# REVISION REGISTER

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<th>Description of Revision</th>
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<td>Ed 1/Rev 0</td>
<td>1.2, Annex B53/1, Annex B53/2</td>
<td>Minor changes.</td>
<td>GM, RNIC</td>
<td>26.07.00</td>
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<tr>
<td>Ed 1/Rev 1</td>
<td>1.2, 11, 11.1</td>
<td>For welding, references to AS 1554.3 are replaced by RTA B204.</td>
<td>GM, RNIC J Woodward</td>
<td>23.09.98</td>
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<tr>
<td>Ed 1/Rev 3</td>
<td>1.2, Annex B53/2</td>
<td>Minor changes.</td>
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<td>26.07.00</td>
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<tr>
<td>Ed 1/Rev 4</td>
<td>14 (a) &amp; (b)</td>
<td>References to Conditions of Contract changed to suit C1.</td>
<td>GM, RNIC</td>
<td>30.05.01</td>
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<tr>
<td>Ed 1/Rev 5</td>
<td>Annex 2</td>
<td>Item 1(a): Testing organisations (vi) and (vii) added. Item 1(b): Testing organisation (iii) added.</td>
<td>GM, RNIC</td>
<td>02.8.01</td>
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<tr>
<td>Ed 2/Rev 0</td>
<td>All</td>
<td>Clauses &amp; annexures rearranged. Text revised to direct imperative style. &quot;Superintendent&quot; replaced by &quot;Principal&quot;. &quot;Contractor&quot; replaced by &quot;you&quot;. &quot;Shall&quot; replaced by &quot;must&quot;. Reformating and editing including font changes. Revised to align with RTA B50 Ed 3/Rev 1. New clause after the Table of Contents. Renumbered and revised.</td>
<td>GM, IC</td>
<td>17.11.08</td>
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<tr>
<td>Ed 2/Rev 1</td>
<td>1.3, 8.1, 8.3, Annex M</td>
<td>Definitions of “you” and “your” added. Added: NPER registration as equivalent to CEng, Engrs Aust, for certification purposes.</td>
<td>GM, IC Bernie Chellingworth</td>
<td>15.01.10</td>
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<td></td>
<td>Foreword Annexures</td>
<td>Referenced documents updated.</td>
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<td>1.2.4</td>
<td>Reference to spec Q on frequency of testing added.</td>
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<td></td>
<td>1.3</td>
<td>Clarification added that “Dynamic Testing” is same as “High-Strain Dynamic Testing”.</td>
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<td>2.1</td>
<td>New heading “General” added to form sub-clause 2.1. Subsequent sub-clauses renumbered.</td>
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<td></td>
<td>2.3</td>
<td>Clause reworded to harmonise with corresponding clause in spec B200.</td>
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<td>4</td>
<td>Where bottom level of pile cap is more than 2 m below existing surface level, requirements for excavation clarified.</td>
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<td></td>
<td>5.3.1</td>
<td>Clause on pile resistance reworded to improve clarity.</td>
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<td></td>
<td>6.1, 7</td>
<td>Minimum period before restrike test increased to 24 hrs to accord with AS 2159.</td>
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<td></td>
<td>6.1</td>
<td>Statement on piling hammer mass and height of drop moved to clause 8.2.</td>
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<td></td>
<td>8.2</td>
<td>Statement on piling hammer mass and height of drop moved here from clause 6.1.</td>
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<td></td>
<td>8.4</td>
<td>Previously clause 8.3.1. Responsibility for cost of preboring under various situations clarified. Details of proposed preboring equipment and methods to be included in PQP. Preboring to nominated depths clarified.</td>
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<td></td>
<td>11</td>
<td>Hold Point on cutting off and stripping of pile moved here from clause 9.3.</td>
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<td></td>
<td>12.1</td>
<td>Reference to list of approved Dynamic Testing systems in Annex F deleted and replaced by url reference for list of approved bridge components on internet.</td>
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<td></td>
<td>12.2</td>
<td>New heading “Procedure” inserted to form sub-clause 12.2. Subsequent sub-clauses renumbered.</td>
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<td></td>
<td>Annex B</td>
<td>Jetting removed from costs of pile driving to be included in Item (c).</td>
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<td></td>
<td>Annex F</td>
<td>Previous lists of approved Dynamic Testing systems in Annex F deleted.</td>
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DRIVEN H-SECTION STEEL PILES

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IC-QA-B53
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FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification RMS B53 Edition 3 Revision 0.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

PROJECT SPECIFIC CHANGES

Any project specific changes are indicated in the following manner:

(a) Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. Additional Text.

(b) Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. Deleted Text.
RMS QA SPECIFICATION B53
DRIVEN H-SECTION STEEL PILES

1  GENERAL

1.1  SCOPE
This Specification sets out the requirements for the supply and driving of H-section steel piles.

1.2  STRUCTURE OF THE SPECIFICATION
This Specification includes a series of annexures that detail additional requirements.

1.2.1  Payment
The method of measurement and payment must conform to Annexure B53/B.

Work and materials will be rejected if they do not conform to the requirements of this Specification.

1.2.2  Schedules of HOLD POINTS, WITNESS POINTS and Identified Records
The schedules in Annexure B53/C list the HOLD POINTS and WITNESS POINTS that must be observed. Refer to Specification RMS Q for the definitions of HOLD POINTS and WITNESS POINTS.

The records listed in Annexure B53/C are Identified Records for the purposes of RMS Q Annexure Q/E.

1.2.3  Planning Documents
The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure B53/D and must be implemented.

1.2.4  Frequency of Testing
The Inspection and Test Plan must nominate the proposed testing frequency to verify conformity of the item, which must not be less than the frequency specified in Annexure B53/L. Where a minimum frequency is not specified, nominate an appropriate frequency. Frequency of testing must conform to the requirements of RMS Q.

You may propose to the Principal a reduced minimum frequency of testing. The proposal must be supported by a statistical analysis verifying consistent process capability and product characteristics. The Principal may vary or restore the specified minimum frequency of testing, either provisionally or permanently, at any time.

1.2.5  Referenced Documents
Unless specified otherwise or is supplied specifically by the Principal, the applicable issue of a referenced document must be the issue current at the date one week before the closing date for tenders, or where no issue is current at that date, the most recent issue.
Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure B53/M.

1.3 DEFINITIONS

The terms “you” and “your” mean “the Contractor” and “the Contractor’s” respectively.

The following definitions apply to this Specification:

**Calculated Set**: The calculated average Set from 10 consecutive blows to achieve the required resistance with the Net Driving Energy stated on the Drawings.

**Contract Level**: Reduced level (RL) of the pile toe shown on the Drawings.

**Dynamic Analysis**: A Wave Equation Analysis of a specific blow using force and velocity measured in Dynamic Testing together with measured pile/soil parameters, to replicate the measured traces of force and velocity and subsequently determine pile resistance, distribution of resistance and pile integrity (e.g. CAPWAP, TNOWAVE).

**Dynamic Data**: The force and velocity near the head of the pile and estimates of pile resistance, Net Driving Energy, pile integrity and stresses in the pile, determined immediately using electronic equipment (e.g. PDA) during pile driving.

**Dynamic Testing**: The measuring and recording of Dynamic Data for each blow of the hammer and subsequent Dynamic Analysis of specific blows. The term is the same as the High-Strain Dynamic Testing of AS 2159.

**Maximum Net Driving Energy**: Net driving energy which must not be exceeded at any time during driving, to prevent damage to the pile.

**Minimum Penetration Depth**: Minimum length of pile below existing surface level or other specified surface level at pile location shown on the Drawings.

**Net Driving Energy**: Driving energy at the top of the pile i.e. after hammer, helmet and cushion losses are accounted for.

**Nominal Driving Energy**: Driving energy nominally imparted by the hammer i.e. before hammer, helmet and cushion losses are accounted for; calculated by multiplying the hammer weight and nominal drop.

**Nominal Refusal**: A penetration of not more than 13 mm from 10 consecutive blows with the Net Driving Energy stated on the Drawings or derived after the driving of Representative Piles.

**Penetration**: Length of pile embedded in the ground.

**Pile Design Load**: The design ultimate axial load shown on the Drawings for the pile.

**Piling Supervisor**: Your employee responsible for supervision and control of the piling operations.

**Representative Pile**: A pile nominated on the Drawings or by the Principal that represents a number of piles that are driven to a resistance, for the purpose of determining driving parameters using Dynamic Testing. Representative Piles which are driven prior to the driving of the piles represented are also Test Piles.

**Set**: Permanent pile displacement after each drop of the hammer.
**Temporary Compression:** Elastic deformation of the pile and soil when the hammer strikes the pile.

**Test Piles:** Piles driven to enable the Principal to confirm or alter as necessary the pile lengths shown on the Drawings. Test Piles which represent piles driven to a resistance are also Representative Piles. Test Piles are nominated on the Drawings, and are usually dimensioned 2 (two) metres longer than required by the design Contract Levels.

**Wave Equation Analysis:** A predictive computer analysis of pile driving, which can use hammer, pile and soil characteristics measured during Dynamic Testing for the determination of resistance versus Set of a pile (bearing graph) or pile driveability (e.g. GRLWEAP).

## 2 MATERIALS AND SUPPLY OF PILES

### 2.1 GENERAL

The materials for and supply of the piles must be in accordance with the Drawings and this Specification.

Where shown on the Drawings, supply and fix steel reinforcing plates to the pile toes prior to driving.

### 2.2 FERROUS MATERIAL

Steel used for piling and for reinforcing plates for pile toes must conform to AS/NZS 3678, AS/NZS 3679.1 and AS/NZS 3679.2, as applicable.

### 2.3 TESTING OF MATERIALS

All structural steel supplied must be manufactured under quality management systems certified to AS/NZS ISO 9001 by a third party accredited by the Joint Accreditation System of Australia and New Zealand.

Provide evidence that the materials used comply with the relevant Australian Standards and RMS specifications. A mill certificate with appropriate NATA registration from the material supplier will constitute documentary evidence of compliance.

Do not use any material or part in the Works until it has been identified with the tests prior to its use.

### 2.4 DEFECTS IN FERROUS MATERIALS

Defects in the steel H-sections and other components arising from their manufacturing which become evident at any stage are considered to be nonconformities.

Submit your proposal for repair or replacement of the defective materials in your PROJECT QUALITY PLAN.

### 2.5 WELDING

All welding procedures, welder qualifications and welding must conform to Specification RMS B201 for Weld Category SP.
2.6  PROTECTIVE TREATMENT AND CLEANING OF STEEL PILES

Where protective treatment of the steel piles is required, submit details of the proposed method of applying the treatment.

Thoroughly clean off all mud, grease, loose rust, loose mill scale, weld spatter, etc. from the portions of the piles which are to be embedded or encased in concrete, prior to the embedment or encasement.

2.7  MARKING OF PILES

Clearly and indelibly mark all Test Piles at one metre intervals commencing from the toe to show penetration depths attained during driving. All other piles must be marked for traceability.

3  HANDLING AND STACKING OF PILES

Verify, by engineering calculations, that your method of lifting and stacking of piles do not cause any damage to the piles.

Determine the size of bearers placed on foundation material, accounting for the site conditions, to keep piles clear of each other and the ground.

Bearers must support the piles over their full width and, where the piles are stacked in more than one layer, be in line vertically to avoid additional bending in any pile in the stack.

Damaged piles are considered to be nonconforming.

4  SITE PREPARATION

Carry out any excavation or backfilling in the vicinity of the piles in accordance with Specification RMS B30.

Where the ground level is to be permanently lowered, such as for an excavated channel, do not drive piles located in the area to be excavated until such excavation is complete.

Where the level of the bottom of the pile cap is more than two metres below the existing natural surface level, prior to the driving of the piles, carry out excavation for the pile cap to a level which is not more than two metres higher than the level of the bottom of the pile cap, to reduce any temporary contribution of the ground above the bottom level to the pile resistance measured during driving.

Where piles are shown on the Drawings as penetrating through a new embankment, place and compact the new embankment prior to driving the piles, unless otherwise specified.

5  ACCEPTANCE CRITERIA FOR PILE DRIVING

5.1  GENERAL

Drawings prepared to AS 5100 show ultimate loads. Ultimate loads are used as the basis for this Specification.
5.2 **Piles Driven to Nominal Refusal in Rock**

Apply this Clause where piles are shown on the Drawings as being driven to Nominal Refusal in rock.

### 5.2.1 Pile Resistance

Drive piles to achieve Nominal Refusal in rock, or to the required pile resistance as demonstrated by Dynamic Testing in accordance with Clause 5.3.1, at the end of driving.

### 5.2.2 Dynamic Testing

Carry out Dynamic Testing in accordance with Clause 12 to verify the Net Driving Energy delivered by the driving equipment and the distribution of resistance along the pile to confirm that the pile is founded in rock, on at least one pile for each different pile rake and each different piling equipment set-up. This must include the first Test Pile driven, if Test Piles are nominated on the Drawings.

5.3 **Piles Driven to a Resistance**

Apply this Clause where piles are NOT shown on the Drawings as being driven to Nominal Refusal in rock.

Unless specified otherwise or instructed otherwise by the Principal, if the driving record indicates that some piles of a footing have founded in rock or in another hard layer, then drive all piles of the footing to found in that same layer.

### 5.3.1 Pile Resistance

After achieving the Minimum Penetration Depth shown on the Drawings, drive the piles further to achieve the required pile resistance, given as follows:

- **(a)** For Representative Piles, the required pile resistance is at least the Pile Design Load divided by the applicable geotechnical strength reduction factor, both of which are shown on the Drawings, and demonstrated by Dynamic Testing.

- **(b)** For piles represented by a Representative Pile, the required pile resistance is the same as in item (a) above but demonstrated by the driving parameters established during the driving of that Representative Pile to achieve the same pile resistance.

- **(c)** For an individual pile not represented by a Representative Pile, the required pile resistance is at least the Pile Design Load divided by the applicable geotechnical strength reduction factor for individual pile testing, both of which are shown on the Drawings, and demonstrated by Dynamic Testing of that individual pile.

The acceptance of a proposal for Dynamic Testing of an individual pile will be at the absolute discretion of the Principal. Payment for such testing when accepted by the Principal must be in accordance with Item (i) in Annexure B53/B.

5.4 **Minimum Penetration Depth**

Apply driving methods that ensure all piles attain the Minimum Penetration Depth shown on the Drawings. Where the Minimum Penetration Depth cannot be achieved, notify the Principal. The Principal will determine whether a pile that does not reach Minimum Penetration Depth is acceptable.
5.5 **POSITIONAL TOLERANCES**

Drive piles with tolerances not exceeding the positional tolerance requirements specified in AS 2159.

5.6 **DRIVING RECORDS**

Prepare a driving record for each pile. The driving record must contain at least the following information:

(a) Date of driving pile.
(b) Design location, inclination and dimensions of pile.
(c) Ground surface level at the time of driving, and toe level at end of driving.
(d) Reports of Dynamic Testing, including restrike tests, when carried out.
(e) Record of Sets and Temporary Compressions for Test Piles and Representative Piles including restrike test results and, for other piles, at the end of driving.
(f) Type and size of hammer and its stroke, or for double acting hammers the number of blows per minute.
(g) Type and condition of packing on the pile head, and of the dolly or follower.
(h) Sequence of driving in pile groups.
(i) Actual location and any apparent deviation from design location and inclination.
(j) Any other relevant information.

Make suitable provision in the records for the names and signatures of your personnel responsible for driving and testing the piles and for verifying its conformity with the specification requirements.

6 **TEST PILES**

6.1 **GENERAL**

Drive Test Piles at locations nominated on the Drawings as “Test Piles”.

Drive all Test Piles BEFORE driving the remaining piles.

For Test Piles which are also Representative Piles, comply also with the requirements of Clause 7.

**HOLD POINT**

Process Held: Driving of each Test Pile.

Submission Details: Notification of the time and location of the driving of each Test Pile at least one working day prior to commencing.

Release of Hold Point: The Principal will attend the site of each Test Pile and may inspect arrangements for monitoring prior to authorising the release of the Hold Point.
Record the number of blows per metre for Test Piles over the whole driven length. For the last ten 
blows, record the final Set in mm and the average Temporary Compression per blow.

Perform Dynamic Testing over the whole driven length and record data for analysis from the start to 
ethe end of driving.

Unless specified otherwise, carry out a restrick test in accordance with Clause 12.3 after a minimum 
period of 24 hours. Where restriking a pile is carried out, the driving parameters achieved must be 
equal to or better than those measured at the end of driving and the distribution of resistance along the 
pile must be effectively unchanged. Where these criteria are not met, submit the driving records to the 
Principal and take such action as directed by the Principal.

Notwithstanding that a Test Pile may have achieved the required pile resistance and the required 
Minimum Penetration Depth, the Principal may require further driving of the Test Pile.

6.2 CONFIRMATION OR ALTERATION OF PILE LENGTHS

On completion of driving of the Test Piles, submit to the Principal the driving records and Dynamic 
Testing reports of the Test Piles.

Allow three working days for the Principal to consider your submission and instruct the lengths of the 
remaining piles.

HOLD POINT

<table>
<thead>
<tr>
<th>Process Held:</th>
<th>Making up the pile lengths, and driving of piles represented by the Test Piles.</th>
</tr>
</thead>
</table>
| Submission Details:                               | Driving records and Dynamic Testing reports of all Test Piles including 
restrike test results.                                                      |
| Release of Hold Point:                           | The Principal will consider the driving records of the Test Piles and will 
confirm or alter the pile lengths shown on the Drawings, prior to authorising 
the release of the Hold Point.                                              |

7 REPRESENTATIVE PILES

Drive Representative Piles at locations nominated on the Drawings as “Representative Piles”.

HOLD POINT

<table>
<thead>
<tr>
<th>Process Held:</th>
<th>Driving of each Representative Pile.</th>
</tr>
</thead>
</table>
| Submission Details:                               | Notification of the time and location of the driving of each Representative 
Pile at least one working day prior to commencing.                         |
| Release of Hold Point:                           | The Principal will attend the site of each Representative Pile and may 
inspect arrangements for monitoring prior to authorising the release of the 
Hold Point.                                                              |
Record the number of blows per metre for Representative Piles over the whole driven length. For the last ten blows, record the final Set in mm and the average Temporary Compression per blow.

Perform Dynamic Testing over the whole driven length and record data for analysis from the start to the end of driving.

Unless specified otherwise or accepted by the Principal, the Set must be in the range of 3 mm to 10 mm per blow at the end of the driving so that the full pile resistance is mobilised and can be measured using Dynamic Testing equipment.

Unless specified otherwise, carry out a restrike test in accordance with Clause 12.3 after a minimum period of 24 hours. Where restriking a pile is carried out, the driving parameters achieved must be equal to or better than those measured at the end of driving and the distribution of resistance along the pile must be effectively unchanged. Where these criteria are not met, submit the driving records to the Principal and take such action as directed by the Principal.

The driving energy and Set corresponding to the required resistance must be the driving parameters for the driving of piles represented by the Representative Pile.

Where Calculated Set and the basis for its calculation are shown on the Drawings, these are indicative only and are not to be used as the driving parameters.

The required pile resistance is deemed to be achieved if Nominal Refusal is reached prior to the required resistance being measured by Dynamic Testing, and subsequent Wave Equation Analysis indicates that the required pile resistance has in fact been achieved.

Notwithstanding that a Representative Pile may have achieved the required pile resistance and the required Minimum Penetration Depth, the Principal may require further driving of the Representative Pile.

Where more than one Representative Pile is used to represent a pile, the required Set may be obtained by linear interpolation between the resistance versus Set curves.

Where there is any reason to believe that the geotechnical conditions are not essentially uniform, the Principal may nominate additional piles to be Representative Piles and determine which piles are represented by those piles.

### 8 DRIVING EQUIPMENT AND METHOD

#### 8.1 GENERAL

Without limiting the requirements of Specification RMS G22, prior to bringing any piling equipment or plant to the Site, provide drawings and calculations certified by a Chartered Professional Engineer with membership of Engineers Australia practising in the field of geotechnical engineering (or equivalent) of any working platforms or supports required to keep the piling rig stable and safe during piling operations at the Site.

An equivalent to membership of Engineers Australia would be an Engineer registered on the National Engineering Register (NER) in the general area of practice of Civil Engineering and experienced in the geotechnical assessment of the stability and safety of working platforms or supports for piling rig during piling operations.
8.2 DRIVING EQUIPMENT

Piles may be driven with diesel, compressed air, drop or vibration hammers or a combination of these. Clutch operated drop hammers must not be used.

The piling hammer must be capable of achieving the specified Net Driving Energy. Drop hammers must be of sufficient mass to achieve the Net Driving Energy with a drop of not more than two metres.

The driving equipment must be capable of producing a consistent driving energy with a variation of less than 10% between piles at equivalent stages of driving.

Maintain the equipment including packing so that whenever measurements are made to determine the driving resistance including restriking, the Net Driving Energy will not differ by more than 10% from that used to establish the driving parameters.

Replace the packing regularly to maintain efficient cushioning of the driving force.

8.3 DRIVING METHOD

Unless specified otherwise or approved by the Principal, the method of driving must be in accordance with AS 2159 and the requirements of this Specification.

Prior to commencing piling operations on site, submit to the Principal certification, including calculations, by a Chartered Professional Engineer with membership of Engineers Australia practising in the field of Civil or Structural Engineering (or equivalent), verifying that under the proposed setting-up and site conditions, the equipment nominated will be used within its safe working capacities.

An equivalent to membership of Engineers Australia would be an Engineer registered on the National Engineering Register (NER) in the general area of practice of Civil or Structural Engineering.

HOLD POINT

Process Held: Setting up of piling frame and driving of all piles, including Test Piles and Representative Piles.

Submission Details: Details of the proposed driving equipment and method together with certification, including calculations, by a Chartered Professional Engineer with membership of Engineers Australia practising in the field of Civil or Structural Engineering (or equivalent), verifying that under the proposed setting-up and site conditions, the equipment nominated will be used within its safe working capacities.

Release of Hold Point: The Principal will consider the details and certification submitted, prior to authorising the release of the Hold Point.

8.4 USE OF PRE-BORING

Pre-boring may be used to assist in attaining the Minimum Penetration Depth specified.

Where pre-boring to nominated depths is shown on the Drawings, the cost of pre-boring must be included in the rate for Item (c) in Annexure B53/B. Where pre boring is not shown on the Drawings but is directed by the Principal, the cost of the pre boring will be borne by the Principal.
Pre-boring may be carried out at your discretion in a manner not detrimental to the pile performance, in which case the costs of the pre-boring will be borne by you.

In all cases where pre-boring is used, submit details of your proposed pre-boring equipment and methods including pre-boring diameter in the PROJECT QUALITY PLAN. Notify the Principal if you require to change the pre-boring diameter, unless approved by the Principal.

The depth of pre-boring must not exceed the Minimum Penetration Depth specified.

Determine the depth of pre-boring by trial and error during the pre-boring of Test Piles/Representative Piles where such piles are specified. Otherwise, determine the depth of pre-boring by trial and error during the actual driving of piles.

Carry out pre-boring of the second and third Test Piles/Representative Piles using information derived from the driving and Dynamic Testing of the first and second Test Piles/Representative Piles respectively.

If the sides of the pre-bored hole are not self supporting, provide temporary support for the hole.

To ensure that the pile is properly supported laterally and will develop skin resistance in the pre-bored hole, backfill before driving any space remaining between the pile and the sides of the pre-bored hole with a suitable granular material, and compact by flooding the granular material. Remove any temporary support after the pre-bored hole has been backfilled.

Record the diameter, use of any temporary support and reduced level (RL) of the bottom of all pre-bored holes as part of the pile driving record.

Extend as necessary, at your cost, any pile which, in the Principal's opinion, requires extending due to excessive pre-boring.

9 Driving Operation

9.1 General

Your Piling Supervisor must supervise and control the driving at all times.

During all driving operations, the driving equipment, procedures and parameters must be in accordance with the procedures established during driving of the Test Pile/Representative Pile. At the end of driving and during restriking, the Net Driving Energy delivered to the pile must be within 10% of that used at the end of driving and restriking of the appropriate Test Pile/Representative Pile.

Confirm during driving using the records of the driving of the Test Pile/Representative Pile that the pile is being driven in the same manner, using the records of number of blows per metre, Penetration and Temporary Compressions.

If driving operations cease for any reason other than to perform a restrike test, then upon recommencement of driving, allow the striking of a minimum of 30 blows at the required Net Driving Energy before assessing whether the pile has met the required driving criteria.

At all times during the driving operation, adjust the driving equipment such that the blow of the hammer is directed centrally and axially on the pile head.
9.2 RESTRICTION ON STRESSES AND NET DRIVING ENERGY DURING DRIVING

During driving, including testing and restriking of piles, ensure at all times that the driving stresses do not exceed those for installation specified in AS 2159, and that the Net Driving Energy does not exceed the Maximum Net Driving Energy shown on the Drawings, unless approved otherwise by the Principal.

Avoid damage to the pile caused by excessive stresses during driving. Initially limit the Net Driving Energy to no more than half of the required Net Driving Energy and the pile Set to no greater than 10 mm per blow. Then gradually increase the energy, ensuring at all times that the Set of the pile does not exceed 25 mm per blow when the driving is between one half and the full required Net Driving Energy.

Should damage to the pile be likely during driving, modify the driving procedure further so as to prevent damage from occurring.

In the case of a diesel hammer, the initial Net Driving Energy may need to be limited to the free fall of the hammer.

9.3 DRIVING OF PILES

WITNESS POINT

Process to be Witnessed: Driving of each pile.

Submission Details: Notification of the time and location of the driving of each pile at least one working day prior to commencing.

During pitching, lift and support piles at the positions on the pile shown on the Drawings.

During the initial stages of driving, do not bend or spring piles into position but effectively hold and guide the pile.

At all stages of driving, the pile frame must not exert any undue lateral force on the pile using frequent checks. Do not use significant horizontal force to correct any tendency for the pile to run off line. At all times, do not restrain the pile against rotation about its longitudinal axis.

If, during driving, the head of a pile is damaged to the extent that further driving is not possible, investigate the causes of the damage and prove that damage has not occurred elsewhere in the pile. Otherwise, extract the pile immediately and replace it with a sound pile. This work will be at your expense unless the cause of the damage was outside your control.

If damage has not occurred elsewhere in the pile, cut off the damaged pile head and continue driving. Where as a result of the cutting off, the pile requires a splice, restore the pile to its correct length. This work will be at your expense unless the need for the splice was outside your control. A suitable off-cut length of pile may be used for this purpose.

Where the pile driving equipment is altered, test the driving equipment to determine the relationship between the operation of the equipment and the Net Driving Energy at the head of the pile. Such a test will be at your own expense.

Where there is reason to believe that the Net Driving Energy differs by more than 10% from the Net Driving Energy measured during driving at equivalent stages of the Test Pile/Representative Pile, the Principal may direct that additional dynamic tests be carried out to re-establish driving criteria.
In this instance, if the test shows that the Net Driving Energy at the head of the pile differs by more than 10% from the Net Driving Energy measured during driving at equivalent stages of the Test Pile/Representative Pile, then you must bear the full cost of the test and of any retest, after modification of the driving equipment or system, and of any other costs. Otherwise, payment will be made in accordance with Item (h) in Annexure B53/B.

If the required pile resistance or Nominal Refusal is obtained before the Minimum Penetration Depth is reached and rock is not encountered, prior to driving any other piles, amend the driving method as necessary to reach the Minimum Penetration Depth without damaging the piles.

**HOLD POINT**  
(For piles not founded in rock and if the Minimum Penetration Depth is not achieved)

Process Held:  
Driving of any further piles.

Submission Details:  
Details of the amended driving method, together with certification that the amended driving method is likely to result in achieving the Minimum Penetration Depth before the required pile resistance is obtained.

Release of Hold Point:  
The Principal will consider the submitted documents and may carry out further surveillance and audit, prior to authorising the release of the Hold Point.

Where it is uncertain that the piles have been driven in the same manner as the Test Piles/Representative Piles, where driving has been interrupted prematurely, or a check on pile resistance needs to be made, or for any other reason, the Principal may require a restrike test to be made in accordance with Clause 12, with payment in accordance with Item (h) in Annexure B53/B.

**10 SPlicing OF PILES**

A pile may be lengthened by splicing on an additional length of identical H-section steel pile.

Unless specified otherwise, the welded connection for pile splices must be full penetration butt welds over the whole cross section, carried out in accordance with Clause 2.5.

**11 CUTTING OFF OF PILES**

**HOLD POINT**  
(On the completion of the driving of each pile)

Process Held:  
Cutting off of a pile after completion of driving.

Submission Details:  
Driving records and survey report showing the alignment and plan position of the pile. Certification by the Piling Supervisor that the pile has been driven in accordance with this Specification.

Release of Hold Point:  
The Principal will consider the details submitted, prior to authorising the release of the Hold Point.

Cut off any excess pile lengths, where necessary, so that the pile tops are at the levels shown on the Drawings.
Remove any unused off-cuts remaining at the end of the Contract from the Site.

12 Dynamic Testing

12.1 General

Carry out Dynamic Testing in accordance with this Clause and AS 2159 using an approved organisation with approved equipment using an approved dynamic testing system, with subsequent wave equation analysis or signal matching carried out using an approved computer program, all as listed in the “Lists of RMS Approved Bridge Components and Systems” at: http://www.rms.nsw.gov.au/business-industry/partners-suppliers/documents/tenders-contracts/listofapprovedbridgecomponentssystems.pdf

12.2 Procedure

Use the following testing procedure:

(a) Attach four bolt-on transducers to the pile at a minimum of 1.5 times the flange width, below the head of the pile in accordance with the requirements of the system supplier.

(b) Following the connection of the transducers to the analyzer, strike the pile with sufficient energy to verify the required pile resistance.

To avoid pile damage, immediately report to the Piling Supervisor if the allowable driving stresses could be exceeded at any time during the driving.

Record the driving stresses, measured pile resistance, Nominal Driving Energy, measured Net Driving Energy and Set.

The relationship between Net Driving Energy and Set determined from a dynamic test is valid only for the specific combination of hammer, helmet, cushion, pile rake, pile size, pile material and founding material.

12.3 Restrike Test

When a restrike test is required, consider only the first 20 blows at the beginning of the driving to be part of the restrike test. Measure the driving parameters at the required Net Driving Energy on blow numbers 6 to 15 inclusive.

The acceptance criteria for a restrike test on a pile are that the driving parameters achieved must be equal to or better than those measured at the end of driving and the distribution of resistance along the pile must be effectively unchanged. Where these criteria are not met, submit the driving records to the Principal and take such action as directed by the Principal at Principal’s cost.

12.4 Dynamic Analysis

Analyse the dynamic test results for each pile tested. Analyses must include full Dynamic Analysis using measured field parameters of the test data (e.g. CAPWAP) and resistance versus Set curves (e.g. GRLWEAP analysis), when requested by the Principal, showing a minimum of six (6) different resistances and the corresponding blowcounts.
12.5 REPORT

Provide to the Principal two copies of a report for each pile tested including:

(a) Complete PDA (or approved equivalent) output for all blows, including driving stresses and Net Driving Energy.

(b) CAPWAP (or approved equivalent) analyses for selected blows.

(c) When requested by the Principal, GRLWEAP (or approved equivalent) output in the form of resistance versus set curves giving the true pile resistance for specific driving energies, using data measured during driving.

(d) Certification that the tested pile has been driven in accordance with this Specification. If it is not possible for this certification to be provided due to nonconformities in the driving or the driven pile, provide instead an itemised nonconformity report together with the proposed disposition.
ANNEXURE B53/A – (NOT USED)

ANNEXURE B53/B – PAYMENT

Refer to Clause 1.2.1.

The Lump Sum covers all activities required to construct piling to the resistance shown on the Drawings plus the value of work under the Provisional Quantity work included in the Schedule of Prices.

In the Schedule of Prices accompanying the Lump Sum Tender, the cost of piling, including Test Piles and Representative Piles, is divided into the following items (similar items must be separately provided for each size of pile):

(a) **Supply of Piles**

This item includes the cost of manufacture, supply and delivery of H-section steel piles of the lengths shown on the Drawings. The units are per metre. The quantities are the total length of piles shown on the Drawings.

The rate includes the cost of any splices required to make up each full length of pile to suit the Contract Levels, from shorter lengths of pile stock, but does not include the cost of the supply and fitting of reinforcing plates for pile toes.

The per metre of pile length rate included in the Schedule of Prices may be used by the Principal in accordance with the Conditions of Contract for the purpose of valuing variations due to changes of the pile lengths instructed under Clause 6.2.

(b) **Supply and Fitting of Reinforcing Plates for Pile Toes**

This item applies only when reinforcing plates for pile toes are shown on the Drawings. The units are per pile.

(c) **Driving of Piles**

This item includes all costs associated with driving H-section steel piles of the number and lengths shown on the Drawings. The units are per pile and per metre of pile length (Provisional Quantity). The quantities are the total number and total length of piles shown on the Drawings.

Payment for pre-boring will be in accordance with Clause 8.4.

The per metre of pile length (Provisional Quantity) rate included in the Schedule of Prices may be used by the Principal in accordance with the Conditions of Contract for the purpose of valuing adjustments to the Contract Price due to changes of the pile lengths instructed under Clause 6.2.

(d) **Splicing of Piles - Provisional Quantity**

Where this item is included in the Schedule of Estimated Quantities, payment for splices in accordance with Clause 10 between H-section steel pile lengths (including the supply of all materials but not including the H-section steel pile lengths) will be made at the tendered rates for these items. The unit of measurement is per splice.
This item is only applicable where the pile is lengthened when instructed by the Principal under Clause 6.2, and such lengthening necessarily requires an additional splice.

No payment will be made for splices used by you to make up piles from shorter lengths than the lengths shown on the Drawings, nor for any splices which are made by you for your own convenience, e.g. to suit your pile driving equipment, nor where the pile is extended as a result of excessive preboring.

(e) Cutting Off of Piles - Provisional Quantity

This item includes all costs associated with the cutting off of all piles in accordance with Clause 11. No payment will be made unless the pile is actually cut off. The unit of measurement is per pile cut off.

(f) Flame Cut Holes in Piles for Reinforcement - Provisional Quantity

This item includes all costs associated with the cutting of holes in a steel pile to allow for the placing of reinforcement where specified on the Drawings.

The unit must be per pile.

(g) Dynamic Testing of Test Piles/Representative Piles for Resistance

This item includes mobilisation and Dynamic Testing in accordance with Clause 12 for each Test Pile/Representative Pile to determine the Net Driving Energy and Set at the required pile resistance. The unit of measurement is per pile tested.

(h) Dynamic Testing of Piles to Verify Dynamic Data - Provisional Quantity

This item includes Dynamic Testing or restrike testing in accordance with Clause 12 when testing is instructed by the Principal to verify the Net Driving Energy delivered by the driving equipment or other Dynamic Data in accordance with Clauses 5.2, 7 or 9.3. The unit of measurement is per pile tested.

Payment is subject to the provisions of Clause 9.3.

(i) Dynamic Testing of Individual Piles for Resistance - Provisional Quantity

This item includes the cost of Dynamic Testing in accordance with Clause 12 of individual piles in accordance with Clause 5.3.1 (c), the cost of which will be borne by you if pile lengths supplied differ from those instructed under Clause 6.2, but otherwise this testing will be paid for at the tendered rate for this item.
ANNEXURE B53/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.2.

C1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS

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<th>Clause</th>
<th>Type</th>
<th>Description</th>
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</thead>
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<tr>
<td>6.1</td>
<td>Hold</td>
<td>Driving of each Test Pile</td>
</tr>
<tr>
<td>6.2</td>
<td>Hold</td>
<td>Making up and driving all piles represented by the Test Piles</td>
</tr>
<tr>
<td>7</td>
<td>Hold</td>
<td>Driving of each Representative Pile</td>
</tr>
<tr>
<td>8.3</td>
<td>Hold</td>
<td>Setting up of driving frame and driving of all piles, including Test Piles and Representative Piles</td>
</tr>
<tr>
<td>9.3</td>
<td>Witness</td>
<td>Driving of each pile</td>
</tr>
<tr>
<td>9.3</td>
<td>Hold</td>
<td>Driving of any further piles (for piles not founded in rock and Minimum Penetration Depth is not achieved)</td>
</tr>
<tr>
<td>11</td>
<td>Hold</td>
<td>Cutting off of a pile after completion of driving</td>
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C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of RMS Q Annexure Q/E.

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<tr>
<th>Clause</th>
<th>Description of Identified Record</th>
</tr>
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<td>Materials test reports</td>
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<tr>
<td>2.5</td>
<td>Welding information</td>
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<td>Driving records for each Representative Pile</td>
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<tr>
<td>9.3</td>
<td>Driving records and survey report for each pile</td>
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<td>12.5</td>
<td>Dynamic Testing report for each tested pile</td>
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</table>
ANNEXURE B53/D – PLANNING DOCUMENTS

Refer to Clause 1.2.3.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. Review the requirements of this Specification and other contract documents to determine any additional documentation requirements.

(a) pile splices, welding procedures, welder qualifications including certificate and repair or replacement of defective pile materials (refer to Clauses 2 and 10).

(b) application of protective treatment, if required (refer to Clause 2.6).

(c) pile driving record sheets (refer to Clause 5.6).

(d) driving equipment including pile hammer, pile helmet, cushion assembly, pile driving rig, crane, leaders and/or other equipment proposed for lifting and driving piles and for positioning and supporting piles during driving (refer to Clause 8.2).

(e) pile driving method (refer to Clauses 8.3 and 9).

(f) proposed preboring diameter, and equipment and methods to be used for preboring (refer to Clause 8.4). and

(g) Dynamic Testing organisation and system, and field testing personnel (refer to Clause 12).

ANNEXURES B53/E TO B53/K – (NOT USED)

ANNEXURE B53/L – FREQUENCY OF TESTING

Refer to Clause 1.2.4.

<table>
<thead>
<tr>
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<th>Characteristic analysed</th>
<th>Test Method</th>
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<td>RMS B201</td>
<td>RMS B201</td>
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<td>Pile position</td>
<td>RMS Q Annexure Q/K</td>
<td>Each pile</td>
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<td>6, 7</td>
<td>Pile resistance by Dynamic Testing</td>
<td>Clause 12</td>
<td>Each Test Pile or Representative Pile</td>
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ANNEXURE B53/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.5.

**RMS Specifications**

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**Australian Standards**

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