5) **Load from handrail:**

   Wt. of side hand rail
   Wt. of other hand rail
   Load from hand rail (other than side HR) to be considered

II. **LIVE LOAD (LL):**

1) **Load on Roof:**

   Load intensity assumed to be acting on Internal Pannel and transferred to the trusses.

2) **Load on floor:**

   LL on 0.8 m wide right/left walkway and 0.175 m wide seal plate supporting members
   LL on bottom chord members from 0.175 wide seal plate
   LL from 0.175 m wide seal plate and 2.05 m wide seal plate supporting members
   LL from 1 m wide middle walkway and 0.175 m wide seal plate supporting members

3) **Material Weight:**

   Total Material weight of conv.(belt wt.+ live load on deck plate)
   Load from each short post/side is calculated based on Short post spacing

4) **Load from pipe:**

   Weight of service water pipe to be considered
   Weight of DS water pipe to be considered
   Weight of potable water pipe to be considered

5) **Load from Cable Tray:**

   Load intensity of cable tray on one girder to be considered
   Load intensity of cable tray on other side (pipe side)
   girder to be considered

6) **Load from Lighting Arrangement:**


30 kg on each node

7) **Load from Fire Fighting Pipe Line:**

Weight of Fire Fighting pipe to be considered.

III. **WIND LOAD:** As per IS.875 (Part.3)

1) **Load on Roof:**

Based on height and width of the gallery
And angle of roof
Wind pressure coefficients for roof to be calculated as per IS875 (Part3) and Consider
When wind blows across the conv.
When wind blows along the conv.
The pressure coefficients to be calculated on Windward Side and Leeward side with different configurations to be computed.
From this, UDL on Roof truss and end panels are to be computed.

2) **Load on Side Sheeting:**

Consider height, width and length of the gallery
and calculate the Wind pressure coefficients for roof as per IS875
When wind blows across the conv. and When wind blows along the conv.

Compute the following load cases
**When wind is blowing across the conv.**

Wind pressure in windward side
Wind pressure in leeward side

**Wind load on verticals (Intermediate Panels)**
Windward side (on Top support)
Windward side (Bottom support)

Leeward side (on Top support)
Leeward side (Bottom support)

**Wind load on Portal**

Windward side (Top support)
Windward side (Bottom support)

Leeward side (Top support)
Leeward side (Bottom support)

*When wind is blowing along the conv.*
(Both windward and Leeward direction are opposite in sign)
wind pressure in perpendicular direction to wind flow

*For Intermediate Panels*

Wind Load on the verticals (Top support)
Wind Load on the verticals (Bottom support)

*For End Portal*

Wind Load on the portals (Top support)
Wind Load on the portals (Bottom support)

**Additional load to be considered**
- Seismic load
- Temperature load

*************************************************

Summation of Load cases and Load combinations to be considered for analysis and design

****************************************************

LOAD 1 [DL]
****************************************************

SELFWEIGHT
*****Load on Roof:
JOINT LOAD
MEMBER LOAD
*****Load on Floor
****DL on  left walkway and seal plate supporting members
******DL on right walkway and seal plate supporting members
****DL on Bottom chord members from Seal plate
*****DL from seal plate and seal plate supporting members
****DL from middle walkway and seal plate supporting members
*****Load of side Sheeting and Side Runner:
***Conveyor Load:
*****Load from handrail
*****Wt of other Hand rail
******Load of side Hand rail

LOAD 2 [LL]
************************************************

********Load on Roof:

JOINT LOAD
MEMBER LOAD
*****Load on Floor
******LL on left walkway seal plate supporting members
*****LL on right walkway and seal plate supporting members
******LL on Bottom chord members from Seal plate
MEMBER LOAD
******LL from seal plate and seal plate supporting members
*****LL from middle walkway and seal plate supporting members
****Material Load:
MEMBER LOAD
****Load from Pipes:
****Load from Cable Tray:
*****Load from Lighting Arrangement:
JOINT LOAD
*****Load from Fire Fighting Pipe Line:
MEMBER LOAD
LOAD 3 [WL(+X)]
************************************************

******Load on Roof:
*****load on roof trusses

JOINT LOAD
*****Load on Side Sheeting:
****Windward side
MEMBER LOAD
LOAD 4 [WL(-X)]
************************************************

******Load on Roof:
*****load on roof trusses

JOINT LOAD
*****Load on Side Sheeting:
****Windward side
****leeward side
 ****************************************
LOAD 5 [WL(+Z)]
 ****************************************
*****Load on Roof :
JOINT LOAD
******Load on Side Sheeting :
****Windward side
MEMBER LOAD
***leeward side
 ****************************************
LOAD 6 [WL(-Z)]
 ****************************************

******Load on Roof :
JOINT LOAD
******Load on Side Sheeting :
****Windward side
MEMBER LOAD
***leeward side
 ****************************************
LOAD 7 SEISMIC LOAD SL (X)
***JOINT LOAD
 ****************************************
LOAD 8 SEISMIC LOAD SL (Z)
***JOINT LOAD
 ****************************************
LOAD 9 TEMPERATURE LOAD TL
***JOINT LOAD
 ****************************************

Following Load combinations to be considered in analysis

LOAD COMB 101 [DL+LL]  
1 1.0 2 1.0
LOAD COMB 102 0.75[DL+LL+WL(+X)]  
1 0.75 2 0.75 3 0.75
LOAD COMB 103 0.75[DL+LL+WL(-X)]  
1 0.75 2 0.75 4 0.75
LOAD COMB 104 0.75[DL+LL+WL(+Z)]  
1 0.75 2 0.75 5 0.75
LOAD COMB 105 0.75[DL+LL+WL(-Z)]  
1 0.75 2 0.75 6 0.75
LOAD COMB 106 [0.9DL+WL(+X)]
1 0.9 3 1.0
LOAD COMB 107 [0.9DL+WL(-X)]
1 0.9 4 1.0
LOAD COMB 108 [0.9DL+WL(+Z)]
1 0.9 5 1.0
LOAD COMB 109 [0.9DL+WL(-Z)]
1 0.9 6 1.0
LOAD COMB 102 1.0[DL+LL+WL(+X)]
1 1.0 2 1.0 3 1.0
LOAD COMB 103 0.75[DL+LL+WL(-X)]
1 1.0 2 1.0 4 1.0
LOAD COMB 104 1.0[DL+LL+WL(+Z)]
1 1.0 2 1.0 5 1.0
LOAD COMB 105 1.0[DL+LL+WL(-Z)]
1 1.0 2 1.0 6 1.0

**Mathematical model Input requirements**

- The mathematical model prepared should have
- Nodal Data
- Member connectivity Data
- Member sectional Data base of all the different types of sections (Standard rolled as well as built-up sections)
- Member material specifications
- Member end release data
- Member truss information
- Support specification in appropriate coordinate system (should consider inclined galleries and its inclined supports)
- Loading data as specified above
- Design Parameters for design of members as per IS800 like
- Effective length of each member in both directions for design
- Design deflection limits
- Design allowable yield stress
- Net effective allowable interaction factors for wind/seismic as well as Dead load cases
- Analysis and design commands
Automated Iterative Procedure for Weight Optimization (using STAAD Pro.)

The programs should choose automatically the required section from the software database of similar sections and perform the optimization interactively to get best possible weight reduction to satisfy the relevant codes of practice under considerations. The main requirement of developed tool is that the complete optimization runs to be carried inside STAAD Pro without any user intervention.

The output should include

Design results with interaction factors or reserve strength available for each member
The optimized member sizes and
Steel requirement tables section wise and plate thickness wise if applicable.

Analysis and Design Checks and Optimization

1) Calculate the seismic coefficients and loading as per IS1893 and impose the loadings in both horizontal directions as separate load cases in the preprocessor if seismic analysis is required.

2) generate different load combinations as per IS800

3) Calculate effective lengths of each of column members in both X and Z directions (Y is vertical direction)

4) Execute the job for all the load cases

5) Code check the results as per IS800 working stress design

6) Optimize or resize /modify the properties as per code check results and rerun and recheck and repeat if necessary

7) Calculate approx. weight of structural members based on property.

8) Calculate Raw material weight if different from above

9) Export various figures to Auto cad or DXF files

12) Preparation of complete report automatically

13) The developed tool along with source code to be submitted

14) Installation and User manual to be prepared and submitted
Delivery/Execution Scheme:

The delivery/Execution of the developed tools must be in a proper stepped delivery (Execution in parts) for immediate implementation of the programs at BHEL for their use.

Stage 1:

a) Preliminary GUI for input data:

The typical GUI screens consist of different parameter to be fed for proper mathematical modeling and analysis requirements.

Typical Forms required (not limited to those shown as an example here) are as shown below:

The first form should also include option for designing double conveyor gallery. This input from should have links to show basic wind speed, map and values of various Indian Cities as per IS875 code and also show the seismic zones, Indian Map and zone factors for various cities in India as per IS1893 code of India.

A typical input data forms is shown below for double conveyor gallery (please note that the variables shown in the figures are tentative and will depend on the actual problem, there may be more variables or less than shown below).
The above input form is for feeding various loads i.e., Dead, Live and Wind Loads from gallery. Since each trestle carries two galleries, provision has to be given for loads from both.

The above shows a typical input sheet and there may be other parameters need to be included as per requirement of load calculations and model preparation.

All these forms have to be prepared taking into consideration of all the possible input data as required for correct mathematical modeling and preparation of design data input files.

There will be certain number of inputs as default values and the user should be able to modify these values with proper check button controls. Controls are also required to move back and forth the forms.
Stage 1 (b)

The mathematical model should consist of (but not limited to the following)

i. Nodal Coordinates.
ii. Member connectivity,
iii. Preparation of data base of all the sections as per Indian Codes,
iv. Identification of truss elements and member end release codes,
v. Support and material specifications,
vi. Material specifications
vii. Identification of members with proper section with sectional data base tables.

Stage 2

i. Calculation of effective lengths of various members as per their end connections,
ii. Dead Load calculations
iii. Live load calculations,
iv. Wind load calculations as per IS875 code
v. Seismic load generation, if required as per IS1893
vi. All other loads and relevant load combinations as per codal requirements (IS800)
vii. Generation of various parameters required for IS 800 code check
viii. Imposition of loads in the model and creation of different loads and their combinations as required by Indian Design codes of practice.

Stage 2

i. Automatic creation of input files as required for different soft-ware mentioned above
ii. Automatic execution of analytical model and tabulating the required forces and moments required for code checking as per IS800
iii. Finding out the reserve strength and carryout the optimization automatically within the GUI prepared without any user intervention with the available database of sectional sizes as specified by BHEL
iv. Preparation of final Optimized input files and running automatically and tabulating the results of code checks

v. Calculation of bill of material and raw material requirements

vi. Preparation of design report automatically with all the tables of input as well as output results and code check results with BOM

vii. Preparation of .dxf files of model for use in AutoCAD

**Software tool Requirement for Double Conveyor Gallery**

The following tools have to be developed based on the above logic and instructions for calculation of loads for preparation of mathematical model and for analysis and design with final optimized structure. (GUI based Design) in a single stroke of inputs.

Automated Development tool (for seamless execution at the push of a button) to be developed for

1) Double Conveyor Gallery of varying span of 6m to 30m.

All the above tools should be prepared with the parameters (like different inclinations, different loads on belt, different wind loads etc) as mentioned in this specification.

**General:**

All the above tools should be prepared with the parameters (like different heights, different loads due to wind etc) as mentioned in this specification.

The analytical model data is to be prepared initially (in FEMAP API) and should be checked and approved by the indenting department before proceeding with the process of analyzing and interfacing with the analytical software for design and optimization with automation.
Finally a common GUI is to be prepared to choose appropriate height of trestle, type of section used for bracing as the case may be. The project data like loads, inclinations etc should then be chosen in a stepped manner for creating the mathematical model. The analysis has to be carried out, design and optimization be done seamlessly and automatically without user intervention by interfacing the code developed with the analysis programs as given above.

The output will be optimum design of the structure with relevant sectional data and required drawings in AutoCAD .DXF file formats and with automatic generation of required report.

The responsibility of the Structural Engineer is to be intact continuously with the BHEL team as well as the software code developers for guiding and checking the Analytical programs for satisfactory working of the tool and all code requirements as needed.

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**Delivery Schedule**

**Delivery Part 1**

First Phase to be completed within 10 weeks after placement of Purchase order consists of

Stage 1 Part (a) and Part (b)  the details of mathematical model and tool for generating the model in FEMAP for the following,

1) Four legged trestle Structure of height varying from 4m to 120m with flat members.

2) Four legged trestle Structure of height varying from 4m to 120m with combination of flat and tubular sections.

**Delivery Part 2**

Preparation of other data such as effective length calculations, load calculations as per Stage 2(I) to Stage 2(Viii) within 10 weeks after delivery of above with validation (from BHEL) for Trestles including the required GUI Programs

**Delivery Part 3**

Preparation of input file and integrating with other standard software like STAAD Pro , Design checks with STAAD Pro, Automatic runs for generation of Optimized structures (2ix to 2xiii) ,Validation of both files for trestles to be delivered within 8 weeks after part 3 above
Delivery Part 4

Delivery of final part consisting of one Final GUI incorporating all the above required modules and submission of User manuals, details of software codes, list of files generated as required in the specifications etc to be submitted within 4 weeks after Part 4 delivery.

The above delivery periods are to be adhered strictly in order to complete the Project in time. The manpower should be able to complete the given tasks in time and it is the responsibility of the Successful party/firm to see that the work is completed in time as described.

Note:
The concerned engineers have to enter into Non Disclosure Agreement (NDA) with BHEL before taking up this work and the Information contained in Tender Documents is confidential and should not be used for any other purpose other than for quoting/executing for this envisaged work.

------------------------------------------ End of Tender Specification ------------------------------------------
Tender Specifications – Sample Problem

Objective: To develop an automation tool for optimizing the portal (Fig 1.1) member sizes subjected to the following loading conditions.

Fig 1.1 Typical Portal Frame – (The structure may be assumed to be symmetrical about the vertical center line)
The following have to be demonstrated in the program

1. GUI – To provide input parameters for creating geometry.
   (Width of Portal Frame, Height and Roof Slope)

2. Mathematical model in Femap (Generation of Nodes, Elements, Properties and Boundary Conditions by interfacing with Femap API).

3. GUI – To provide input for Loading (magnitude of UDL and concentrated load and load combinations)

4. Export the .modfem (Femap Model) model into STAAD Pro.

5. Convert the properties as per IS code specification.

6. Generate and Impose loads on the model (UDL and concentrated loads have to be separate load cases)

7. Static Analysis of the model

8. Optimize and design the member sizes.

9. Display property wise weight and total weight of the structure.

Source code of the program (developed for the example problem should be submitted along with the .exe file.)