

Master Specification

Part ST-PI-C1

Driven Piles

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ST-PI-C1 Driven Piles

1 General

- a) This Master Specification Part specifies the requirements for driven piles, including:
 - i) the documentation requirements, as set out in section 2;
 - ii) the requirements for the manufacture of driven piles, as set out in section 3;
 - iii) the Site works requirements, as set out in section 4;
 - iv) the driving operation requirements, as set out in section 5;
 - v) the requirements for the splicing and stripping of piles, as set out in section 6;
 - vi) the driving record requirements, as set out in section 7;
 - vii) the testing of piles requirements, as set out in section 8;
 - viii) the Hold Point and Witness Point requirements, as set out in section 9; and
 - ix) the verification requirements and records, as set out in section 10.
- b) This Master Specification Part applies to the following types of driven piles:
 - i) precast concrete piles;
 - ii) steel piles; and
 - iii) driven cast in situ concrete piles,
which may be either end bearing or friction piles.
- c) Driven piles must comply with the Reference Documents, including:
 - i) AS 2159 Piling - Design and installation;
 - ii) AS 5100.3 Bridge design, Part 3: Foundations and soil-supporting structures; and
 - iii) AS/NZS 1554.3 Structural steel welding, Part 3: Welding of reinforcing steel.
- d) The Contractor is responsible for:
 - i) providing the design of the piles to achieve the specified design geotechnical strength (unless a design has been provided by the Principal);
 - ii) the installation of piles that achieve the design geotechnical strength and design durability; and
 - iii) verifying that the design geotechnical strength has been achieved in practice.

2 Documentation

2.1 Construction Documentation

In addition to the requirements of PC-CN3 “Construction Management”, the Construction Documentation must include documents, procedures, and instructions for the installation and testing of driven piles, including:

- a) method of transporting, storing, lifting, and driving piles, to prevent damage to the pile or protective coating;
- b) details of the proposed driving equipment, including:
 - i) pile hammer;

- ii) pile helmet and cushion assembly; and
- iii) pile driving rig, crane, leaders, or other equipment proposed for pile driving operations;
- c) method of controlling noise;
- d) details of the equipment and method to be used for any pre-boring or jetting;
- e) for any temporary filling in waterway areas proposed during construction, the evidence of compliance and documentation required by section 4.2;
- f) method of monitoring adjacent infrastructure during pile driving;
- g) method of backfilling;
- h) method of cutting and breaking back of piles;
- i) details of the procedure to record pile driving, including an example recording sheet;
- j) details of the proposed test methods, including:
 - i) the name and qualifications of the independent specialist Subcontractor nominated in section 8.2; and
 - ii) details of the proposed system and field-testing personnel;
- k) details of the testing regime and methodology to demonstrate that the required design geotechnical strength and pile integrity is achieved in practice, including supporting calculations; and
- l) where the Contractor proposes to use pile driving software other than CAPWAP or TNOWAVE, details of the Contractor's proposed alternative equivalent software, as required by section 8.4a)v).

2.2 Quality Management Records

- a) In addition to the requirements of PC-QA1 "Quality Management Requirements" or PC-QA2 "Quality Management Requirements for Major Projects" (as applicable), the Quality Management Records must include:
 - i) the pile driving records required by section 7;
 - ii) pile manufacturing data, including:
 - A. inspection reports;
 - B. concrete strength;
 - C. location cast;
 - D. date cast; and
 - E. weather conditions and curing;
 - iii) in relation to the testing:
 - A. integrity testing results, in accordance with section 8.3;
 - B. load testing results, in accordance with section 8.4;
 - C. where applicable, static load testing results, in accordance with section 8.5; and
 - D. 2 copies of a report showing the measured field parameters and the results of analysis to determine pile capacity, in accordance with section 8.4a)vii); and
 - iv) the verification records required by Table ST-PI-C1 10-1.
- b) Records (including test results) for each driven pile must be made available as part of the Quality Management Records within 6 hours of the completion of each pile (or group of piles).

3 Manufacture of driven piles

3.1 General

- a) This section 3 applies to steel piles and precast concrete piles.
- b) During transportation, handling, and storage, piles must not be deformed, damaged, or have the integrity of any protective coating compromised.

3.2 Steel piles

- a) Steel piles must be manufactured in accordance with ST-SS-S1 "Fabrication of Structural Steelwork".
- b) Protective treatment of steel piles must be carried out in accordance with ST-SS-S2 "Protective Treatment of Structural Steelwork".
- c) Portions of piles which are to be embedded or encased in concrete must be thoroughly cleaned in accordance with ST-SS-S2 "Protective Treatment of Structural Steelwork".
- d) Piles must be clearly and indelibly marked at 500 mm intervals, commencing from the toe, to show penetration depths attained during driving.

3.3 Precast concrete piles

- a) Precast concrete piles must be manufactured in accordance with ST-SC-C1 "Pre-Tensioned Concrete".
- b) The concreting and prestressing operations for precast concrete pile must be completed in accordance with ST-SC-C1 "Pre-Tensioned Concrete".
- c) Piles must be lifted, supported, and pitched at the required position.
- d) Prior to lifting, concrete must be at least 75% of its 28-day characteristic compressive strength.
- e) Piles must be clearly and indelibly marked at 1.0 m intervals, commencing from the toe, to show penetration depths attained during driving.

4 Site works

4.1 Site preparation

The following requirements apply to the Site preparation for driven pile installation:

- a) local excavation must be completed prior to the commencement of pile driving;
- b) excavations must be trimmed after driving is completed to remove any material forced up between the piles during driving;
- c) any over excavation in the vicinity of the piles must be backfilled with lean mix concrete after completion of the pile driving;
- d) where piles are to penetrate through a new embankment, the new embankment must be placed and compacted to the specified requirements in accordance with RD-EW-C1 "Earthworks" and RD-EW-C2 "Trench Excavation and Backfill", prior to driving the piles;
- e) piles must not be driven through an embankment until any settlement that may adversely affect the pile performance has occurred;
- f) piles must be constructed in accordance with:
 - i) AS 2159 Piling - Design and installation; and
 - ii) AS 5100.3 Bridge design, Part 3: Foundations and soil-supporting structures;

- g) where the Contractor proposes to change the pile design (e.g. due to unforeseen ground conditions), the Contractor must update and resubmit:
 - i) the IFC Design Documentation in accordance with the requirements of PC-EDM1 “Design Management”; and
 - ii) the Construction Documentation; and
- h) where the Contractor proposes to change the installation methodology (e.g. due to unforeseen ground conditions), the Contractor must update and resubmit the Construction Documentation to reflect the revised installation methodology.

4.2 Temporary filling of a waterway

Where the temporary filling of a waterway is proposed for the installation of driven piles, the Contractor must provide the following information as part of the Construction Documentation:

- a) evidence to demonstrate that the addition of the fill will not cause any adverse ground movements for either the short or long term;
- b) prior to commencing temporary filling, written acceptance from the relevant Authority, regarding the methods of filling and restoration, and any proposed reduction in waterway area during construction; and
- c) evidence that the Temporary Works comply with all relevant environmental requirements set out in the Contract Documents.

5 Driving operation

5.1 General

- a) At all times during the pile driving operation:
 - i) the net driving energy must not exceed the maximum net driving energy specified, including testing and restriking of the piles;
 - ii) piles must not be damaged; and
 - iii) the driving equipment must be adjusted such that the blow of the hammer is directed centrally and axially on the pile head.
- b) For each pile, the Contractor must provide notice of intention to drive, which will constitute a **Witness Point**. Driving of each pile must not occur until the Contractor has proceeded past the Witness Point.

5.2 Driving of piles

The following requirements apply to the driving of piles:

- a) piles must be effectively guided and held during the initial stages of driving;
- b) piles must not be bent or sprung into position;
- c) frequent checks must be made during all stages of driving to ensure that the pile frame does not exert any undue lateral force on the pile;
- d) a significant horizontal force must not be used to correct any tendency for the pile to run off line;
- e) at all times, a pile must not be restrained against rotation about its longitudinal axis; and
- f) if driving operations cease for any reason other than to perform a restrike test, then driving must recommence after striking a minimum of 30 blows at the required net driving energy before assessing whether the pile has met the required driving criteria.

5.3 Tolerances

All driven piles must be installed in accordance with the tolerances specified in AS 2159 Piling - Design and installation, except that:

- a) the pile head must finish within 75 mm of the specified plan position; and
- b) variation from vertical must not be more than 1 in 50.

6 Splicing and stripping of piles

6.1 Steel piles

The following requirements apply to the splicing of steel driven piles:

- a) piles may be extended by splicing on an additional length of identical steel pile section prior to, during, or after driving;
- b) piles must be spliced using full penetration butt welds over the whole cross section;
- c) pile welds must be ground smooth after splicing; and
- d) all welds must be tested in accordance with ST-SS-S1 "Fabrication of Structural Steelwork".

6.2 Precast concrete piles

The following requirements apply to the splicing of precast concrete driven piles:

- a) piles may be extended by splicing on an additional length of precast concrete pile prior to, or during driving;
- b) piles must be spliced as detailed in the Design Documentation;
- c) mechanical pile splices must be located at least 5 m below the lowest natural or existing ground surface after the completion of driving;
- d) a pile may be extended by casting a cast-in-place reinforced concrete extension to it after completion of driving (but not prior to, or during driving);
- e) the connection and the extension must be capable of developing the full structural capacity of the whole pile, including the bending capacity and durability classification;
- f) any welding of reinforcement carried out as part of the extension of precast concrete piles must be:
 - i) in accordance with AS/NZS 1554.3 Structural steel welding, Part 3: Welding of reinforcing steel; and
 - ii) to the manufacturer's recommendations; and
- g) tendons must not be welded.

6.3 Stripping of concrete piles

The following requirements apply to the stripping of concrete driven piles:

- a) explosives must not be used for the stripping operation;
- b) handheld equipment must be used for stripping of the pile head;
- c) prior to stripping heads of piles, a circumferential saw cut must be carried out to a depth of 13.0 mm less than the minimum clear cover to the longitudinal steel bars or the prestressing strands (whichever has the least cover);
- d) the method used to strip the pile must ensure that:

- i) spalling, cracking or scoring of the face of the pile below the cut-off level does not occur; and
- ii) reinforcement and stressing tendons are not damaged for their full final length;
- e) the stripping must expose the longitudinal reinforcement or strands for the corresponding bond lengths; and
- f) any excess length of pile must be cut off and removed.

7 Driving records

The Contractor must complete a pile driving record sheet for each driven pile and submit as a part of the Quality Management Records, which must include the following information:

- a) date of driving pile;
- b) casting or manufacturing details of pile;
- c) design location of pile;
- d) final natural surface level and toe level;
- e) if applicable, splice depth of pile;
- f) pile penetration (blows verses displacement) and the corresponding energy input at all stages of the driving;
- g) type and size of hammer and its stroke, or, for double acting hammers, the number of blows per minute;
- h) type and condition of packing on the pile head, and of the dolly or follower;
- i) sequence of driving in the pile groups;
- j) actual location and any apparent deviation from design location and inclination;
- k) details of piles that are re-driven due to the effect of ground movements;
- l) if applicable, pre-bore depth; and
- m) if applicable, details regarding the time of, and reasons for stoppages to driving activity.

8 Testing of piles

8.1 General

The results of the testing of driven piles required in section 8.3 and 8.4, and where applicable, section 8.5, must be submitted as part of the Quality Management Records. The submission of the test results will constitute a **Hold Point**. Breakback of the pile and any construction work on the pile cap or abutment, must not occur until this Hold Point has been released.

8.2 Independent specialist Subcontractor

- a) Testing of driven piles must be carried out by an independent specialist Subcontractor approved by the Principal.
- b) The Contractor must nominate the independent specialist Subcontractor which will constitute a **Hold Point**. Testing of driven piles must not occur until this Hold Point has been released.

8.3 Integrity testing

- a) Integrity testing for driven piles must be carried out:
 - i) by the independent specialist Subcontractor nominated in the section 8.2;

- ii) on all piles; and
 - iii) in accordance with integrity test methods specified in AS 2159 Piling - Design and installation.
- b) Integrity testing equipment must be capable of checking cross-sectional irregularities in driven piles and identifying the location and characteristics of any significant anomalies, such as voids or contaminants, throughout the full length of the pile.
- c) Acceptance criteria, supervision, and reporting of integrity testing must be in accordance with the requirements of AS 2159 Piling - Design and installation.

8.4 Dynamic load testing

- a) Subject to section 8.4b), the following requirements apply to load testing for driven piles:
- i) dynamic load testing of driven piles must be carried out by the independent specialist Subcontractor nominated in the section 8.2;
 - ii) where requested by the Principal, the Contractor must provide the raw data, collected from the testing in accordance with this section 8.4, to the Principal within 1 day of such request, which may be used for independent review by a third party;
 - iii) the Contractor must carry out dynamic load testing of driven piles to confirm that the design pile capacity has been achieved, including:
 - A. at least one dynamic load test at each bridge abutment and pier location; and
 - B. dynamic load testing of at least 10% of the total number of driven piles;
 - iv) if a test pile has been constructed, additional dynamic load testing (in addition to section 8.4a)iii)) must be carried out on the piles where the toe level varies by more than 2 m from the test pile toe level;
 - v) testing must be carried out by use of a pile driving analyser and the data obtained from each pile must be analysed using CAPWAP, TNOWAVE or equivalent software as nominated in the Construction Documentation;
 - vi) the test procedure and test reports must conform with the requirements of AS 2159 Piling - Design and installation;
 - vii) 2 copies of a report showing the measured field parameters and the results of analysis to determine pile capacity must be provided as part of the Quality Management Records; and
 - viii) the measured ultimate capacity of test piles must be equal to or greater than the pile test load.
- b) Dynamic load testing is not required for driven piles where the primary load effect on the driven pile is lateral loading and which have no vertical load capacity requirement.

8.5 Static load testing

- a) Where nominated in the Contract Documents or on the Design Documentation, static load testing for driven piles must be carried out:
- i) by the independent specialist Subcontractor nominated in section 8.2;
 - ii) on the nominated piles;
 - iii) where requested by the Principal, the Contractor must provide the raw data, collected from the testing in accordance with this section 8, to the Principal within 1 day of such request, which may be used for independent review by a third party; and
 - iv) in accordance with static load test methods specified in AS 2159 Piling - Design and installation.

- b) Acceptance criteria, supervision, and reporting of static load testing must be in accordance with the requirements of AS 2159 Piling - Design and installation.

9 Hold Points and Witness Points

- a) Table ST-PI-C1 9-1 details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.
- b) Table ST-PI-C1 9-2 details the review period or notification period, and type (documentation or construction quality) for each Witness Point referred to in this Master Specification Part.

Table ST-PI-C1 9-1 Hold Points

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
8.1	Submission of test results	Documentation	5 Business Days review
8.2b)	Nomination of independent specialist Subcontractor	Documentation	10 Business Days review

Table ST-PI-C1 9-2 Witness Points

Section reference	Witness Point	Documentation or construction quality	Review period or notification period
5.1b)	Notification of intention to drive a pile	Construction quality	24 hours notification

10 Verification requirements and records

The Contractor must supply written verification as part of the Quality Management Records that the requirements listed in Table ST-PI-C1 10-1 have been complied with.

Table ST-PI-C1 10-1 Verification requirements

Section reference	Subject	Record
7	Installation verification	Pile driving records