

BRIDGE TECHNICAL DIRECTION BTD2011/08

TESTING OF CAST-IN-PLACE CONCRETE PILES

Background

Cast-in-place concrete piles, with or without permanent casing, as specified in RTA QA specifications B58 and RTA B59 respectively, are often founded in rock of *medium* strength or better classification to AS 1726 and were traditionally designed using working stresses. As the examination of pile holes and socket of piles founded in these materials was considered sufficient to ensure pile strength, the current versions of RTA B58 and RTA B59 do not specify pile testing.

Following the issue of AS2159-2009, less conservative limit state designs are increasingly being used for cast-in-place concrete piles. Verification of the geotechnical design resistance of these piles is best achieved by pile testing in addition to pile hole examination, especially where the pile is founded in soft rock or weaker stratum. AS 2159-2009 encourages testing of all types of piles, and mandates testing under certain circumstances, depending on the site conditions and extent of investigation, and the design assumptions and construction methods.

This Technical Direction details the requirements for the testing of cast-in-place concrete piles to cover their use when founded in various founding materials and to address the requirements of AS 2159-2009 pending the revision of both RTA B58 and RTA B59. This Bridge Technical Direction supersedes BTD2010/05 which is now withdrawn.

Information

RTA B58 and RTA B59 are written to conform to AS 5100.3-2004 and AS 2159-1995 which are referenced in both specifications. Dynamic or other testing of cast-in-place concrete piles is not specified.

For all pile types, AS 2159-2009 mandates integrity testing where $\phi_{gb} > 0.4$, and load testing where both $\phi_{gb} > 0.4$ and the average risk rating (ARR) ≥ 2.5 . However AS 2159-2009 allows designers to specify, where considered necessary, additional testing with $\phi_{gb} \leq 0.4$.

The extent and type of pile testing as revised by AS 2159-2009 is based on the ARR value and designer's specific requirements. The new Standard encourages pile testing by permitting use of higher values of ϕ_g when testing is carried out.

Bridge Technical Direction

Cast-in-place concrete piles for RTA works or those that will be property of RTA shall be tested as detailed below to confirm:

- a. Design geotechnical strength where $\phi_{gb} > 0.4$; and
- b. Pile integrity using low-strain impact testing methods regardless of ϕ_{gb} value, as detailed below.

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All testing excluding static load testing shall be carried out by RTA approved organisations using RTA approved processes and equipment included in the Lists of RTA Approved Bridge Components and Systems at:

<http://www.rta.nsw.gov.au/doingbusinesswithus/downloads/listofapprovedbridgecomponentssystems.pdf>

Piles selected for testing shall be as nominated on the Drawings or as determined in agreement with RTA's geotechnical representative.

(A) Design Geotechnical Strength and/or Serviceability

The minimum percentage and number of piles to be tested at each bridge site for strength and/or serviceability shall conform to Table 1.

Table 1. Minimum Percentage ⁽¹⁾ and Number of Piles ⁽²⁾ to be Tested for Design Geotechnical Strength

Rock classification ⁽³⁾	ARR ⁽⁴⁾	<3.0	3.0-3.99	4.0-5.0
Medium or better	%	0	0	1
	Minimum Number	0	0	1
Low ⁽⁵⁾	%	1	2	3
	Minimum Number	1	2	3
Very Low ⁽⁵⁾	%	2	3	4
	Minimum Number	2	3	4
Extremely Low ⁽⁵⁾	%	3	4	5
	Minimum Number	3	4	5

⁽¹⁾ Fractions shall be rounded up to the next integer

⁽²⁾ The higher of these two values shall be adopted for testing

⁽³⁾ Rock classification to ASI 726-1993 (not for pile design purposes)

⁽⁴⁾ Average risk rating as per AS 2159-2009

⁽⁵⁾ Extent of testing for piles founded in low to extremely low strength rock may be increased depending on site specific conditions in agreement with RTA's geotechnical representative.

Testing may comprise static loading, high-strain dynamic testing, bi-directional load testing or rapid load testing as detailed in AS 2159-2009. Unless otherwise specified on the Drawings, the maximum test load P_g shall be as specified in Clause 8.3.3 of AS2159-2009.

For dynamic testing, the hammer mass shall be such that the net energy imparted to the pile is sufficient to mobilise the design pile resistance corresponding to the maximum test load. The hammer drop may be increased incrementally to no more than 3 m until the required resistance is achieved. Testing shall not result in the allowable concrete stresses being exceeded.

(B) Pile Integrity

Integrity testing may be carried out using any of the integrity testing methods specified in AS 2159-2009.

The minimum percentage and number of piles to be integrity tested at each bridge site using low-strain head impact testing methods, eg pulse echo (PE) or impulse response (IR), shall conform to Table 2.

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Table 2. Minimum Percentage ⁽¹⁾ and Number of Piles ⁽²⁾ to be Integrity Tested Using PE or IR Methods

A ⁽³⁾	%	20
	Minimum Number	4
B ⁽⁴⁾	%	25
	Minimum Number	5

- (1) Fractions shall be rounded up to next integer
- (2) The higher of these two values shall be adopted for testing
- (3) When pile design load is governed by pile geotechnical capacity
- (4) When pile design load is governed by pile shaft structural capacity

PE or IR methods must be capable of testing the full length of the pile taking into account the specific rate of energy dissipation of the founding material. The maximum length to diameter ratio (L:D) of a pile to be tested using PE or IR methods shall conform to Table 3 unless otherwise approved by RTA's geotechnical representative.

Table 3. Maximum L:D of Piles for Integrity Testing Using PE or IR Methods

Founding Material	Rock	Stiff/ hard soil	Medium stiff soil	Very soft soil
Pulse Echo	10	20	40	60
Impulse Response	10	20	30	30

Depending on bridge site conditions and design assumptions, the RTA's geotechnical representative may seek validation of PE or IR tests by comparing them to high strain dynamic tests carried out on the same piles subsequent to their PE or IR testing.

Where use of PE or IR test methods is deemed inappropriate by the RTA's geotechnical representative because of bridge site conditions, pile geometry and/or construction methods, Sonic Logging (SL) methods shall be considered. The extent of SL testing shall be in accordance with Table 4.

Table 4. Minimum Percentage ⁽¹⁾ and Number of Piles ⁽²⁾ to be Integrity Tested Using SL Method

ARR ⁽³⁾		<2.5	2.5-2.99	3.0-3.49	3.5-3.99	4.0-4.49	4.5-5.0
A ⁽⁴⁾	%	5	10	10	15	15	20
	Minimum Number	1	2	2	3	3	4
B ⁽⁵⁾	%	15	15	20	20	25	25
	Minimum Number	3	3	4	4	5	5

- (1) Fractions shall be rounded up to next integer
- (2) The higher of these two values shall be adopted for testing
- (3) Average risk rating as per AS 2159-2009
- (4) When pile design load is governed by pile geotechnical capacity
- (5) When pile design load is governed by pile shaft structural capacity

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Provide at least four cast-in steel logging tubes for every pile to be SL tested. PVC tubes are not permitted for use in SL testing. The diameter of logging tubes shall be appropriate for the probes to be used for logging.

References: BTD 2010/05

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Principal Bridge Engineer

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