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REVISION REGISTER

<table>
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<tr>
<th>Ed/Rev Number</th>
<th>Clause Number</th>
<th>Description of Revision</th>
<th>Authorised By</th>
<th>Date</th>
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<tr>
<td>Ed 1/Rev 0</td>
<td></td>
<td>First issue</td>
<td>GM, IC</td>
<td>27.05.11</td>
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Driven Cast-in-Place Concrete Piles

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IC-DC-B57
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FOREWORD

RMS COPYRIGHT AND USE OF THIS DOCUMENT

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When this document forms part of a deed

This document should be read with all the documents forming the Project Deed.

When this document does not form part of a deed


BASE SPECIFICATION

This document is based on Specification RMS B57 Edition 2 Revision 2.
RMS SPECIFICATION D&C B57

DRIVEN CAST-IN-PLACE CONCRETE PILES

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for the design, testing and installation of piles classified in accordance with AS 2159 as driven cast-in-place displacement piles.

The driven cast-in-place piles covered by this Specification are those constructed insitu by driving a tubular liner to form a void which is then wholly filled with reinforced concrete. The liner has an end closed by means of a plug or plate. The liner may be either:

(i) permanent – made of concrete or steel of constant section; or
(ii) temporary – steel tube extracted during concreting.

An expanded concrete base may or may not be formed at the bottom of the pile.

1.2 STRUCTURE OF THE SPECIFICATION

This Specification includes a series of annexures that detail additional requirements.

1.2.1 (Not Used)

1.2.2 Schedules of HOLD POINTS, WITNESS POINTS and Identified Records

The schedules in Annexure B57/C list the HOLD POINTS and WITNESS POINTS that must be observed. Refer to Specification RMS D&C Q6 for the definitions of HOLD POINT and WITNESS POINT.

The records listed in Annexure B57/C are Identified Records for the purposes of RMS D&C Q6 Annexure Q/E.

1.2.3 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure B57/D and must be implemented.

1.2.4 Minimum Frequency of Testing

The Inspection and Test Plan must nominate the proposed testing frequency to verify conformity of the item and it must not be less than that specified in Annexure B57/L. Where a minimum frequency is not specified, nominate an appropriate frequency.

1.2.5 Referenced Documents

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure B57/M.
1.3 DEFINITIONS

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

The following definitions apply to this Specification:

**Designer:** Your design engineer and/or consultant responsible for the design of the piles covered by this Specification.

**Design Level:** Reduced level of the pile toe shown in the Design Documentation.

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

**Pile:** The completed reinforced concrete pile with or without a liner and with or without an expanded concrete base.

**Test Piles:** Piles which are constructed, subjected to Static Load Testing and Integrity Testing, and evaluated for acceptance prior to the construction of other piles.

2 MATERIALS

2.1 GENERAL

Supply the materials for all piles in conformity with the requirements of AS 2159 and the additional requirements of this Specification.

2.2 LINERS

The dimensions and quality of liners must be adequate to withstand the stresses caused by handling and driving without damage or distortion.

Where a liner is to be made from series of short sections it must be watertight.

2.3 REINFORCEMENT AND CONCRETE

The supply of reinforcement and concrete for the pile must conform to the requirements of RMS D&C B80 and this Specification.

3 DESIGN

3.1 PILE DESIGN LOADS

Pile design loads are the ultimate design loads shown in the Design Documentation.

Where alternative pile sizes or configurations different from those shown in the Design Documentation are proposed, the Designer must re-analyse the structure and determine the pile design loads in accordance with AS 5100.3.
3.2 DESIGN REQUIREMENTS AND SUBMISSION

Design piles in accordance with AS 5100.3 and this Specification.

Submit Design Documentation and certification by a Chartered Professional Engineer with membership of Engineers Australia practising in the field of civil or structural engineering or equivalent, and experienced in pile and bridge design, certifying that the design will provide a factored resistance equal to or greater than the pile design loads.

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.

The design must be verified by Static Load Testing on Test Piles in accordance with Clause 5.

<table>
<thead>
<tr>
<th>HOLD POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Held:</td>
</tr>
<tr>
<td>Submission Details:</td>
</tr>
<tr>
<td>Release of Hold Point:</td>
</tr>
</tbody>
</table>

4 SITE PREPARATION

Backfill any over-excavation in the vicinity of the piles in accordance with RMS D&C B30.

Where piles are shown in the Design Documentation as penetrating through a new embankment, place and compact the new embankments as required prior to driving the piles, unless otherwise specified.

5 TEST PILES

The minimum number of Test Piles must be in accordance with Annexure B57/L.

Construct and test all Test Piles BEFORE construction of the remaining piles.

Testing of Test Piles must comprise Integrity Testing in accordance with Clause 11 and Static Load Testing in accordance with Clause 12.

Test Piles will be deemed conforming if they satisfy the conformity criteria for Integrity Testing and the static load testing conformity criteria in Table B57.1.
Table 57.1 Static Load Testing Conformity Criteria

<table>
<thead>
<tr>
<th>Load (%) of the Pile Design Load Shown in the Design Documentation</th>
<th>Maximum Deflection (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>15*</td>
</tr>
<tr>
<td>0 (after removing 75% Load)</td>
<td>7*</td>
</tr>
<tr>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>0 (after removing 150% Load)</td>
<td>15</td>
</tr>
</tbody>
</table>

* Movement to include no more than 3 mm creep over 5 hours (after load has been in place for 15 minutes)

WITNESS POINT

Process to be Witnessed: Construction of each Test Pile.
Submission Details: At least 1 working day prior to the proposed construction, give the Nominated Authority notification of construction of Test Pile(s).

Based on results of the Static Load Testing on Test Piles, submit design verification documentation and certification by a chartered professional engineer with membership of Engineers Australia practising in the field of Civil or Structural Engineering (or equivalent), and experienced in pile and bridge design, certifying that the test results verify the adequacy of the design submitted in accordance with Clause 3.

HOLD POINT

Process Held: Construction of piles other than Test Piles.
Submission Details: Design verification and certification in accordance with Clause 5. Construction, driving and testing records and pile penetration depths of Test Piles.
Release of Hold Point: The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point.

6 PILE PENETRATION DEPTH

Pile penetration depth must be the greater of:
(a) the Minimum Penetration Depth as defined in Clause 1.3; and
(b) the penetration depth of Test Piles which conform to Clause 5 of this Specification.
7 CONSTRUCTION OF PILES

7.1 GENERAL

The construction of all piles must conform to the requirements of AS 2159 and the additional requirements of this Specification.

WITNESS POINT

Process to be Witnessed: Construction of any pile.

Submission Details: At least 1 working day prior to the proposed construction, give the Nominated Authority notification of construction of the pile.

7.2 PILING PLANT AND EQUIPMENT

Provide and maintain piling plant or equipment conforming to Chapter 5 of the NSW Work Health and Safety Regulation 2011 suitable for carrying out the piling works.

Without limiting the requirements of Specification RMS D&C G22, prior to bringing any piling equipment or plant to the Construction Site, provide the Project Verifier with 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 Construction 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.

Prior to commencing piling operations on the Construction Site, forward a certificate and calculations from 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 and the relevant procedures, the equipment nominated used within its specified safe working capacities is adequate for the piling operations.

7.3 DRIVING OF LINERS

7.3.1 Driving

Do not drive a liner closer than 5 times its diameter (measured centre to centre) from an unfilled liner or from an uncased concrete pile where the concrete age is less than 24 hours.

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 end plug or plate.

Drive liners to the criteria established from driving Test Piles which conform to Clause 5 of this Specification.

Do not bend or spring liners into position but effectively guide and hold them on-line during the driving. Frequently check during all stages of driving to ensure that the pile frame does not exert any
undue lateral force on the pile. Do not use significant horizontal force to correct any tendency for the pile to run off line.

7.3.2 Driving Records

Enter on a pile driving record sheet the driving details for each pile. The driving record must contain at least the following information:

(a) date of driving liner;
(b) design location and actual location, inclination and dimensions of completed pile;
(c) type and size of hammer and its stroke;
(d) record of sets;
(e) penetration depth of Test Pile;
(f) actual pile penetration depth;
(g) final natural surface level and toe level;
(h) sequence of driving in pile groups; and
(i) any other relevant information.

The records must show the names and signatures of your personnel responsible for driving and testing the piles and for verifying its conformity with the design and specification requirements.

7.4 REINFORCEMENT

Place the reinforcement for the piles in conformity with the requirements of RMS D&C B80 and the additional requirements of this Specification.

Pass the reinforcement bars projecting from the piles through the pile-cap reinforcement bars. In placing the pilecap reinforcement, take into account the variation in location of the piles which may occur within the specified tolerances.

Incorporate in reinforcement cages for raked piles provisions for inserting and removing the concreting chute without any risk of it being snagged.

The spacers attached to the reinforcement cage must be of a type and distribution capable of maintaining the reinforcement cage in the specified position after placement.

8 PLACING CONCRETE

8.1 GENERAL

Place the concrete for the pile in conformity with the requirements of RMS D&C B80 and this Specification.

Concrete used in plugs or expanded concrete bases may, subject approval, be excluded from conformity with RMS D&C B80. Notwithstanding this exclusion, concrete mix details must be submitted in accordance with RMS D&C B80.
Driven Cast-in-place Concrete Piles

The quality and volume of concrete placed to form plugs or expanded bases, and the compaction procedure adopted, must be equivalent to that of Test Piles constructed in accordance with Clause 5 of this Specification.

Where placing concrete in the pile shaft requires dropping the concrete more than 1.6m, use suitable placing procedures and/or specially designed concrete mixes and reinforcement configurations, to prevent segregation. Assess the suitability of these procedures and provisions from the results of Integrity Testing on Test Piles.

Place concrete in the pile shaft such that after the concrete has set, the top level of sound concrete is not lower than the cut-off level shown in the Design Documentation.

8.2 EXTRACTION OF TEMPORARY LINERS

Do not bend or spring liners into position but effectively guide and hold them on-line during the extraction.

When the liner is being extracted, maintain a sufficient head of concrete within it to counter external pressure from the surrounding ground material so that the concrete forming the minimum cover to the reinforcement is not contaminated in any way.

Maintain the direction of pull on the liner along the axis of the pile. Withdraw the liner slowly during concreting at a rate and in a manner such that no significant disturbance is caused to the surrounding material and that the pile hole is completely filled up with concrete.

9 CUT-OFF AND CLEAN-UP OF PILE TOP

Remove any concrete and/or liner above the cut-off level carefully without damaging the permanent work, not earlier than 24 hours after completion of placement of concrete.

Clean the top of the pile (which will be later embedded in concrete) of laitance and any loose material. Keep clean the reinforcement bars projecting from the piles and protect them from corrosion and damage.

Disposal of excess material is your responsibility.

10 CONFORMITY

Piles conform when:
(a) they are found sound when tested and reported in accordance with Clause 11; and
(b) all requirements of this Specification have been conformed with.

11 INTEGRITY TESTING

Carry out Integrity Testing of piles in accordance with AS 2159 with a minimum frequency of testing as specified in Annexure B57/L.
Submit to the Project Verifier a report on each pile, or group of piles, tested in accordance with AS 2159.

Where results of Integrity Testing on one or more piles are not definitive, carry out further Integrity Testing using the same test method or other recognised test methods in accordance with AS 2159 and/or AS 2159 Supp1.

12 **STATIC LOAD TESTING**

Carry out Static Load Testings and provide a test report in accordance with AS 2159 and the additional requirements of this Specification with a minimum frequency of testing as specified in Annexure B57/L.
ANNEXURES B57/A TO B57/B – (NOT USED)

ANNEXURE B57/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.2.

C1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS

<table>
<thead>
<tr>
<th>Clause</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td>Hold</td>
<td>Commencement of pile construction (including Test Piles).</td>
</tr>
<tr>
<td>5</td>
<td>Witness</td>
<td>Construction of each Test Pile.</td>
</tr>
<tr>
<td>5</td>
<td>Hold</td>
<td>Construction of piles other than Test Piles.</td>
</tr>
<tr>
<td>7.1</td>
<td>Witness</td>
<td>Construction of any pile.</td>
</tr>
</tbody>
</table>

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of RMS D&C Q6 Annexure Q/E.

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description of Identified Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td>Design documentation and certification</td>
</tr>
<tr>
<td>5</td>
<td>Verification of the submitted design</td>
</tr>
<tr>
<td>5</td>
<td>Driving and test records of the Test Piles</td>
</tr>
<tr>
<td>7.3.2</td>
<td>Driving records of each pile</td>
</tr>
<tr>
<td>11</td>
<td>Report on the integrity testing of each pile</td>
</tr>
<tr>
<td>12</td>
<td>Report on the static load testing of each pile</td>
</tr>
</tbody>
</table>
The information to be submitted as part of the PROJECT QUALITY PLAN must include:

(a) details of the proposed driving equipment including the hammer, driving rig, crane, leaders and/or other equipment proposed for driving, positioning and supporting the liners during driving (refer to Clause 7.2);

(b) driving procedure and procedures for detecting and overcoming obstructions to driving of liner (refer to Clause 7.3.1);

(c) liner driving record sheets (refer to Clause 7.3.2);

(d) method of placing and supporting reinforcement cage and details of the arrangement whereby the reinforcement bars projecting from the piles pass through the pile-cap reinforcement bars (refer to Clause 7.4);

(e) method and procedures for placing concrete in the pile and special procedures, mixes and reinforcement configurations when dropping concrete more than 1.6 m (refer to Clause 8.1); and

(f) method of extraction of liner, if applicable (refer to Clause 8.2).
ANNEXURES B57/E TO B57/K – (NOT USED)

ANNEXURE B57/L – MINIMUM TESTING FREQUENCY

Refer to Clause 1.2.4.

L1 TEST PILES – INTEGRITY AND STATIC LOAD TESTING

The minimum testing frequency (ie minimum number of Test Piles) must be in accordance with Table B57/L1.

Table B57/L1 – Test Piles – Minimum Testing Frequency

<table>
<thead>
<tr>
<th>Ground Condition</th>
<th>Value of Geotechnical Strength Reduction Factor $\Phi_g$ used in the design</th>
<th>Minimum Testing Frequency (Minimum Number of Test Piles) (Test Piles per 100 Piles or part thereof)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>0.65</td>
<td>3</td>
</tr>
<tr>
<td>Variable</td>
<td>0.5</td>
<td>1 per each ground condition</td>
</tr>
<tr>
<td></td>
<td>0.65</td>
<td>3 per each ground condition</td>
</tr>
</tbody>
</table>

Notes:
1. The strength reduction factor $\Phi_g$ is in accordance with AS 5100.3
2. If the value of $\Phi_g$ used by the Bridge Designer is between 0.5 and 0.65, the minimum testing frequency requirements for $\Phi_g$ of 0.65 must be used.

L2 PILES OTHER THAN TEST PILES – INTEGRITY TESTING ONLY

The minimum testing frequency for piles other than Test Piles must be in accordance with Table B57/L2

Table B57/L2 – Piles Other than Test Piles – Minimum Testing Frequency

<table>
<thead>
<tr>
<th>Construction Stage</th>
<th>Minimum Testing Frequency (Minimum Number of Piles to be Tested)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of the first piles of each type</td>
<td>Test the first 5 piles of each type</td>
</tr>
<tr>
<td>Construction of the remaining piles of each type</td>
<td>1 in 4 piles selected at random in order of construction</td>
</tr>
</tbody>
</table>
ANNEXURE B57/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.5.

**RMS Specifications**

- RMS D&C G22  Work Health and Safety (Construction Works)
- RMS D&C Q6  Quality Management System (Type 6)
- RMS D&C B30  Excavation and Backfill for Bridgeworks
- RMS D&C B80  Concrete Work For Bridges

**Australian Standards**

- AS 2159  Piling – Design and installation
- AS 5100 (Set)  Bridge design
- AS 5100.3  Part 3: Foundations and soil-supporting structures

**NSW Government Legislation**

- Work Health and Safety Regulation 2011