Technical Specification

Transport and Main Roads Specifications MRTS63A Piles for Ancillary Structures

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Queensland Government

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Contents

1 Introduction

This Technical Specification applies to the construction of cast-in-place / bored reinforced concrete piles with high moment and low axial loads used for such applications as sign gantries, retaining walls, road barriers, pad footings, traffic signal and light poles which are outside the scope of MRTS92 *Traffic Signal and Road Lighting Footings*, masts, hoardings, advertising boards and other ancillary structures.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

The intention of this Technical Specification is that the piles are cast in dry conditions. Wet holes are only permitted when all reasonable methods (for example, extending length of liner) to have a dry hole have been unsuccessful.

This Technical Specification is based largely on MRTS63 *Cast-in-Place Piles* which is the Technical Specification used for bridge foundations and other heavy load applications. This current Technical Specification is only used where moment capacity is the dominant requirement. It is not appropriate for bridge construction where MRTS63 *Cast-in-Place Piles* must be used irrespective of the loading conditions. Due to the nature of this current Technical Specification some procedures permitted in the current Technical Specification may not be permitted in MRTS63 *Cast-in-Place Piles*. Due to the moment issue in this class of piles the design socket length is more critical than the base capacity. Similarly, geotechnical capacity should focus on socket condition rather than base condition.

Cast-in place pile types not covered by this Technical Specification include:

a) piles consisting of driven, closed-end tubes which are later filled with concrete

b) piles utilising enlarged bases formed by extruding a concrete plug from the toe of a liner using an internal drop hammer, and

c) piles constructed using bentonite or polymer slurry.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

The requirements for the manufacture of cast in place concrete elements include the use of suppliers and products for the items listed in Table 1 that are registered by Transport and Main Roads.

Table 1 – Items requiring use of registered suppliers and products

Clause	Category of Work
6.1, 7	Steelwork fabricator
6.1, 12	Reinforcing steel
12	Reinforcing spacers

For information regarding approved suppliers and products for the above items refer to the departmental website, https://www.tmr.qld.gov.au/business-industry/Business-with-us/Approved-products-and-suppliers or email TMRStructuralMaterials@tmr.qld.gov.au.

2 Definition of terms

The terms used in this Technical Specification shall be as defined in Clause 2 of MRTS01 *Introduction to Technical Specifications* and *Geotechnical Terms and Symbols*.

In addition, terms listed in Table 2 are applicable to this Technical Specification.

Table 2 – Definitions of terms

Term	Details
down-the-hole inspection	An inspection involving the lowering down the hole of a person or camera (or similar device) to inspect a socket or part of a socket. Down-the-hole inspections involving people should be considered as a last resort activity and shall only be undertaken in circumstances where it can be safely undertaken.
founding level	The level of the base of the socket at the time of pouring the pile. The design founding level is the design level of the same point.
high workability concrete	Concrete with high workability where consistency is measured as spread rather than slump.
rake	For non-vertical piles, the deviation of the pile from the vertical. Rake may be in the plane of the pier / abutment, or at some specified orientation from the plane of the pier / abutment.
toe of liner	The level of the base of the liner, not to be confused with the 'founding level' which is the base of the socket. The difference between the 'toe of liner' and 'founding level' is the length of the socket.

3 Referenced documents

Table 3 lists documents referenced in this Technical Specification.

Table 3 – Referenced documents

Reference	Title
AS 1379	*Specification and supply of concrete*
AS 2159:2009	*Piling – Design and installation*
AS 5100.3	*Bridge design, Part 3: Foundation and soil-supporting structures*
AS/NZS 1554.1	*Structural steel welding, Part 1: Welding of steel structures*
AS/NZS 3678	*Structural steel - Hot-rolled plates, floorplates and slabs*
CAC014M	*Contract Administration System Checklist – Insitu Concrete Piles*
CAC021M	*Contract Administration System Checklist – Cast-In-Place Piles*
CIA Z17	*Recommended Practice: Tremie Concrete for Deep Foundations. Concrete Institute of Australia 2012.*
MRTS01	*Introduction to Technical Specifications*
MRTS50	*Specific Quality System Requirements*
MRTS56	*Construction Surveying*
MRTS63	*Cast-In-Place Piles*
MRTS70	*Concrete*
MRTS71	*Reinforcing Steel*
MRTS71A	*Stainless Steel Reinforcing*

Reference	Title
MRTS78	*Fabrication of Structural Steelwork*
MRTS92	*Traffic Signal and Road Lighting Footings*
–	*Geotechnical Design Standard (minimum requirements)* – Transport and Main Roads
–	*Geotechnical Terms and Symbols* – (Transport and Main Roads)
–	*Workplace Health and Safety Act,* 2011

4 Quality system requirements

4.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points and Milestones applicable to this Technical Specification are summarised in Table 4.1. There are no Witness Points defined.

Table 4.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
6.2	1. Pile construction		Submit procedure for construction of pile (28 day notice period)
7	2. Weld Procedure Specification for liner fabrication and field splice welding		
11.1	3. Geotechnical certification of socket and pile base		
13.1	4. Geotechnical certification of socket and pile base after delay or reclean 5. Placement of concrete with a tremie		
14	6. Submission and approval of Pile Integrity Test Reports		

4.2 Construction procedures

The Contractor shall prepare documented procedures for all construction processes in accordance with the quality system requirements of the Contract.

Construction procedures for those activities listed in table shall be submitted to the Administrator in accordance with the quality system requirements of the Contract.

Table 4.2 – Construction procedures

Clause	Procedure
6.2	Construction of piles including driving, excavation, cleaning, inspection and certification
13.4.3	Procedure for placing concrete underwater with a tremie including continuous supply of concrete.

4.3 Lot size for testing

The minimum lot size for cast-in-place pile work covered by this Technical Specification is each pile.

4.4 Conformance requirements

The conformance requirements which apply to each pile for work covered by this Technical Specification are summarised in Table 4.4.

Table 4.4 – Conformance requirements

Clause	*Conformance requirement*
9	Location and tolerances
10	Size of pile base / socket
13.4.3.2	Resolution of the issues following the tremie being pulled out
MRTS70	Concrete conformance

5 Assessment of foundation information

In assessing the foundation information provided in the tender documents, the Tenderer's attention is drawn to the provisions of the Contract with respect to:

a) the need for the Contractor to be self-informed of all available information pertaining to the physical conditions upon and below the surface of the Site, and

b) latent conditions.

The borehole drilling logs, cores and the associated reports should be available for the Tenderer to make an assessment of the nature of the material when determining the equipment and plant needed. The borehole data represents subsurface information at a specific location only. Information on strata between boreholes is the subject of interpretation and also of the inherent variability of soil and rock strata. Departures from the strata conditions indicated by the borehole information are inevitable.

In regard to the available foundation information, this will generally include items other than just those included in the Contract documents, for example further reports, test results and samples. It is the responsibility of the Contractor to make the assessment based on all the information not just that which is bound into the Contract documents.

In regard to latent conditions the Contractor needs to be aware that these only apply where a material difference exists between what should reasonably have been anticipated by the Contractor and what is found on the Site.

The Contractor shall be deemed to have allowed for the departures as could reasonably be expected.

6 Materials and processes

6.1 General

Materials and processes shall conform to the following standards:

a) Steel for liners — As stated on the drawings but not less than AS/NZS 3678 Grade 250

b) Structural steel welding — AS/NZS 1554.1

c) Reinforcing steel — MRTS71 *Reinforcing Steel,* MRTS71A *Stainless Steel Reinforcing*

d) Concrete — MRTS70 *Concrete* together with Clause 13 herein, and

e) Steel — MRTS78 *Fabrication of Structural Steelwork.*

All reinforcing steel shall be sourced from a registered supplier of reinforcing steel (refer to Clause 1).

6.2 Construction procedures

The Contractor shall submit a procedure for construction of the piles. The procedure shall give details of the method of sinking the pile shaft, the method of socket construction, the method of maintaining stability of the walls, the equipment to be employed for this operation and the method of sealing the base of the pile against the ingress of water.

The Contractor shall make an assessment with regard to the anticipated stability of the socket walls and shall make allowance for any necessary measures required to maintain the stability of the socket during construction. If temporary liners are to be utilised, full details of installation and removal of liners shall be included in the procedure.

The procedure shall minimise the time between any base / socket excavation and certification and placing of concrete.

The completed procedure shall be submitted to the Administrator at least 28 days prior to the date for sinking of pile shafts. **Milestone** Work shall not commence until approval from the Administrator has been received in writing. **Hold Point 1**

7 Fabrication of liners

Steel liners, if required, shall be fabricated in accordance with MRTS78 *Fabrication of Structural Steelwork*, by a Transport and Main Roads registered steel fabricator.

Steel liners shall conform to the dimensions and thicknesses shown on the Standard Drawings. Spirally welded liners are permitted for this class of piles, unless it is envisaged that the liners will be driven into Moderately Weathered, Slightly Weathered or medium (or higher) strength rock, in which case use of this liner type is not approved.

> Weathering and strength grades are defined in *Geotechnical Terms and Symbols*.

The inside diameter of the liner shall not be less than the nominal diameter shown on the Standard Drawings, nor shall the out-of-round tolerance exceed 5% of diameter of liner. The outside circumference of the steel liner shall not be less than the nominal circumference calculated from the pile diameter and the liner thickness. Steel liners shall not exceed a bow of 1% of the length of the pile

in any direction. Liners shall be free of any internal steps or ridges which may interfere with drilling equipment or catch buckets or personnel during inspections.

Welding shall be carried out in accordance with the provisions of AS/NZS 1554.1 and MRTS78 *Fabrication of Structural Stainless Steelwork* as applicable. A Weld Procedure Specification for both shop fabrication of steel liners and field splice welding shall be submitted to the Administrator for approval prior to welding liners. **Hold Point 2**

All spiral, longitudinal, transverse and all field splice welds (including joints) shall be full penetration butt welds. Segments shall be rotated 90 degrees to each other so that longitudinal welds along the liner are staggered. All fabrication shop welds shall be made using a submerged arc process.

Liners shall be supplied to the Site in the longest lengths possible, commensurate with the overall length of the pile and the transport facilities available.

Liners shall be stored and transported in such a manner as to prevent damage. Damaged liners shall be repaired or replaced by the Contractor at no additional cost to the Principal. **Nonconformance**

8 Sinking of liners

8.1 General

The founding levels shown on the Standard Drawings are provisional levels and have been determined using foundation information available prior to construction. Following excavation of the liner and inspection of the socket and base by the Geotechnical Assessor, the founding level may be varied (subject to minimum requirements shown on the Standard Drawings to obtain a watertight seal, achieve the design moment and load capacity and obtain the Geotechnical Assessor's certification.

When, in the opinion of the Contractor the strata is self-supporting above design liner toe level, and is expected to be self-supporting to final liner toe level, the Contractor may elect to terminate the liner above the design liner toe level, in which case the total length of the pile will remain unchanged.

> This provision allows the Contractor to terminate the liner short, however the critical parameter of the total length of the pile remains unchanged as these are moment rather than end bearing piles.
>
> When a pile is to terminate above the design level the concurrence of the Designer to this change must be obtained, as this it is generally not just a geotechnical decision.

The sinking of pile liners shall be performed from firm ground, temporary supports, or a fixed platform.

Whatever the method used, it shall provide sufficient rigidity to ensure accuracy of sinking under all conditions and/or hammer blows.

The liner length shall be marked on the liner at no less than 1 m intervals from the toe of the liner before sinking of the liner so that the depth of penetration of the liner into the ground can be clearly seen.

Any liner which is incorrectly located, or damaged, or which shows partial collapse to an extent that it results in a decrease in the load carrying capacity of the pile, may be rejected, removed and replaced, or repaired. **Nonconformance** Remedial measures shall be submitted by the Contractor for the approval of the Administrator. Replacement of any rejected pile or other remedial work shall be at no cost to the Principal.

8.2 Bored holes without liners

Boring of uncased holes shall be permitted only where the walls of the shaft consist of material which is self-supporting. Special precautions shall be taken in the event of boring through material exhibiting excessive water absorption properties.

The diameter of the bored hole shall be not less than that shown of the Standard Drawings except for small local variations which shall not exceed 5% of the diameter at any location. In places where the diameter is less than that specified, the cover requirement to the reinforcement shall be maintained.

Boring shall be carried out using rotary or percussion type equipment. Where percussion equipment is used, the level of energy per blow at the drilling bit shall be kept to a minimum, consistent with effective boring, so as to minimise vibration and avoid damage to adjacent piles, structures or services. The Contractor shall take all measures necessary to prevent water from entering the hole.

If it is elected to optimize proposed construction procedure by increasing input energy over and above that necessary to drive liners as detailed on the Standard Drawings, then a heavier liner is to be used to sustain the application of such increased driving energy. Any change to the nominated liner design to be approved by the Administrator and no additional cost will be borne by the Principal as a consequence of this change to liner thickness.

Boring shall continue to the level shown on the Standard Drawings or, to such other founding level as is capable of sustaining the design pressure shown on the Standard Drawings.

No additional payment will be made by the Principal for prebored holes.

8.3 Liners driven by oscillation or vibration

Liners may be driven using an appropriate rig which oscillates the liner in a horizontal plane, vibrates the liner vertically or rotates the liner. All methods shall employ a vertical load applied simultaneously with the oscillations, vibrations or rotation.

The toe of the liner shall be kept far enough ahead of the excavation inside the liner to prevent material entering the cavity. At the terminal level, the liner shall penetrate sufficiently deep into firm stratum to form an effective seal against the entry of material and water into the final excavation.

8.4 Liners in prebored holes

Liners may be placed in prebored holes with the Designer and Administrator approval, where the strata is self-supporting and the length of the liner is 3 m or less such approval shall be automatic.

Preboring is not allowed in strata that is not self-supporting, in which case the liner shall be inserted and the hole progressively excavated.

The diameter of a prebored hole shall be of a minimum size to facilitate insertion of the liner and the liner is driven or sunk into firm stratum at its base to prevent the entry of water.

Preboring shall be included in the cost of pitching or driving and not paid as a separate item. No additional payment will be made by the Principal for prebored holes.

Any resultant space between liner and hole shall be backfilled using flowable fill or other approved material, using a method that fills the void around the liner completely. Flowable fill shall be piped to the base of the prebored hole and the gap filled from the base upwards. Fill shall be inserted at a minimum of three points equally spaced around the liner circumference.

8.5 Construction limitations

A pile which is located within 2.5 m clear distance from a newly concreted pile shall not be bored or driven until 18 hours after completion of concreting in the adjacent pile.

A pile which is located between 2.5 m and 9 m clear distance from a newly concreted pile shall not be driven in the period between initial set and 12 hours after casting is completed.

The top of a newly concreted pile shall not be in contact with the driving platform while another pile is being prebored or driven from that platform.

9 Tolerances

The completed pile shall be located as shown on the Standard Drawings within the following tolerances:

a)	Top of pile, in plan	75 mm in any direction
b)	Top of pile, vertically	5 mm in height
c)	Variation from vertical or designated rake	20 mm per metre
d)	Bow of pile	1% of length of pile in any direction, and
e)	Diameter of liner and socket	- 0, + 5% of nominal diameter at any position.

Any piles which are outside these tolerances shall be corrected by the Contractor to the satisfaction of the Administrator at no additional cost to the Principal. **Nonconformance** Correction may include additional reinforcement, increased dimensions of pile caps or additional piles.

Any design changes consequent to out of tolerance piles will need to be approved (generally undertaken) by the Designer and the Administrator and will be at no cost to the Principal. This includes design costs if applicable.

10 Excavation of cast-in-place piles (bored piles)

10.1 General

All piles shall be excavated to a stratum of adequate capacity to sustain the imposed loadings including moment capacity shown on the Standard Drawings and shall penetrate the founding strata not less than the distance shown on the Standard Drawings.

When the liner is at its anticipated terminal level and the strata immediately below are considered by the Contractor to be self-supporting and not liable to water inflow, the excavation may proceed to the approved founding level. If, during this operation, there is an influx of material into the excavation, the liner shall be re-driven until a new seal or stable sides occur. Payment in such circumstances shall be limited to the direct consequence of lengthening the liner / socket. No additional cost shall be ascribed to the Principal in regard to 'setting up to redrive' or similar work items.

Piles may be bored or excavated under water but both inspections and concreting must generally be undertaken in the dry. If wet excavation methods are used the Contractor must take steps to seal the liner from water ingress prior to inspection and concreting.

The pile shall penetrate the founding strata not less than the distance shown on the Standard Drawings. The pile base shall be clean and free of loose material.

When a pile is to terminate above the design level, the concurrence for this change must be obtained from the Designer, it is not just a geotechnical decision.

Temporary safety shields shall be used where manual work is carried out in unlined holes and sockets as required by the *Workplace Health and Safety Act,* 2011.

After completion of the excavation the Contractor shall take all reasonable steps to dewater the pile to facilitate inspection. Prior to inspection the bearing surface shall be thoroughly cleaned of all foreign and loose material, and the surface dressed to level. Pockets or seams of inferior material shall be removed.

Actual foundation levels and socket dimensions shall be recorded by the Contractor. In all cases these shall equal or exceed the dimension shown on the Standard Drawings and the requirements of this Technical Specification.

10.2 Pile sockets

Typically, these piles will have significant unlined sockets which carry the applied load and provide the moment capacity. The design loads shall be carried by a combination of socket wall friction and base resistance as per the *Geotechnical Design Standard*.

The walls shall be clean and free of smeared material. Smeared walls shall be cleaned and roughened prior to certification and subsequent concreting.

11 Geotechnical certification

11.1 General

The purpose of the geotechnical certification is to confirm that the design requirements have been achieved, and the foundation is safe, adequate and durable.

As these piles are essentially laterally load or bending moment piles with lower axial loads, it is the condition of the socket that is more critical than the condition of the base, which is almost the converse of the situation with some MRTS63 *Cast-In-Place Piles*.

Foundations are to be logged, inspected and certified by the Geotechnical Assessor as set out in Clause 11 prior to casting concrete. The Geotechnical Assessor shall consider the information available and, when satisfied, certify that the ground condition is in accordance with the design assumptions, the factored geotechnical strength pertaining to the pile axial capacity is greater than the design loads shown on the Standard Drawings in accordance with AS 5100.3 and the foundation complies with the requirements shown on the Standard Drawings. The Height of the toe of the liner and the founding level of the pile will also be recorded in the geotechnical certification in accordance with the requirements of MRTS56 *Construction Surveying.*

Where the Geotechnical Assessor identifies issues with the pile, for example, cleanliness of the socket, such issues must be resolved prior to moving to the next stage of construction. The Geotechnical Assessor shall ensure all issues are resolved prior to the next stage of construction.

The Contractor shall forward a copy of the geotechnical certification of the foundation to the Administrator prior to concreting. Insertion of reinforcement and concreting of the pile shall not proceed prior to the Administrator's approval. **Hold Point 3**

As Constructed records of all excavations, including the rock classification, and the basis upon which the certifier issued the certificate shall be maintained and forwarded to the Administrator.

11.2 Geotechnical assessor

Unless stated otherwise in Clause 1 of Annexure MRTS63A.1, the Geotechnical Assessor shall be a Geotechnical Engineer, who is also a Registered Professional Engineer Queensland (RPEQ) with at least five years' experience in design and assessment of bored pile foundations. Where stated in Clause 1 of Annexure MRTS63A.1, the Geotechnical Assessor may be an engineering geologist with at least 10 years' experience in heavy civil engineering foundation design and assessment procedures.

Unless approved otherwise by the Administrator, the Geotechnical Assessor shall be independent from the pile design, pile driving and installation, and pile testing organisations or companies.

The name and qualifications of the Geotechnical Assessor shall be submitted to the Administrator for approval at least 28 days prior to commencing pile construction **[Refer to Hold Point 1]**.

> The role of the Geotechnical Assessor is critical to the process of constructing the pile. The assessor certification cannot be over ridden by the Contractor. Should an issue arise between the Assessor and the Contractor then this should be referred to the Administrator who will need to obtain expert advice regarding the issues.

Cast-in-place pile foundations shall be inspected by cameras or by an inspection from the top of the pile.

If the pile excavation contains water, it shall be dewatered and the foundation properly cleaned immediately prior to inspection.

11.3 Safe access

As part of the construction procedures, the Contractor shall undertake a safety and hazard assessment to ensure all procedures are in accordance with the *Workplace Health and Safety Act*.

If the pile capacity assessment and certification requires down-the-hole access, the Contractor shall provide sufficient equipment and safe transport within the pile for personnel, the Administrator and the Geotechnical Assessor who will certify the pile capacity.

The Contractor shall install an approved safety shield in all unlined sockets greater than 1.2 m long during periods of work or during down hole inspection.

11.4 Dewater and clean

The Contractor shall attempt to pump the hole dry using an appropriate sump arrangement and clean the pile base to allow full assessment.

While one criterion for concreting a pile is an inflow rate which causes a rise in water level of less than 12 mm / minute to facilitate inspections much greater rates of inflow can be tolerated. It would be expected that the Contractor would have adequate pumping equipment to remove water at these higher flow rates.

11.5 Assessment methods

The Geotechnical Assessor shall select sufficient processes to obtain the information needed to certify the foundations using the original geotechnical investigation and reports, any additional investigation and reports undertaken during the Contract and inspection and investigation of the foundation material. Where there is not sufficient information, the Contractor may undertake additional investigations. Dewatering of piles is fundamental process which must occur prior to the Assessor attempting to certify the pile. If an excavation cannot be dewatered then the Assessor must determine how the required information can be obtained to permit the excavation to be certified.

The foundation assessment shall be based on a combination of methods of obtaining data on foundation capacity. As a review of the geotechnical investigation data is fundamental to any assessment, the drill cores and a copy of the borelogs and geotechnical report shall be kept on the Site until foundations are completed.

The Geotechnical Assessor is expected to use their professional judgment in determining the acceptability of the foundation. A range of tools may be used by the Assessor, these include a review of the geotechnical report and cores and samples obtained during that investigation. The collection and analysis of samples obtained during the excavation of the socket, taking into account not only the properties of the material but also analysing the likely location within the socket such samples may be derived. Inspections of the socket must be undertaken.

This can be undertaken either directly (inspection from the surface or down-the-hole inspection) or indirectly using a camera or similar device. Soundings to determine the depth of the socket should be considered an integral part of the process.

The tools used must be adequate to enable the Geotechnical Assessor to come to a conclusion regarding the adequacy of the foundation.

11.6 Geotechnical assessment

Following inspection and assessment of the actual ground conditions during construction, a strength classification of the observed rock profile is to be undertaken to ensure that the required friction and base capacities have been achieved.

Geotechnical assessment shall ensure that:

a) The design requirements of the foundation have been achieved. Design considerations are axial compression, axial tension (if applicable), bending moment, scour, moment fixity and lateral shear.

b) The minimum strength classification of the pile base has been achieved.

c) The minimum socket length and diameter have been achieved.

d) The socket walls are clean and free of smear material.

e) The classification of the rock into both lithological and weathering type has been undertaken.

f) The defect spacing and orientations has been examined and recorded.

g) Bands of weak rock, intrusions, shear planes and fault lines have been examined and recorded.

h) Macro weathering profile in 3D has been undertaken, and

i) Water seepage, if any has been recorded.

Inspection and/or geotechnical assessment of cuttings from the length of the liner or socket shall not be accepted as the sole means of logging.

11.7 Minimum information to assess pile capacity

11.7.1 General

For piles that are designed to transfer most of the load into the foundation to the socket wall, the following factors shall be assessed, prior to certification of pile capacity.

11.7.2 Walls of socket

After excavation, a visual inspection of the socket walls shall be undertaken to ensure the socket walls are clean, free from smear, appear self-supporting, and no portion of the wall has collapsed or appears likely to collapse.

11.7.3 Socket wall shear capacity

If socket walls are relatively uniform in strength, assessment may be made with a conforming video camera inspection. If the socket consists of several variable strength strata layers, and more than 50% of socket capacity relies on strata occurring over less than one-third of the socket wall, a more detailed inspection shall be undertaken.

11.7.4 Presence of weak areas in socket

Where the inspection / certification indicates any of the following defects occur that may significantly reduce the design socket capacity, a down-the-hole inspection should be made to assess the effect on socket capacity:

a) material substantially differs from that shown on borelogs

b) defect spacing and orientation are worse than that assessed from borelogs

c) bands of weak rock, intrusions, shear zones or fault lines are evident, but not assessed in socket design, or

d) macro weathering appears worse than that recorded in the borelogs.

If the Geotechnical Assessor finds that the socket material has less capacity than that assumed in design, the changes shall be referred to the Designer and shall have approval of the Designer and the Administrator prior to finalising the new foundation design.

11.8 Stronger strata than expected in design

If during excavation of a pile base or socket or subsequent certification the material is found to be significantly stronger than that assumed in the design, a change in design may be proposed. All such

changes shall be referred to the Designer and shall have approval of the Designer and the Administrator prior to finalising the new foundation design.

When a pile is to terminate above the design level the concurrence of the Designer to this change must be obtained it is not just a geotechnical decision.

12 Steel reinforcing

Steel reinforcing shall be supplied and placed in accordance with the requirements of MRTS71 *Reinforcing Steel* and MRTS71A *Stainless Steel Reinforcing*. Steel reinforcing shall be assembled as detailed on the Standard Drawings to form a rigid cage capable of being lowered into the excavation without any disintegration occurring.

MRTS71 *Reinforcing Steel* and MRTS71A *Stainless Steel Reinforcing* require the use of registered suppliers of reinforcement. These Technical Specifications also require the steel to be Australian Certification Authority for Reinforcing Steel (ACRS) certified.

Cover to steel reinforcing shall be maintained using registered spacers or stainless steel nibs welded to the longitudinal reinforcement. The spacers shall be located on the periphery of the pile cage 90 degrees apart at a maximum of 2.5 m centres axially, as shown on the Standard Drawings.

Where welded cages with a continuous spirally wound helix are used, the distance between spacers may be increased to 4 m provided that there are always at least two sets of spacers on each cage.

Prior to lowering the reinforcing cage, the pile excavation shall be cleaned of all loose material. If there is any evidence of spacers crushing or being displaced after lowering the reinforcement cage into the liner, the cage shall be withdrawn and alternative stronger spacers fitted.

Note that care must be exercised during the placement of the reinforcement to avoid conflicts with other reinforcement such as that required for the pile caps or headstocks or anchors.

13 Concreting

13.1 General

After excavation has been completed and the pile foundation certified by the Geotechnical Assessor and the certificate accepted by the Administrator, **[refer to Hold Point 3]** the reinforcement shall be inserted and concreting operations shall commence without delay.

Where there has been a delay of more than 24 hours between certification and when the Contractor is ready to start concreting or when the foundation has been observed to deteriorate significantly, the foundation shall be re-cleaned (if required) and re-certified. **Hold Point 4**

If water flow into the pile exceeds 12 mm per minute, measured over 15 minutes or more, concrete shall be placed underwater as stated in Clause 13.4.3. It shall not be placed until the inflow has ceased. This can be achieved more quickly by pumping fresh water into the liner until internal and external water levels are equal.

CACO14M Contract Administration System Checklist exists for this item.

All concrete shall be placed in accordance with MRTS70 *Concrete* except as otherwise specified in Clauses 13.2 to 13.4. The Contractor shall observe all relevant Milestones and Hold Points in MRTS70 *Concrete*. Placement of concrete underwater shall only commence after the tremie and the placing procedure have been accepted for use by the Administrator. **Hold Point 5**

13.2 Concrete

Concrete shall comply with the requirements of MRTS70 *Concrete*, except where specifically stated in this clause and Clause 13.3.

The concrete mix shall be designed to limit excessive bleeding of water, which is likely to occur in deep concrete pours and be tested for water retention in accordance with MRTS70 *Concrete*.

The mix design shall include the selection of suitable combined aggregate grading curves (particularly in the sand component), the use of appropriate admixtures and the need to retain adequate workability during placement particularly for piles cast in wet conditions.

13.3 Slump or spread of concrete

The target slump or spread of concrete shall be selected from the range given in MRTS70 *Concrete* for either dry or wet conditions. A mix specified by spread is recommended for wet pile conditions.

With the approval of the Administrator, a wet pile concrete mix may be used in a dry pile.

Slump or spread tests on delivery shall conform to the target slump or spread and the tolerances given in MRTS70 *Concrete*.

CACO21M – Contract Administration System Checklist exists for this item.

13.4 Placement and compaction

13.4.1 General

Concrete shall be placed in dry conditions except where ingress of water into the hole is too great to ensure a homogeneous mass of concrete of the specified strength (refer Clause 13.1).

Prior to commencement of concreting the length of the pile from the base to the top of the liner shall be measured and the socket walls and pile base checked for cleanliness.

CACO14M - Contract Administration System Checklists exists for this clause.

To assist compaction by hydraulic head, the rate of placing the concrete shall not be less than 10 m of pile length per hour.

Concrete supply shall be effectively continuous with delays between concrete delivery trucks of 15 minutes or less, unless an approved specific retarded mix design has been developed to allow for longer delays, as in remote areas.

13.4.2 Concrete placement in dry conditions

The base of the pile shall be clean and all water removed immediately prior to placing concrete. This shall be confirmed by direct observation or by using a camera.

The method of placement shall allow the following:

a) delivery hose or pipe to 2 m above the pile base, and

b) ability to lift and/or shorten the delivery hose / pipe quickly with delays no longer than 10 minutes.

Concrete shall be dropped 2 to 3 m from the end of the delivery hose / pipe onto the concrete surface to provide compaction or shall be compacted using vibration.

The delivery hose / pipe shall be positioned so that the concrete does not fall onto the reinforcement cage. For raked piles, the Contractor shall detail in the procedure for construction of piles the method of delivering concrete down the piles that minimises the risk of segregation. **[Refer to Hold Point 1]**

The top 3 m of concrete shall be well compacted with a concrete vibrator with a minimum diameter of 50 mm.

13.4.3 Concrete placement underwater

13.4.3.1 General

Before placing any concrete underwater, the liner shall be full of water to a level at least equal to the external water level or to a stable level with no further inflow or out flow. In a salt water environment the pile shall be pumped as dry as possible and then filled using fresh water to minimise the salt content of the pile water during concreting.

The placement of concrete underwater shall be effected by means of a watertight tremie which complies with the following requirements:

a) A tremie long enough to rest on the pile base with watertight seals at all joints and a base that can be sealed. The seal shall be designed to break and allow discharge of concrete when the pipe and hopper are filled, and the tremie is lifted no more than 300 mm off the pile base. Suitable types of seals include balls, bags of vermiculite or similar materials or a plate attached to the base of the tremie which will break away when the tremie is full of concrete and lifted off the base.

b) A controlled means of carefully raising the discharge end so that it always remains embedded 2 m in the concrete.

c) Adjustable pipe length or removable segments, and

d) A supply of concrete that is effectively continuous and a rate of placing not less than 10 m of pile length per hour.

Procedures shall comply with MRTS70 *Concrete* for underwater placement. The tremie shall remain in the concrete at all times.

A tremie pouring record shall be kept during the tremie pour, in which is recorded the following:

a) the level or depth (from a point of known Height)

b) depth of the base of the pile

c) time pour started

d) arrival time of each truck

e) depth at the start of delivery from each truck

f) depth and time when the tremie is shortened

g) the length of tremie kept within the concrete column during the shortening operation, and

h) the estimated quantity of material allowed to flow to waste at the end of the process.

Tremie placement of concrete is a high-risk procedure unless all staff are fully aware of the procedures to be followed. A concrete pump does not constitute a tremie and shall not be used as a substitute to a tremie.

An example of a suitable tremie pouring record can be found in Appendix D3 of CIA Z17.

13.4.3.2 Tremie lifted out of concrete

If the tremie base is lifted out of the concrete (a pull out) in the pile at any stage prior to completion, concrete placement shall stop and pull out resolved. **Nonconformance**

If the pull out is within the socket or in the lower 2 m of the shaft (within the liner), all concrete shall be removed, the reinforcement extracted and the socket re-cleaned and certified. The pile shall then be re-concreted and finished.

This can only be achieved while the concrete is still wet. If this process is delayed, then removal of even partially set concrete from within the pile becomes problematic resulting in additional delay and cost.

If the pull out is within the liner and beyond the bottom 2 m of the liner, then all contaminated concrete or at least the top 2 m of the concrete shall be removed using a grab or similar device. This work may either done either immediately following the pull out, when the concrete is still wet, or following partial set of the concrete not less than 8 hours after the event. A construction joint shall be prepared at the revised top of the concrete surface, the surface levelled, cleaned and inspected. When approved by the Administrator, the rest of the concrete shall be placed using dry placement methods after removal of all water from the pile (refer Clause 13.4.2).

Coring the pile is a last resort suitable method for confirming the quality of the concrete in the affected zone. The excavation of wet or partially set concrete will require equipment small enough to fit within the reinforcement cage.

13.4.3.3 Significant delay in concrete placing

If the placement of concrete underwater ceases at any time before completion of the pile for a period of more than 45 minutes, concrete placement shall cease and the concrete allowed to set for at least

8 hours. All water and contaminated concrete (typically the top 2 m or 2 pile diameters, whichever is the greater) shall be removed and the pile finished as stated in Clause 13.4.3.2.

13.4.3.4 Removal of contaminated concrete at completion of concrete placement (wet pours)

On completion of a wet pour the top section of concrete, the greater of 2 m or 2 pile diameters, shall all be removed and not be allowed to form part of the final structure.

When placing underwater, the pile liner shall be extended by at least 2 m above the design cut off level and subsequently cut back, or the liner shall be finished to level and the contaminated material allowed to overflow. This overflow shall be captured on the Site and not allowed to run off Site.

CACO21M – Contract Administration System Checklist exists for this item.

If the overflow method is used, concrete placement shall continue until the pile surface is all sound concrete with the same slump and consistency as the concrete out of the truck and then the top 3 m of pile concrete shall be compacted with internal vibrators of 50 mm minimum diameter.

Careful operation of the tremie will limit the volume of contaminated material.

After concrete has hardened, the pile shall be cut back to the specified level or to the level of sound concrete, whichever is the lower. If any concrete below the specified cut off level is contaminated or lacks the normal proportion of coarse aggregate, it shall be removed. When cutting off, the Contractor shall take care to avoid shattering or otherwise risk damaging the rest of the pile. Cracked or defective concrete shall be broken away. The pile shall be repaired in an approved manner to provide a full and sound section at the cut off level.

All such repair and replacement shall be at no cost to the Principal.

14 Pile Integrity Testing

Pile Integrity Testing shall be undertaken on a minimum of one pile, but not less than 25% of the piles at location on the project. The method of testing unless otherwise specified shall be low strain pulse echo method in accordance with Clause 8.8 and Appendix D of AS 2159. Acceptance of testing results shall be in accordance with Clause 8.8.3 of AS 2159. The selection of piles for testing shall be at the sole discretion of the Administrator and may be based on pile construction records.

Pile Integrity Testing shall not be a substitute for coring or load testing of the pile if there is a nonconformance associated with the concrete or concreting process in the pile, or as a substitute for Geotechnical Certification of the pile or foundation.

Unless approved otherwise by the Administrator, the Pile Integrity Testing shall be conducted by a company or organisation independent of the pile designer, and piledriving / installation companies or organisations.

No further construction above the pile cut off level shall commence until the Pile Integrity Test Reports have been submitted and approved by the Administrator. **Hold Point 6**

15 Survey

After completion of pile construction and cutback to the specified level an As Constructed survey shall be completed in accordance with MRTS56 *Construction Surveying.*

16 As Constructed records

The Contractor shall provide the following As Constructed records in relation to each pile, no later than 28 days after completion of piling:

a) The base Height of both liner and pile extracted from the Geotechnical Assessors Report.

b) Assessment of the pile socket and base certified by the Geotechnical Assessor. The pile certification shall contain all Site records obtained during the inspection, such as excavation machinery deployed, pile excavation logs, including photos of excavated materials, liner installation records, and pile socket inspection records including photos of sidewall and bottom cleanliness, water infill records, and any insitu / Site testing procedures and associated test results.

c) Tremie Pouring Record for each pile.

d) All concrete testing results, and

e) As Constructed survey in accordance with MRTS56 *Construction Surveying.*

17 Supplementary requirements

The requirements of MRTS63A *Piles for Ancillary Structures* may be varied by the supplementary requirements given in Clause 1 of Annexure MRTS63A.1 Part A.

13 QGOV (13 74 68)
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