

Particular Specification for Jacked Steel H-piles

1.0 Definition

A jacked steel H pile is installed by jacking a steel H-pile section into the ground against a machine of sufficient dead weight to achieve the penetration and resistance required for the designed bearing capacity.

2.0 General

This Particular Specification shall be read in conjunction with Section 5 of the General Specification for Building 2007 Edition (GS).

The notations and terms used in this Particular Specification (PS) are defined as follows:

P_{max} - maximum jacking force applied to the pile during installation.

WL - theoretical safe loading capacity.

Pre-Loading Test - the test carried out at the 2nd stage of the Pre-Loading process as required in Clause 6.10.

3.0 Design Submissions

In addition to the submissions stated in Clause 5.02 of the GS, submit 2 copies of each of the following with the design submissions:-

- (a) Detailed information on the jacking machine and associated equipment, which shall include the maximum capacity of the jacking machine, details of the load controlling device and the pile clamping system, as stated in Clause 6.4.
- (b) Method statement for the installation of jacked steel H-piles as stated in Clause 6.3.
- (c) Settlement analysis for pile groups consisting of more than 10 piles, as required in Clause 5.3.

No piling works shall commence on site unless the submissions are approved by the SO.

4.0 Materials and Workmanship of H-pile Section

Clause 5.18 (i), (ii), (iii), (v), (vi), (vii) of the GS shall apply to Jacked Steel H-piles.

Provide an experienced and competent operator to supervise welding. Welders shall be tested to meet the requirements of BS EN 287-1 or approved equivalent standards. Test on welders shall be witnessed by a qualified welding inspector and certificates are to be endorsed by an independent inspection authority. The certification shall remain valid providing it complies with the conditions for re-approval of certification specified in BS EN 287-1.

The Contractor shall employ an independent approved specialist firm to carry out and interpret the inspection and testing of welds, and provide any necessary labour and attendance. Submit certificates issued by a recognized authority proving that the operators carrying out the inspection and testing have been trained and assessed for competence in the inspection and testing of welds.

The maximum length of spliced pile sections in horizontal or inclined positions shall not exceed 24 m, unless an acceptable method of lifting the pile has been agreed by the SO.

5.0 Design Requirements

5.1 Loading Capacity

The theoretical safe loading capacity of a pile shall not exceed 2950 kN.

5.2 Design Assumptions

Unless specified otherwise by the SO, no corrosion protection to the jacked steel H-piles is required. However, when the jacked steel H-pile is subjected to combined axial and bending under permanent load, the combined extreme fibre stress at working load shall not exceed $0.33 f_y$, where f_y is the minimum yield stress of the H-pile material. When the calculation of stress is based on loadings including transient load or wind load, the permissible combined stress can be up to $0.42 f_y$.

The pile group reduction of 0.85 stipulated in Clause 5.07 of the GS shall apply.

The use of tension piles and raking piles is not permitted.

5.3 Settlement Analysis

For pile groups consisting of more than 10 piles, a proper settlement analysis of foundations under the total working loads including negative skin friction (NSF) shall be carried out by a recognized foundation engineering method. The assumed parameters are to be verified at the contractor's own expense. After installation of all piles, a further settlement analysis, based on actual conditions of piles installed, shall be carried out to verify the compliance of settlement requirements.

6.0 Installation of Jacked Piles

6.1 Maximum Jacking Force

The maximum jacking force P_{max} shall not exceed 90% of total weight of the pile-jacking machine. The allowable axial stress during pile jacking shall not exceed 80% of the yield stress of the H-pile material. A control system should be in place to control the jacking force within $\pm 2\%$ accuracy. .

6.2 Calibration of Hydraulic Jack

6.2.1 The hydraulic jack shall be calibrated by an independent firm accredited by HOKLAS by using a calibrated load cell as agreed by the SO at the start of the Contract. A designated pile with sufficient load carrying capacity can be used to provide the reaction for calibration of the hydraulic jack. The calibration should cover the whole range of jacking forces to be applied during pile installation.

Submit method statement for the calibration of hydraulic jack for SO's approval before calibration.

The calibration shall be carried out in the presence of the SO with at least two days notice. Submit the calibration report to the SO.

6.2.2 Re-calibration of the hydraulic jack at a force of 2.2WL shall be carried out after jacking every 30 piles or repair of the hydraulic system. It shall be carried out during the Pre-Loading Test of Clause 6.10 (ii) or otherwise as directed by the SO. The pressure gauge readings shall be measured against a calibrated load cell in the test. The measured δ/L (as stated in Clause 6.12) of tested piles shall also be reported.

6.3 Method Statement for Pile Installation

Submit method statement for installation of piles for SO's approval before jacking of any pile. The method statement should include but not be limited to the following:-

- (a) Sequence of jacking of piles over the whole site;
- (b) Maximum jacking force, P_{max} , to be used;
- (c) Termination procedures and criteria of the jacked piles;
- (d) Verticality control during pile jacking;
- (e) Splicing of piles;
- (f) Storage of spliced piles;
- (g) Transportation and lifting of pile sections;
- (h) Measures to overcome underground obstructions and proposed depths of pre-bored holes;
- (i) Measures to prevent pile buckling.

6.4 Machinery for Jacking of Piles

Submit details of the hydraulic jacking machine for jacking of the piles. The details shall include but not be limited to the following:-

- (a) Allowable maximum capacity of the jacking machine;
- (b) Total dead weight of the jacking machine
- (c) Limitations for jacking of piles near site boundary and existing structures;
- (d) Load controlling devices; and
- (e) Devices for guiding and restraining the pile during jacking.

6.5 Monitoring of Jacking Force

The applied jacking force shall be continuously monitored during pile installation. The jacking force should be increased in small increments when approaching the target maximum applied jacking force P_{max} .

6.6 Verification Test of Jacking Force

At least 10% of the piles (minimum five piles) shall be subjected to a verification test of the jacking force. In the verification tests, the piles shall be loaded to 2.2WL as in the Pre-Loading Test of Clause 6.10 (ii) and the force shall be maintained for 15 minutes. The forces applied on the piles shall be measured by a calibrated load cell while the total and residual settlements of the piles shall be measured by dial gauges or optical surveying instrument with an accuracy of +/- 0.1mm. The measured δ/L (as stated in Clause 6.12) of tested piles shall also be reported.

The verification test of jacking force can be carried out either during or after the Pre-Loading process as required in Clause 6.10 (ii) as directed by the SO.

6.7 Control Panel of Jacking Machine

The control panel shall be installed in a convenient and safe position for inspection by the SO.

6.8 Overcoming Underground Obstructions to Piles

In case pre-boring is necessary to overcome underground obstructions, soil and rock excavated during pre-boring shall be removed and the pre-bored hole shall be backfilled with sand or other materials, subject to the approval of the SO, before the steel pile is jacked into the ground.

6.9 Prevention of Pile Buckling

At any time during jacking, gaps between the steel-H pile and the pile hole shall be kept filled up with sand.

6.10 Termination Procedures and Criteria

Before a pile can be terminated for installation, the pile shall undergo a Pre-Loading process. The Contractor shall propose his termination procedures and criteria for the Pre-Loading process which shall consist at least of the following:

- (i) Before termination of a pile, the pile shall be first jacked to a force of not less than 2.3WL and hold for a certain period of time to be determined by the Contractor. The pre-loading shall be repeated to a no. of cycles to be determined by the Contractor.
- (ii) The 2nd stage of the Pre-Loading process is a Pre-Loading Test which shall be carried out at a force of 2.2WL until the settlement rate is less than 5mm per 15 minutes. The total and residual settlements of the pile shall also be measured in the presence of the SO's supervisory staff and the records should all be certified by the SO's supervisory staff.

The Contractor may propose any other additional steps of Pre-Loading process as he considers necessary.

6.11 Trial Pile

A trial pile shall be installed to verify the termination procedures and criteria proposed by the Contractor. In the trial pile, the forces applied on the pile shall be measured by a calibrated load cell while the settlement of the pile shall be measured by dial gauges or other precision optical instrument with an accuracy of +/- 0.1mm.

The trial pile shall then be subjected to a static loading test as instructed by the SO. Acceptance of the loading test is based on Clause 5.28(ii) to (iv) of the GS. If the trial pile fails the static loading test, either the trial pile shall undergo the Pre-Loading process in accordance with revised termination procedures and criteria to be proposed by the Contractor and then load tested again for verification, or the theoretical safe loading capacity has to be reduced. In the latter case, a new trial pile has to be installed in accordance with revised termination procedures and criteria to be proposed by the Contractor and then load tested to twice the reduced theoretical safe loading capacity for verification. .

All working piles have to undergo a Pre-Loading process by the amount and sequence determined from the trial pile. The total and residual settlements of all working piles during the Pre-Loading process shall also be measured.

6.12 Monitoring of settlement and elastic shortening of piles during the Pre-Loading Test

The total and residual settlements of every pile during the Pre-Loading Test under the termination procedures shall be measured by optical surveying equipment with an accuracy of +/- 0.1mm or dial gauges. The elastic shortening (δ) of a pile during the Pre-Loading Test is defined as the difference between the measured total and residual settlements of the pile under the Pre-Loading force. The value of elastic shortening (mm)/total pile length (m) (δ/L) of every pile shall be reported.

Any piles with δ/L less than the average value of δ/L of all tested piles determined from the verification test of jacking force (Clause 6.6) and re-calibration of the hydraulic jack (Clause 6.2.2) by more than 15% of the average value shall be subjected to a verification test as stated in Clause 6.6.

6.13 Sufficiency of Design and Construction

The Contractor shall satisfy himself that the above method of pile installation provides sufficient factor of safety in his design. Should he consider that this method does not provide an adequate factor of safety in his design, he shall submit an alternative proposal for the approval of the SO.

7.0 Piling Records

The Contractor shall keep records of the installation of each pile and submit two signed copies of the records to the SO not later than noon of the next working day after the pile has been installed. The record shall contain the following information in an approved format: -

- Pile reference number
- Date pile installed
- Pile type and size
- Type of hydraulic jacking machine
- Depth of pre-bored hole
- Details of any obstructions, delays and other interruption during the jacking process of the pile
- Pile top level
- Pile toe level
- Length of pile
- Pile penetration versus jacking force record
- Settlement vs time and elastic shortening during the Pre-Loading Test
- Any other data requested by the SO.

On completion of all piling works, the Contractor shall submit to the SO two sets of piling record plans showing, as appropriate, the position, pile reference number, size, orientation and levels of top and bottom of each pile installed. The as-built piling

record plans shall be certified by both the Contractor and an independent qualified surveyor employed by the Contractor at his own cost.

8.0 Pile Spacing and Tolerances

Pile spacing and tolerances for steel H-piles stated in Clauses 5.08 and 5.22 respectively of GS apply equally to jacked steel H-piles.

9.0 Loading Test

Loading tests shall be required as instructed by the SO in accordance with Clause 5.28 of the GS. Notwithstanding the provisions given in Clause 5.28 of the GS, kentledge for loading tests may be provided by the weight of the jacking machine subject to approval by the SO.

10.0 Failure of Loading Test

When a pile fails a loading test, carry out remedial works to the pile or install additional piles such that the revised piling layout is sufficient to sustain the loadings as given in the loading schedule. Carry out test probes if required to position additional piles. Design extended or extra pile caps and strap beams and any other work necessitated by the pile failure. The agreement of the SO in writing shall be sought before carrying out the remedial works. The Contractor shall carry out two additional pile-loading tests as directed by the SO at the Contractor's own cost and time.

Alternatively, the failed pile can be subjected to a revised termination procedures and criteria proposed by the Contractor and then load tested again for verification at the Contractor's own cost and time. The batch of piles of which this pile is representative have to undergo the same termination procedures and criteria.