sample for every 10,000sq.m area of each compacted layer. In addition random checks shall be carried out in compacted layers by means of Proctor needle penetration test. Contractor shall submit all the test results to the engineer immediately after completion of the tests. A sample shall be deemed to have passed the test when the dry density of the compacted fill is equal to or more than 95% of its maximum dry density. When field density measurements reveal any soft areas in the fills, further compaction shall be carried out as directed by the engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be replaced with approved material compacted to the density requirements and satisfaction of the engineer.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the engineer.

Where the filling is to be done across low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

5.07 Dewatering and Drainage

It shall be ensured that the area to be excavated/filled shall be free from water. The contractor shall remove the water (if any) by pumping or by any other means as approved by the engineer. At all times, the surface of cutting/filling during execution shall be maintained at such a cross fall as will shed water and prevent ponding. All existing drains/channels (if any) in the work area shall be suitably diverted by the contractor before taking up any excavation or filling. These diversions shall be such that it shall ensure effective disposal of water without any accumulation or flooding within the project site and in adjoining areas.

5.08 Finishing Operations

Finishing operation shall include the work of shaping and dressing the excavated/filled ground to the required grades, levels, lines, side slopes, cross-sections and dimensions as shown on the approved drawings or as directed by the engineer.

5.09 Turfing

Turfing shall be provided at the slopes and other locations as shown on the drawings or as directed by the engineer. The turf shall be of approved quality of grass. The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. The grass on the sod shall have a length of approximately 50mm and

the sod shall be free of any debris. Thickness of the sod shall be as uniform as possible with 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that all the dense root system of the grasses are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than about 300mm x 250mm size but not so large so that it is convenient to handle and transport without damage.

The area to be sodded shall be previously constructed to the required slope and cross section. Prior to placing the sods, the slopes shall be roughned and wetted in order to have a satisfactory bond. The strips of sod shall be laid in close contact with each other and be tamped firmly in place so as to fill and close the joints between them. The turfing so laid shall be well watered and protected until final acceptance.

5.10 Approaches

The contractor shall provide proper approaches for workmen and inspection.

5.11 Lighting

Full scale lighting are to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the edges of excavations and fills.

6.00 RATES AND MEASUREMENTS

6.01 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

a) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

6.02 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS: 1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numericals shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in cutting shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rocks so arrived shall be taken as soil.

e) For earth work in filling, the actual measurements of fill shall be calculated by taking levels of the original ground before start of the work but after site clearance and after compaction of fills. The quantity of earth work in filling shall be computed from these levels in cubic meter.

f) For turfing, the measurement shall be made on the finished work in square metre.

SECTION - D

SUB-SECTION – D23

ANTI- TERMITE TREATMENT

C O N T E N T

CLAUSE NO	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	RATES
5.00.00	METHOD OF MEASUREMENT
6.00.00	I.S. CODES

TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT

1.00.00 SCOPE

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.
All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.
Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 Chemicals and Rate of Application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals		Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	:	0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	:	1.0

2.02.01 Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M^2 of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M^2 of the vertical surface. Chemical treatment shall be done in stages following the

compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

2.02.02 **Treatment of Top Surface of Plinth Filling**

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M^2 of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.02.03 **Treatment of Soil Surrounding Pipes, Wastes and Conduits**

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.02.04 **Treatment of Expansion Joints**

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.02.05 **Treatment at Junction of the Wall and the Floor**

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.
A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 ACCEPTANCE CRITERIA

The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.

4.00.00 RATES

Rates shall be of complete work per unit area as stated in the Schedule.

5.00.00 METHOD OF MEASUREMENT

Complete work of anti-termite treatment shall be measured for plinth area treated.

This includes treatment, to foundations, walls, trenches, basements, plinth, burried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work.

6.00.00 I.S. CODE

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981 : Code of Practice of Anti-Termite Measures in Buildings Pre-constructional chemical treatment measures.