DEPARTMENT of INFRASTRUCTURE, ENERGY and RESOURCES, TASMANIA

BRIDGEWORKS SPECIFICATION

B5 - STEEL PILES April 2003

Includes previous B5 and B7

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B5.1 SCOPE

This Specification sets out the requirements for the supply and driving of structural steel piles or casings to a prescribed capacity.

B5.2 REFERENCES

The following Australian Standards apply:

A.S. 1450 Steel tubes for mechanical purposes

A.S. 1554 Structural steel welding

A.S. 1548 Steel plates for pressure equipment

A.S. 2074 Steel castings

A.S.2159 Piling design and installation

A.S. 3678 Structural steel - hot rolled plates, floor plates and slabs

A.S. 3679 Structural steel

B5.3 MATERIALS

B5.3.1 Specifications

Steel piles shall comply with the following Australian Standards as appropriate.

AS 1450 All Grades

AS 1548 All Grades

AS 3678 Grades 250 and 350

AS 3679 "Hot Rolled Structural Steel Bars and Sections"

B5.3.2 Pile Shoes

Cast steel pile shoes shall be of steel to AS2074-C4.

B5.3.3 Dimensional Tolerances

(i) Size

Steel piles shall be of section size and mass per unit length as shown on the Drawings.

The steel casings shall have an outside diameter and wall thickness not less than that shown on the Drawings.

(ii) Length

The length of the pile shall be not less than the supply length nominated on the Drawings. Where the supply length is less than the maximum single length for the section size as supplied by the mill, piles shall be supplied in single (unspliced) lengths. Where splices are required, no more than two shall be used to make up the supply length.

The pile lengths specified on the Drawings should enable the piles to be driven to the estimated tip levels with approximately one metre of surplus length.

(iii) End Preparation

The surface at the driving end of the piles shall not depart from the true square cross-section by more than 2 mm.

B5.3.4 Testing of Materials

Test Certificates showing the results of mechanical tests and chemical analysis of the steel used in the work shall be submitted to the Superintendent. No material or part shall be used in the work until it has been identified with the Test Certificates.

The costs of all testing shall be borne by the Contractor.

B5.4 FABRICATION

B5.4.1 Pile Splices

Pile fit up, weld preparation and welding for full strength butt welds shall be carried out in accordance with Specification B25.

B5.4.2 Reinforcing for Pile Toes

Where shown on the Drawings, the Contractor shall, prior to driving, reinforce the toe of the pile to the details shown.

B5.4.3 Fabrication of Pile Casing

Fabrication shall conform to Specification B25 and to the dimensions shown on the Drawings. The inside diameter of the casing shall not be less than the nominal diameter shown on the Drawings with a maximum out of round tolerance of $\pm$ 2 mm.

All longitudinal and transverse welds shall be made with full penetration butt welds and adjacent segments shall be rotated 90^{o} relative to each other so that longitudinal welds on the fabricated casing are staggered.

The toe of the casing for each pile shall be reinforced with a welded driving ring, as shown on the Drawings.

If field splicing is necessary, at each field splice the upper section of casing shall be fitted with a bevelled backing plate welded into the casing. At the backing plate, the casing itself shall also be bevelled in preparation for field splicing by butt welding, as detailed on the Drawings.

B5.4.4 Defective Materials

Defects arising from the manufacture of steel which become evident at any stage of fabrication shall be the subject of a non-conformance report.

The cost of repairs or replacement shall be the Contractor's responsibility.

B5.4.5 Cutting

Steelwork may be cut by flame cutting, sawing or shearing unless specified otherwise. Surfaces produced by such cutting shall be finished square (unless a bevelled edge is called for) true and smooth to the required dimensions.

Where the finish of cut edges is not satisfactory, they shall be ground or machined.

B5.4.6 Welding

Welding and welding inspection shall be carried out in accordance with the relevant provisions of AS 1554. Electrodes shall comply with AS 1552 and AS 1553 in accordance with Specification B25.

Two weeks prior to the fabrication of the piles, the Contractor shall submit to the Superintendent details of the proposed weld preparation, electrodes and procedures to be used.

B5.5 REINFORCED CONCRETE TOES

The reinforced concrete toe section shall not be removed from the casting plinth until the concrete has attained a compressive strength, as proved by standard test cylinders manufactured for this purpose, of F'c = 20 MPa.

Concrete in the toe section shall be cast at least 14 days before placing the pile in position for driving.

B5.6 HANDLING, STORAGE AND PITCHING OF PILES

All piles shall be stored above the ground on adequate supports. They shall be held straight and protected from damage. Under no circumstances shall piles be moved by dragging.

During handling, transport and pitching, piles shall be supported by slings or bridles such that the bending stresses in the steel sections shall not exceed 140 MPa when the mass of the piles is increased by 50 percent to allow for impact.

B5.7 UNEXPECTED GROUND CONDITIONS

The Contractor shall report immediately to the Superintendent any circumstances which indicate that in the Contractor's opinion the ground conditions differ from those expected by him from his interpretation of the site investigation information.

B5.8 CONTRACT LEVELS

All reduced levels (R.L.) of the bottom of the piles marked as "Contract Level" on the Drawings, represent the extent of the work to be included in the lump sum tendered.

The Superintendent may order in writing such changes of the levels as may be necessary to ensure a satisfactory foundation.

B5.9 DRIVING OF PILES

B5.9.1 Site Preparation for Driving

In order to ensure that the required levels of toes of piles are obtained, the Contractor shall be responsible for preparing the site for driving.

Any material forced up between the piles during shall be removed to the correct level before concrete for the foundation is placed. At all times care shall be taken to avoid disturbing the site by excavation below the level of the base of the pile cap.

B5.9.2 Leaders and Trestles

At all stages during driving and until incorporation in the superstructure the piles shall be adequately supported and restrained such that damage to the pile does not occur.

Where a pile drives off line or encounters an obstacles which prevents further driving within 4 metres of the start of the driving, the pile shall be excavated, the obstacle removed, the excavation back filled and the pile redriven. Back filling material and compaction shall be in accordance with Specification B1.

B5.9.3 Performance of Driving Equipment

The Contractor shall detail in his Contract Management Plan the method of piling and the plan he proposes to use, including details of the energy and efficiency of the driving equipment. During driving, the top of the pile shall be protected by a suitable helmet.

Piles shall not be bent or sprung into place during or after driving, but shall be effectively guided and held in the specified position.

B5.9.4 Driving Procedure

Piles shall be driven in the locations shown on the Drawings to a driving resistance (P) which is equal to or greater than the design loads shown on the Drawings.

The estimated pile tip levels shown on the Drawings are for general guidance only. The final pile levels shall be determined by achievement of the resistance above.

Each pile shall have its length marked clearly at 500 millimetre intervals.

Each pile shall be driven in the presence of the Superintendent, who shall be given 24 hours notice that pile driving is to take place.

B5.9.5 Measurement of Pile Capacity - Pile Driving Analyser

The driving resistance shall be calculated using the Pile Driving Analyser.

(i) Equipment and Software Specification

Pile capacities shall be determined by field use of a "Pile Driving Analyser" (PDA) as manufactured by Pile Dynamics Inc of Ohio, U.S.A. Unless otherwise approved by the Superintendent all piles will be tested by this method in the final blows of driving. Pile resistance calculations shall be carried out for each pile to satisfy the requirements of Clause B5.7.4 as follows:

$$P = RU / FS$$

where P = Safe load in kilonewtons

RU = Ultimate Bearing Value in kilonewtons

FS = Factor of Safety of 2.5

The PDA shall be capable of producing pile analysis using an externally input value of soil damping constant and the closed form solution of the one-dimensional wave equation. This method is referred to herein as the Case - Goble Method.

In addition, off-site software "CAPWAPC", as produced by Goble, Rausche, Likens and Associates Inc, Ohio, U.S.A. shall be used for further analysis. This method is referred to herein as the CAPWAPC method.

(ii) Driving of Piles

Whilst each pile is being driven, blows per 500 millimetre shall be recorded over the full length of the pile and during the last 3 metres of driving, sets shall be taken at intervals to establish the behaviour of the pile.

At least 25 percent of all piles being driven shall be redriven not less than 12 hours after initial driving and monitored by PDA. At least 20 hammer blows shall be maintained during redrive.

At least 15 percent of all piles being driven shall be analysed by the CAPWAPC method. The piles nominated for analysis by the Contractor shall be approved by the Superintendent. The analysis shall be used to determine the optimum value of soil damping constant J to be used in the Case - Goble Method. Previous Case - Goble results shall be adjusted for this value of J. In addition, a relationship between ultimate pile resistance and set (bearing graph) shall be obtained. Where under Clause B5.7.6 (i) approval is given by the Superintendent not to test all piles using PDA this relationship shall be used to control the driving of all remaining piles in the pile group which are not monitored using PDA with the following exceptions:

(a) where there is a change in hammer

(b) where there is a change in operation of the hammer

(c) where there is a change in helmet thickness or characteristics of packing material.

In the case of (a), (b) or (c) above the PDA calibration procedure shall be repeated.

B5.9.6 Final Set

When a final set is being measured, the following requirements shall be met:-

(i) The exposed part of the pile shall be in good condition without damage or distortion.

(ii) The dolly and packing, if any, shall be in sound condition.

(iii) The hammer blow shall be in line with the pile axis and the impact surfaces shall be flat and at right angles to the pile and hammer axis.

(iv) The hammer shall be in good condition and operating correctly.

(v) The temporary compression of the pile shall be recorded.

The precise technique for measuring the pile sets shall be detailed in the Contract Management Plan.

B5.9.7 Records

The Contractor shall keep records of the installation of each pile as follows:-

(i) Contract Number

(ii) Pile reference number

(iii) Pile type

(iv) Nominal cross-sectional dimensions

(v) Length of pile

(vi) Date and time of driving and/or redriving

(vii) Pile tip level at the commencement of driving

(viii) Working level

(ix) Depth of working level to pile toe

(x) Toe level

(xi) Type, weight, drop and mechanical condition of hammer

(xii) Number and type of packing used and type and condition of dolly used driving the pile

(xiii) Set of pile in mm per 10 blows

(xiv) Sets taken at intervals during the last 3 m of driving

(xv) Temporary compression of ground

(xvi) Blows per 500 mm intervals, when required

(xvii) All information regarding obstructions, delays, and other interruptions to the sequence of work.

(xviii) Calculations of driving resistance of pile and PDA records where applicable

(xix) Site measurements of hammer performance.

The Contractor shall submit two signed copies of these records to the Superintendent not later than noon of the next working day after the pile has been installed.

Any unexpected driving conditions reported in accordance with Clause B5.5 shall be noted in the records.

B5.9.8 Noise and Disturbance

The Contractor shall carry out the work in such a manner and at such a time as to minimise noise and disturbance.

Ear protectors shall be available for employees working on the piling operation and other works in the immediate vicinity.

B5.9.9 Damage to Piles

The Contractor shall ensure that damage does not occur to complete piles. He shall be responsible for all costs of repairing or replacement of damaged piles.

B5.10 PREBORING

Piles driven through abutment fill shall be pre-bored to the depth of the fill. The diameter of the prebored hole shall not exceed 50 mm less than the diagonal dimension of the pile.

After pile driving is completed all voids shall be filled with grout or sand.

B5.11 TOLERANCES IN DRIVING

The maximum permitted deviation of the pile centre from the centre point shown on the setting out Drawing shall be 75 mm in any direction.

The maximum permitted deviation of the finished pile shall be 1 in 75 from the axial alignment shown on the Drawings.

The maximum permitted angle of plan twist of the pile at the cut off reduced level shall be 15 degrees.

Forcible corrections to the alignment of piles shall not be made. In the event of a pile being driven out of tolerance the Contractor shall submit his proposals for rectifying the matter to the Superintendent in a non-conformance report.

B5.12 CUTTING OF PILE HEADS

When driving of a pile has been approved, and if not otherwise specified, the pile top shall be cut off to the correct level shown on the Drawings. Any unused cut-offs remaining at the end of the Contract shall become the property of the Contractor and shall be removed from the site.

B5.13 REINFORCEMENT

The steel casing walls shall be thoroughly cleaned of all loose material, including any material adhering to the inside of the casing, before the reinforcement is placed. The reinforcement shall be welded or tied to form a rigid cage. Adequate spacers shall be securely attached to the cage to ensure that no displacement will take place during concreting and that the correct cover is maintained.

B5.14 PAYMENT

B5.14.1 Supply and Fitting of Toe Reinforcing Plates - per Pile

The rate in the Bill of Quantities for this item shall apply only when toe reinforcing plates are shown on the Drawings.

B5.14.2 Casting of Reinforced Concrete Toes - per Pile

The rate in the Bill of Quantities for this item shall include pile shoes and cutting, bending and placing of reinforcement.

B5.14.3 Fabrication of Steel Pile Casings - per Metre

The rate in the Bill of Quantities for fabrication of steel pile casings shall include fabrication into cylindrical sections of suitable lengths for handling and transport, transporting from the fabrication shop to site, and unloading at site.

B5.14.4 Supply of H pile- per metre

The rate in the Bill of Quantities for supply of H piles shall include the delivery to the site and manufacture into the lengths shown on the Drawings, or the amended lengths to conform with the Amended Contract Levels directed by the Superintendent. This rate shall also include the cost of any splices required to make up each full length of pile to suite the Contract Levels, or Amended Contract Levels as appropriate, from shorter lengths of pile stock, but shall not include the cost of the supply and fitting of toe reinforcing plates.

B5.14.5 Driving of Piles - per metre

The rate in the Bill of Quantities for driving steel pile casings or steel piles shall include taking the piles from storage area, all necessary welded field splices, setting up at each pile location, pitching the pile and driving it until the toe is at the Contract Level, or to such other level as directed by the Superintendent prior to the acceptance of the pile. No increase in rate will be allowed for driving below the Contract Level shown on the Drawings.

The quantity for driving under this item shall be based on the authorised length of each pile pitched, conforming to the lengths shown on the Drawings or the amended lengths to suit the Amended Contract Levels as directed by the Superintendent, and shall include extensions spliced on before driving is completed, other than extensions added to replace damaged lengths cut off during driving. No payment will be made under this item for any lengths of pile spliced on after driving has been completed.

B5.14.6 Splices (Provisional Item) - each

The rate in the Bill of Quantities for splices shall apply when the Superintendent directs that additional lengths of piles should be spliced onto piles driven below the Contract Level shown on the Drawings, provided an actual splice is made. A nominal quantity is shown in the Bill of Quantities as a provisional item.

No payment shall be made for splices used by the Contractor to make up piles from shorter lengths than the lengths on the Drawings, or for any splices which are made by the Contractor for his own convenience, e.g. to suit his pile driving equipment.

B5.14.7 Cutting Off - each

The rate in the Bill of Quantities for cutting off shall apply to piles of authorised lengths that require cutting off to the correct level after driving has ceased. No payment will be made unless the pile is actually cut off.

B5.14.8 Measurement of Pile Capacity (Provisional Item) - each

Where measurement of pile capacity is specified as by Pile Driving Analyser, the item in the Bill of Quantities for providing this monitoring shall include all costs associated with hire of equipment together with personnel trained in its use, performance of tests to the number specified by the Superintendent, performance of off-site analysis and reporting of results and performance of drive and redrive checks. In addition, the cost of any delays to the works caused by delays in receipt of analysis shall be deemed to be covered by this item. Such delays shall not be grounds for extension of time.

B5.15 HOLDPOINTS

The following hold points have been identified in this Specification:

- Weld preparation details (B5.4.6)
- Unexpected ground conditions (B5.7)

B5.16 INFORMATION TO BE INCLUDED IN CONTRACT MANAGEMENT PLAN

The following information to be included in the Contract Management Plan has been identified in this Specification:

- Steel manufacturers test certificates (B5.4.4)
- Procedures for the handling, transport and storage of piles (B5.6)
- Pile driving equipment and procedures (B5.9)