PILING PART-V
TESTING OF CONCRETE PILES

REV. NO.  PREPARED  APPROVED  DATE
00        Marina       P Mishra

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEVY ELECTRICAL LTD. It must not be used directly or indirectly in any way detrimental to the interest of the Company.
CONTENTS

1. GENERAL
2. VERTICAL LOADING TESTS
3. LATERAL LOADING TEST
4. PULL OUT CAPACITY OF PILES
5. COMBINED VERTICAL AND LATERAL LOADING
6. SPECIAL TYPE OF LOADING

APPENDIX 1 – PILE LOADING TEST RECORD
1. GENERAL

1.1 Scope

1.1.1 This specification covers the requirements and methods of testing of a single pile for evaluating its safe capacity in:

a) Vertical Loading (compression)

b) Lateral loading

c) Pull out.

d) Combined vertical and lateral loading.

e) Special type of loading such as vibratory loadings.

1.1.2 These specifications shall be applicable for all types of piles in general excepting sheet piles.

1.1.3 For specific work requirements or otherwise modifying or supplementing the provisions of this specification, refer to specific requirements. In case of conflict between requirements set forth in the specific requirements and the provisions of this specification, the specific requirements shall govern.

1.2 Definitions

1.2.1 Reference to Indian Standard codes shall always mean reference to the latest issue of the relevant standards, including all the amendments up to date.

1.3 Codes

1.3.1 All testing shall be performed in accordance with the following codes and the provisions of these specifications:

IS: 2911 – (part-IV) – Codes of practice for design and Construction of Pile Foundations – Load test on piles.

1.4 Requirements

1.4.1 The load test shall be required to provide data regarding the load – deformation characteristics of the pile up to failure or otherwise specified and the safe design capacity.
1.4.2 Full details of the equipment proposed to be used and the test set up shall be submitted to the Engineer-in-Charge with detailed sketches for approval. Approval of the Engineer-in-Charge shall be also be obtained after the test set up is complete, prior to commencement of loading.

1.4.3 All measuring devices shall be tested satisfactory performance and accuracy at an approved institution and certificate to that effect obtained and submitted to the Engineer—in-charge, prior to use.

1.4.4 The test pile shall be constructed using the same equipment and technique as for the job piles.

1.4.5 A minimum time period of one week shall be allowed between the time of installation and testing in case of a precast pile and less than four weeks from the time of vesting in case of a cast-in-situ pile.

1.4.6 Records

A full record giving all details of the test in the Proforma in appendix-1 shall be submitted in TRIPlicate to the Engineer-in-Charge immediately on COMPLETION of each test. The record shall also include the plot of load-time settlement characteristics of the piles.

2 VERTICAL LOADING TEST:

2.1 Equipment and test Set-up

2.1.1 Test pile

2.1.1.1 The test pile shall be decided by the Engineer-in-Charge. It may be one of the working piles or separate test pile.

2.1.1.2 The head of the test pile shall be brought to the proper level and provided with a pile cap with a moral and plane surface and with adequate space for proper seating of a jack and dial gauges.

2.1.1.3 Test pile surface shall be prepared for testing purposes on the expiry of one week after casting the pile.

2.1.2 Loading Systems

2.1.2.1 Loading shall be applied by the reaction method consisting of an hydraulic jack reacting centrally against a loaded platform. Supports of the platforms shall be adequately designed. Special anchor piles or any other suitable type of anchorage system may also be used. However, use of the uplift supply of neighboring piles for providing the reaction shall normally not be permitted.
2.1.2.2 The loading system shall be adequate to ensure that the test can be carried up to
the specified limit. The reaction to be made available for the test shall be at least
25% greater than the maximum jacking force required.

2.1.3 Measuring System

2.1.3.1 Loading on piles

The load applied on the pile shall be recorded on a calibrated pressure gauge
mounted on the jack.

2.1.3.2 Settlement of pile

a) Settlement of pile shall be recorded by dial gauges suspended from datum
bars.

b) The datum bars shall have rigid supports preferably of concrete pillars or
steel section, embedded well into the ground. The supports shall be locked
more than three times the piles diameter, subject to a minimum of 1.5 M,
clear away from the pile face and also sufficiently away from the supports
of the loaded plat from to avoid any disturbance on these accounts.
Movements near the supports of the datum bar shall be avoided while the
test is in progress.

2.2 Method of conducting Test

The test shall be carried out by the direct method of loading in successive
increments or by the cyclic loading method as specified and as directed by the
engineer-in-charge.

2.2.1 Direct Method of Loading in Successive Increments

The test shall be carried out as per the procedure outlined.

a) The load shall be applied to the pile top in increments of about one fifth
the rated capacity of the pile or as specified. Settlement readings shall be
taken before and after the application of cash new load increment and at 2,
4, 8, 15, 30, 60 minutes and at every two hours until application of the next
load increment.

b) Each stage of loading shall be maintained till the rate of movement of the
pile top is not more than, 0.1 mm in first 30 minutes, 0.2 mm per hours or
until two labours have elapsed, whichever is later.

c) Yield of soil-pile system occurs causing progressive settlement of the
pile exceeding a value of one tenth of the pile diameter.
(II) The loading on the pile top equals twice the rated capacity or as specified in the case of a separate test pile and 1.5 times the rated capacity of the pile in case of a working pile.

d) Where yielding of the soil does not occur, the full test load shall be maintained on the pile head for 24 hours or more if necessary and settlement reading shall be taken at 6 hours interval during the period.

e) Unloading shall be carried out in the same steps as loading. A minimum period of ½ hour shall be allowed to elapse between two successive stages of load decrement. The final rebound shall be recorded 6 hours after the entire test load has been removed.

f) If so directed by the Engineer-in-charge, loading and unloading cycles shall be carried out for all load stages within the assumed working load.

g) Assessment of Safe Load:

The safe of the pile shall be the least of following values:

i) 2/3 of final load at which the total displacement attains a value of 12mm. Unless otherwise required, in given case on the basis of nature and type structure in which case, the safe load should be corresponding to the stated total displacement permissible.

ii) 50 percent of final load at which the total settlement equate the 10% of pile diameter in case of bored piles and 7.5 percent of bulb diameter in case of under-reamed piles.

2.2.2 Cycle Loading Test

The test shall be carried out as per the procedure outlined by IS: 2911 – (part – IV) and as described below:

a. The load shall be supplied to the pile top in increments of about one fifth the estimated safe capacity of the pile or as specified. Settlement readings shall be taken before and the application of each new load increment and at 2, 4, 8, 15, 30, 60 minutes and at every two hours until application of the next load increment.

b. Alternate loading and unloading shall be carried out at each stage and the total and net settlements recorded as specified. If so directed by the Engineer-in-charge, more then one cycle of loading and unloading shall be carried out at any or all of the stages.
c. Each stage of loading or unloading shall be maintained till the rate of movement of the pile top is not more than 0.2 mm per hour provided that the minimum period is two hours for loading and one hour for unloading. The following load stages shall however be maintained for longer periods as given below:

i) At 1.5 times assumed safe capacity (for routine test only) - 24 hours.

ii) At load of twice assumed safe capacity (for initial test only) - 24 hours

This loading shall be continued till one of the following occurs:

i) Yield of the soil pile system occurs causing progressive settlement exceeding one tenth of the pile diameter.

ii) The loading on the pile top equals twice the estimated safe load in case of a separate test pile and 1.5 times the rated capacity of the pile in case of working pile.

d) Assessment of Safe Load:

The safe capacity of the pile shall be the least of the following:

i) Two thirds of the final load at which the total settlement attains a value of 6 mm.

ii) Two thirds of the final load at which the total settlement attains a value of 6 mm.

iii) Half of the final load at which the total settlement equals one tenth of the pile diameter.

3. LATERAL LOADING TEST:

3.1. Equipment and test set-up

3.1.1 Test Pile

The test pile shall be decided by the Engineer-in-Charge. It may be one of the working piles or a separate test pile.

The test pile shall be cut off at the proper level and provided with a cap with vertical plane sides having an adequate area for proper seating of the jack and dial gauges.

3.1.2 Loading System
Loading shall be applied by an hydraulic jack of adequate capacity, abutting the pile horizontally and reacting against a suitable system. The reaction may be provided by the wall of the excavated-pit when the test is being conducted below ground level or by a neighbouring pile in which case thrust pieces shall be inserted on either end of the jack to make up the gap.

3.1.3 Measuring System

3.1.3.1 Lateral load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack, having a least count of 500 Kg.

3.1.3.2 Deflection of the pile hand shall be measured by dial gauges, fixed to datum bars and having a least count of 0.01 mm. The datum bars shall be provided with rigid supports as described in Clause 2.1.3.2 (b) above.

3.2 Method of Conducting Test:

The test shall be carried out in accordance with the provisions of IS: 2911– (part-I) and as detailed below:

3.2.1 Loading shall be applied in increments of 500 kgs. or as specified.

3.2.2 Each stage shall be maintained for a period till the rate of movement of the pile head is not more then 0.1 mm / 30 min. or 1 hr. whichever is greater.

3.2.3 Loading shall be continued till one of the following occurs:

a) Deflection of the pile head exceeds 12 mm.

b) The applied load on the pile is twice the assumed lateral load capacity of the pile in case of a separate test pile and 1 ⅔ Times the rates capacity in the cast of a working pile.

3.2.4 Assessments of Safe Load:

The safe load shall be the smaller of the following:

i) Half the final load for which the total deflection is 12 mm.

ii) Loading corresponding to 5 mm total deflection.

NOTE: The deflection is at the cut off level of the pile.

4. PULL OUT CAPACITY OF PILES

4.1 Equipment and test Set up

4.1.1 Test pile
The test pile shall be decided by the Engineer-in-Charge. The test shall be conducted on a separate pile installed specifically for this purpose.

4.1.1.2 The test pile shall be built to the proper length and the head provided with suitable arrangements for anchoring the load applying system.

4.1.2 Loading System

4.1.2.1 Load shall be applied using an approved reaction system. Uplift force may be applied directly to the test pile or through a lever system. The reaction may be provided by neighboring piles or blocks may be constructed for the purposes. A hydraulic jack shall be used for load application.

4.1.3 Measuring System

4.1.3.1 Load applied by jack shall be measured by a calibrated pressure gauge with a least count of 1000 kgs.

4.1.3.2 Movement of the pile shall be measured by dial gauges, fixed to datum bar and having a least count of 0.01 mm. A minimum of two dial gauges, placed diametrically opposite shall be used. Datum bars shall be provided with rigid supports as described in 2.1.3.2 (b) above.

4.2 Method of Conducting Test

The test shall be conducted as outlined below:

4.2.1 Loading shall be applied to the pile in increments of one-fifth the rated capacity of pile.

4.2.2 Each stage shall be maintained for a period till the rate of movement of the pile head is not more than 0.1 mm / 30 min. or one hour, whichever is greater.

4.2.3 Loading shall be continued until one of the following occurs:

a) Yield of soil pile system occurs causing progressive movement of the pile exceeding 12 mm.

b) The loading on the pile top equals twice the estimated safe load or as specified.

4.3 Assessment of Safe Load

The safe capacity of the pile shall be the smaller of the following:
a) Two-thirds of the load at which the total displacement is 12 mm or the load corresponding to a specified permissible up lift, and

b) Half of the load at which the load-displacement curve show as a clear break (downward trend).

5. COMBINED VERTICAL AND LATERAL LOADING:

5.1 Equipment and Test Set-up

5.1.1 The equipment and test set up shall be same described in Clause 3. In addition a platform shall be constructed on the pile top, and loaded to 1.0 times the pile capacity in vertical loading.

The pile shall be first subjected to the full vertical load. The lateral load shall commence after all settlements due to the vertical load have ceased and while the full vertical load is in position.

5.1.2 The loading system, measuring system and recording of results shall be the same as described in Clause – 3.

5.2 Method of Conducting Test and Assessment of Safe Load

This shall be in accordance with the provision of Clause 3.2 above.

6. SPECIAL TYPE OF LOADING

This shall include evaluating the pile response to vibratory loads, both horizontal and vertical in nature. The test set up and method of conducting the test shall be covered under specific requirements.
APPENDIX-1

<table>
<thead>
<tr>
<th>FILE NO.</th>
<th>DATE OF</th>
<th>WT. OF HAMMER</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE</td>
<td>DRIVING</td>
<td>AVR. DROP OF HAMMER</td>
</tr>
<tr>
<td>DIAMETER (CM)</td>
<td>CASTING</td>
<td>TOTAL NO. OF BOWS</td>
</tr>
<tr>
<td>LENGTH BELOW</td>
<td>COMMENCEMENT OF TEST</td>
<td>SUM OF TEMPORARY</td>
</tr>
<tr>
<td>G.L. (M)</td>
<td>COMPRESSION IN CMS</td>
<td>LOCATION</td>
</tr>
<tr>
<td>TYPE OF TEST: DIRECT/CYCLE LOADING</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>TOTAL TIME</th>
<th>LOAD ON</th>
<th>LOAD OFF</th>
<th>SETTLEMENT</th>
<th>AVRSETTLEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GAUGE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
<th>TOTAL</th>
<th>NETT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR</td>
<td>MINS</td>
<td>TONNES</td>
<td>TONNES</td>
</tr>
</tbody>
</table>

SOUND REMARKS

I II TOTAL NETT