SECTION 606 ‑ BORED CAST‑IN‑PLACE PILES (WITHOUT PERMANENT CASING)‑‑‑

##This section cross-references Sections 175, 610 and 611.

If any of the above sections are relevant, they should be included in the specification.

If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent:

606.01 GENERAL

This section covers the requirements for the construction of reinforced concrete piles which are bored and cast‑in‑place without the use of permanent casing.

606.02 STANDARDS

Material, design and construction of bored and cast‑in‑place piles without the use of permanent casing shall comply with the requirements of relevant Australian Standards including but not limited to the following:

 AS 2159 Piling - Design and installation

 AS 5100 Bridge Design

In circumstances where AS 5100 and AS 2159 requirements differ, the requirements of AS 5100.3 shall take precedence over those of AS 2159.

Section 175 details the relevant references to Australian Standards (AS) and other documents in this section.

606.03 BORING AND TEMPORARY CASING

(a) General

The following minimum information shall be provided for each pile on relevant foundation drawings:

 (i) pile diameter and founding level

 (ii) design axial and lateral capacity (Ultimate Limit State and Serviceability Limit State)

 (iii) design bending moment capacity (Ultimate Limit State and Serviceability Limit State)

 (iv) inspection requirements -

• the required foundation conditions where the pile is required to develop its capacity via end bearing; and

• the required socket conditions where the pile is required to develop its capacity via skin friction

 (v) pile testing requirements e.g. magnitude of test loads (clause 606.07)

 (vi) pile acceptance criteria -

Criterion 1 - the performance of the pile footing under the design serviceability load; and

Criterion 2 - a resistance equal to at least the design geotechnical ultimate limit state

 (vii) reference of geotechnical investigation and design reports from which the above information has been established.

Each pile shall be bored to allow the construction of the pile to the size, position and level shown on the drawings.

**©** Department of Transport July 2017

Section 606 (Page 1 of 6)

Temporary pile casings shall be used unless the Contractor can demonstrate to the satisfaction of the Superintendent that an alternative construction method without casing will achieve the specified pile dimensional tolerances and cover to the steel reinforcement and that the durability and strength of the finished concrete will not be impaired by inclusions of foreign material or voids. The Contractor may be required to carry out any tests that are reasonably requested by the Superintendent to demonstrate compliance with these requirements. The cost of such testing shall be borne by the Contractor.

All excavated material shall be removed from the site and disposed of as soon as practicable, so that the site of the works is kept in a clean and tidy condition.

If excavations are to be left open, the Contractor shall ensure that they are made safe with appropriate fall protection measures such as guardrails with a footplate around the full perimeter of the pile hole, a sleeve extending at least 1 metre above ground level or a secure pile hole cover. Fall protection shall be provided at all times during excavation and after excavation is completed. The Contractor shall provide effective measures to protect each pile hole from site run‑off and from loose material falling in.

The Contractor shall be responsible for ensuring services or adjacent structures are not damaged by the piling operations. Where percussion equipment is used, the level of energy per blow of the drilling bit shall be kept to the minimum consistent with effective boring, so as to minimize vibration, and avoid damage to adjacent piles, structures or services.

Where piles are to be founded on rock, they shall extend a minimum of two pile diameters into rock of the type and quality shown on the drawings, but shall not finish above the levels shown on the drawings.

**HP The Contractor shall submit for review by the Superintendent a quality procedure for the construction of the piles not less than 4 weeks prior to the commencement of the piling works. Piling works shall not take place until the quality procedure has been reviewed and approved by the Superintendent.**

The procedure shall provide details of materials and the plant and equipment to be used, the boring operation, the method of sealing the base of the pile against the ingress of water, full details of the installation and removal of the temporary steel casings, full details of the steel reinforcement including bar chair details and fixing to ensure minimum cover requirements, and concreting operations, including placement of concrete under water and in dry bores.

(b) Temporary Steel Casings

Unless otherwise approved by the Superintendent as per clause 606.3(a) temporary casing shall be used to prevent collapse of holes during the boring operation.

If holes are bored prior to placing the steel casing in position, the nominal size of the drilling bit used to bore the holes shall not be more than 25 mm larger than the outside diameter of the steel casing and any protective coating.

The toes of the steel casings shall be driven into solid rock where specified on the drawings or suitable alternative material as required to seal them sufficiently to prevent soil and water entering from outside the casing.

Temporary casings shall be free from holes and distortion and the internal surfaces shall be free of any projections that may interfere with the placing and positioning of the steel reinforcement cage. Splices in the casing shall be waterproof and strong enough to sustain any stresses induced during installation and extraction of the casing. Fixing of the steel reinforcement cage onto the temporary steel casing shall not be allowed.

The type and thickness of the steel plate used in the temporary casing shall be selected by the Contractor who shall be fully responsible for its structural adequacy. The type and thickness of the temporary casings include providing safe access for personnel, resisting all superimposed loads from driving, extraction, earth and water pressures and the effects of any distortion which is likely to occur to the casing shall be proof-engineered by a Proof-Engineer who is prequalified in accordance with the VicRoads scheme for prequalification.

**©** Department of Transport July 2017

Section 606 (Page 2 of 6)

(c) Boring Excavation

**Boring excavations under bentonite or polymer fluids alone, or in combination with temporary casings shall be the subject to approval by the Superintendent.**

Any proposal to bore under bentonite or polymer fluids alone, or in combination with temporary casings shall be supported with full details of materials, plant and equipment to be used, disposal of bentonite or polymer fluids and drilling cuttings and full details of the whole boring operation, which shall be certified by the Contractor’s geotechnical consultant who is prequalified in accordance with the VicRoads scheme for prequalification in the area of design and construction of deep foundation works under bentonite and polymer fluids. Bentonite and polymer fluids shall be of the biodegradable type and the Contractor shall obtain approval of use of such materials from the relevant waterway management authority and government agencies.

606.04 PROTECTION OF ADJACENT PILES

The Contractor shall ensure that the pile construction process does not result in damage to adjacent newly cast piles due to ground vibration. The following minimum requirements shall also be met.

(a) no pile construction shall be commenced within 2.5 m clear distance of a newly cast pile until the concrete in the pile has attained a strength of 15 MPa;

(b) piles more than 2.5 m clear distance from a newly cast pile may be installed by boring at any time providing there is no likelihood of damage to the newly cast piles;

(c) installation of piles by methods which involve driven temporary casing or result in significant vibration shall not be carried out within the distance 2.5 m to 9.0 m until the concrete in the pile has attained a strength of 15 MPa and set for a minimum of 24 hours.

606.05 INSPECTION OF PILE EXCAVATION

The Contractor shall notify the Superintendent for inspection of the pile excavation by the Superintendent. A minimum of 48 hours notice shall be given to the Superintendent for arrangement of the inspection. Prior to inspection, the pile excavation shall be de‑watered and the walls and base of the pile cleaned out, including the internal surface of the casing, to remove all mud, loose or foreign material.

In the event that the Contractor is unable to de‑water the pile hole for inspection, full details of the proposed method of cleaning out the pile and the pile inspection shall be submitted to the Superintendent for review. The Contractor shall obtain confirmation from its geotechnical consultant regarding the appropriateness of the proposed method before submitting to the Superintendent for review.

**HP** **The temporary casing (where used) shall not be removed, nor shall reinforcement and/or concrete be placed until the pile walls and base have been inspected by the Superintendent and that the inspection has confirmed that the geotechnical strength of the materials in the pile wall base have satisfied the design assumptions.**

The Contractor shall provide all plant, equipment, temporary casing or protective inspection casing/shield, labour and for all other requirements necessary to provide safe and effective access for the inspection of the pile excavation.

No person shall enter the pile excavation unless the pile hole diameter is greater than 900 mm and appropriate precautions have been taken in accordance with:

 Occupational Health and Safety Regulations 2017 – Part 3.4 - Confined Spaces

 WorkSafe Publication, Confined Spaces - Shafts, Tunnels and Trenches

 WorkSafe Compliance Code – Confined Spaces

**©** Department of Transport July 2017

Section 606 (Page 3 of 6)

606.06 CASTING PILES

(a) General

Concrete used for the construction of bored piles shall comply with the requirements of Section 610.

Steel reinforcement shall comply with the requirements of Section 611.

Further to the requirements of clause 611.10 spacers and supports for bored pile steel reinforcement shall be placed at intervals of no more than 2 m along the full length of the steel reinforcement cage to ensure that the specified concrete cover to the steel reinforcement is maintained.

Concrete placed in the dry shall be either self compacting concrete (SCC) or highly workable concrete in accordance with the requirements of clause 610.07, clause 610.13 and clause 610.18(c).

Where highly workable concrete is placed in the dry, it shall be compacted with immersion type, high frequency vibrators.

Concrete shall be placed through a tremie tube and shall not be dropped from a height greater than 2 m through air. Concrete which is being discharged from a tremie shall be positively guided away from the pile reinforcement so that segregation is not caused by the flow of concrete impinging on the reinforcement.

Alternative methods for placing concrete in the dry from those specified in this clause may be used subject to a review by the Superintendent.

The casing shall be withdrawn with care during casting of the concrete.

Care shall be taken to prevent soil and rock dislodging from the side of the hole and contaminating the concrete forming the minimum cover to the reinforcement.

The minimum height of concrete within the casing shall be adjusted to ensure that water is not permitted to enter from outside the casing, and that the soil pressure at the toe of the casing is balanced by the mass of the concrete within the casing. The free surface of the concrete shall be at least 1.5 m above the bottom of the casing.

If after driving the casing, it is found not possible to seal the excavated pile from the inflow of water, mud, loose rock or similar materials, the reinforcement and concrete may be placed under water, subject to a review by the Superintendent and the requirements of clause 606.06(b).

**HP** **Reinforcement and/or concrete shall not be placed until the proposed method of removing mud, loose rock or similar materials, and the method of placement of concrete under water has been reviewed by the Superintendent.**

Piles shall be concreted within 24 hours of completion of the pile excavation. For delays greater than 24 hours, the Contractor shall ream the walls and the base of the pile to remove not less than 25 mm thickness of material, or any other foundation material which has softened in that time.

Piles placed in the dry shall be constructed to a minimum of 300 mm above pile cut-off level to allow breaking back of contaminated concrete at the top of the pile.

(b) Casting Under Water

Concrete placed under water shall be self compacting concrete (SCC) in accordance with the requirements of clause 610.07, clause 610.13 and clause 610.18(c).

The concrete shall be of such consistency, and shall be placed in such a manner that pockets of air or water or ground materials are not entrapped in the concrete, and the space between the reinforcement and the side walls of the hole are completely filled with compacted concrete.

Concreting using tremie methods shall not commence until the pile hole is filled with such head of water as to equalise the external water pressure from the surrounding ground.

**©** Department of Transport July 2017

Section 606 (Page 4 of 6)

Where a tremie is used, the hopper and pipe of the tremie shall be steel, smooth bore, clean and water tight throughout. The tremie pipe shall be sealed with a plate taped to its outlet, to prevent direct contact between the first discharge of concrete in the pipe of the tremie and the water. The tremie pipe shall extend to the base of the pile hole before the tremie is charged with concrete.

Where a pump is used in lieu of a tremie, a sponge shall be inserted in the discharge line before the discharge hopper is loaded so that water and air in the line are prevented from mixing with the advanced column of fresh concrete. The end of the discharge hose shall be held against the bottom of the hole until the sponge is released. The whole operation shall be controlled to ensure that no voids are trapped in the pile concrete.

Concreting shall not commence until the tremie pipe or pump discharge hose are fully charged. The outlet of the tremie pipe or pump discharge hose shall not be lifted from the bottom of the hole until the hole has been filled with a minimum of 2 m depth of concrete. Thereafter, concreting shall be kept a minimum of 2 m below the top surface of the concrete at all times and the Contractor shall continuously monitor and ensure that the 2 m depth of embedment is to be maintained at all time. The rate of withdrawal of the tremie pipe or pump discharge hose during concreting shall be pre-determined by the Contractor based on the actual pile hole diameter and the volume of concrete pumped into the pile hole. The rate of withdrawal of the tremie pipe or pump discharge hose versus the volume of concrete placed shall be recorded by the Contractor and the records shall be submitted to the Superintended within 24 hours on completion of concreting of a pile. The method used for concrete placement shall be such that a continuous supply of concrete is available at the top of the tremie tube or pump hopper during the entire process of placing concrete. Concreting shall be continued until sound concrete appears a minimum of 400 mm above the required cut off level. The pile concrete shall not be cut back to its required level until a minimum of 24 hours after completion of placement of concrete.

606.07 TESTING

**HP All testing shall be undertaken by a prequalified consultant in accordance with the VicRoads scheme for prequalification and approval of the Superintendent. The consultant shall be independent of the piling contractor. The contractor shall provide details of the pile testing consultant to the Superintendent for review at least 2 weeks prior to the testing.**

(a) Integrity Testing

Integrity testing shall be carried out on bored and cast‑in‑place piles in accordance with integrity test methods specified in AS 2159. Integrity testing equipment shall be capable of checking cross-sectional irregularities in piles and identifying the location of discontinuity and characteristics of any significant anomalies such as voids or contaminants.

Acceptance criteria, supervision and reporting of integrity testing shall be in accordance with the requirements of AS 2159.

Testing shall be carried out on the first 6 piles constructed, and subject to acceptable integrity test results being obtained, 1 in 3 remaining piles shall be tested. If any pile fails to meet the acceptance criteria, all piles shall be tested.

Integrity testing shall not be carried out until the concrete has achieved a compressive strength of at least 25 MPa and not before 7 days after casting of the pile.

**Raw data of pile integrity testing shall be provided to the Superintendent within 48 hours of request of the Superintendent.**

(b) Static Load Testing

The Contractor shall carry out static load testing on bored and cast-in-place shown on the drawings. Static load testing such as compression test, tension test and lateral load test shall be undertaken in accordance with AS 2159.

Load testing shall not be carried out until the concrete achieves the specified 28 day compressive strength.

**©** Department of Transport July 2017

Section 606 (Page 5 of 6)

(c) Dynamic Pile Testing

In addition to Integrity Testing and Static Load Testing, the Contractor shall carry out dynamic testing of piles to confirm that design pile capacity has been achieved. At least one (1) load test shall be performed for every 10 piles or, one load test per pile cap or bridge abutment, whichever gives the greatest number of pile testing. Dynamic testing shall also be carried out on piles of which the pile toe levels vary by more than 2 metres from the test pile.

The Contractor shall ensure that a pile driving rig with adequate capacity to mobilise the test pile with a single blow is employed during Dynamic Pile Testing.

Where the Contractor intends to seek dispensation of pile testing, the Contractor shall demonstrate to the satisfaction of the Superintendent that an appropriate geotechnical investigation(s) has been carried out at the piling location with relevant geotechnical information at least 5 m below the design pile toe level. The submission shall include a proof engineer’s certificate to confirm that where the pile is expected to develop its capacity, the lowest bound value of material strength established from the investigation has been adopted, and that a maximum geotechnical strength reduction factor of 0.45 has been adopted in the Ultimate Limit State geotechnical strength design in accordance with AS 2159. This information shall be provided to the Superintendent for review at least 4 weeks prior to construction. No consideration for dispensation of pile testing shall be given during or after construction.

**The details of the proposed pile driving rig, hammer size and drop heights shall be provided to the Superintendent for review prior to undertaking the testing.**

Testing shall be carried out by use of a Pile Driving Analyser (PDA) and the data obtained from each pile shall be analysed using CAPWAP, TNOWAVE or other approved equivalent software.

(d) Reporting

The test procedure and test reports shall conform with the requirements of AS 2159, and two copies of a report showing the measured field parameters and the results of analysis to determine pile capacity shall be provided to the Superintendent. Where confirmation of pile capacity using dynamic pile testing is obtained by re‑strike, the report shall include the results of the initial drive and all subsequent re‑strike.

(e) Acceptance Criterion

The integrity testing shall demonstrate that the measured cross-sectional area of each test pile is not less than 5% of the corresponding pile shown on the drawings.

Where piles are subjected to static load testing, the following criterion shall be satisfied:

• the plot of pile settlement with log time shall be linear or decreasing rate of creep, and the creep rate shall be less than 2 mm per log cycle of time at the test load;

• the maximum total pile settlement and lateral displacement at the design load shall not exceed the value shown on the drawings.

The test results are required to demonstrate meeting the acceptance criteria shown on the drawings.

The measured ultimate capacity of test piles by dynamic testing shall be equal to or greater than the pile test load shown on the drawings.

606.08 TOLERANCES

The following tolerances shall apply to completed piles:

(a) pile head shall finish within 75 mm of the specified plan position;

(b) variation from the vertical or the specified batter/rake shall not be more than 1 in 100;

(c) where piling excavation has developed a curve or out of verticality, the offset from the theoretical straight pile line shall not exceed 150 mm over a length of 15 metres or proportionally for greater or shorter lengths.

**©** Department of Transport July 2017

Section 606 (Page 6 of 6)