

CONCRETE SPECIFICATION FOR WATERTIGHT POST-TENSIONED CONCRETE

Note: This specification has been prepared on the basis of the ACSE (NSW) Concrete Specification and amended where applicable to suit the requirements of the Post-tensioning Institute of Australia Limited.

SECTION 1: CONCRETE SUPPLY

1.1 GENERAL

1.1.1 Scope

This specification sets out the requirements for the supply of concrete for all post-tensioned concrete slabs to achieve a watertight structure. This is to be read in conjunction with the structural Engineer's specification, if applicable, and where there is a conflict, the more stringent requirement is to be adopted.

1.1.2 Responsibility

The Contractor shall be responsible for the supply of the concrete in accordance with this specification and the associated contract documents.

1.1.3 Definitions

Engineer - a person qualified for Corporate Membership of the Institution of Engineers, Australia, or with equivalent qualifications and competent to practice in the design and construction of concrete structures.

Approved - written confirmation of acceptance from the Engineer.

1.1.4 Standards

Concrete and its constituent materials shall comply with the current requirements of the following codes and standards except where modified by this specification.

Standards No.	Title
AS1012	Methods for testing of concrete
AS1141	Methods for sampling and testing aggregates
AS1315	Portland cement
AS1317	Blended cements
AS1379	The Specification and Manufacture of Concrete
AS2758.1	Aggregates and rock for Engineering purposes Part 1 - Concrete Aggregates
AS1478	Chemical admixtures for use in concrete
AS1479	Code of Practice for the use of chemical admixtures in concrete
AS3600	Concrete Structures
AS3582.1	Supplementary cementitious materials for use with portland cement Part 1: Fly Ash
AS3582.2	Supplementary cementitious materials for use with portland cement Part 2: Slag - Ground granulated iron blast - furnace

1.1.5 Certificates

Prior to the supply of concrete to the project, the Contractor shall, upon the request of the Engineer, supply copies of NATA endorsed test certificates covering the relevant tests from the current Australian standard.

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The test results shall relate either to materials already stockpiled for the project or to the most recent production of materials from the source and of the quality intended to be supplied to the project. During the course of the project additional test certificates shall be supplied at the frequency listed in the schedule for each source of supply.

1.2 MATERIALS

1.2.1 General

Concrete shall be made with Portland Cement or Blended cement, fine aggregate, coarse aggregate, water and any admixtures that may be specified or approved.

The contractor shall submit details of all concrete mixes and obtain approval from the Engineer before commencement of work.

1.2.2 Cement

All cement shall be Type SL Portland cement, in accordance with AS 3972 Portland and Blended Cements.

1.2.3 Aggregate

Aggregate shall comply with AS 2758.1.

1.2.4 Water

Water shall be free from matter which in kind and quantity is harmful to concrete or its reinforcement

1.2.5 Chemical Admixtures

Admixtures shall not contain chlorides, fluorides or nitrates and if approved for use, shall comply with AS 1478, and its use in concrete shall be in accordance with AS 1479. No admixture shall be used except with the permission of the Engineer.

1.2.6 Fly Ash and Ground Granulated Slag

Fly ash or ground granulated slag is not to be used in the concrete mix.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 General

The concrete for the various parts of the work shall be so designed and produced that the performance requirements of this specification shall be met.

The selection, proportioning and mixing of the concrete materials shall be such as to produce a mix which works readily into corners and angles of the forms and around reinforcement with the method of placement employed on the work, but without permitting the material to segregate or excess free water to collect on the surface. The resultant concrete shall be sound and have the other qualities specified.

1.3.2 Strength

The characteristic strength of the concrete shall be as follows;

i) Early Age Strengths (refer to section 3 for testing requirements)

18 hours maximum after concrete pour $f_{18\text{hours}} = 7 \text{ MPa (min)}$

5 days minimum after finish of concrete pour $f_{5\text{days}} = 22 \text{ MPa (min)}$

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(or to suit Contractors intended stressing time)

ii) 28 day Strengths (refer to section 3 for testing requirements)

28 days for A1, A2 and B1 exposure classifications $f'c = 32 \text{ MPa (min)}$

28 days for B2 exposure classifications $f'c = 40 \text{ MPa (min)}$

1.3.3 Slump

The slump shall not exceed $80 \pm 15 \text{ mm}$.

1.3.4 Dying Shrinkage

The maximum dying shrinkage strain shall not exceed 550μ at 56 days tested in accordance with AS1012.

1.3.5 Maximum Aggregate Size

The maximum size of aggregate shall be 20mm.

1.4 QUALITY CONTROL

All concrete shall be supplied by manufacturers with a quality management system in place to at least the requirements of AS 1379.

All concrete delivered to site shall be subject to project assessment for slump, compressive strength and any other tests specified.

The Contractor shall nominate a Concrete Delivery Supervisor who shall be a suitably experienced person to the approval of the Engineer, to monitor the delivery and placing of the concrete for each pour on the project.

1.5 READY-MIXED CONCRETE

Ready-mixed concrete shall be supplied in accordance with AS 1379, except where modified by this specification.

The supplier of ready-mixed concrete shall be approved by the Engineer prior to the commencement of the works. Ready-mixed concrete shall not be delivered in non-agitating trucks.

The Contractor shall ensure that the supplier of ready-mixed concrete will permit inspection of the plant and materials; and, if so required, will permit the taking of samples for testing purposes.

The Contractor shall advise the ready-mixed concrete supplier of all requirements of this specification and shall require that each batch of ready-mixed concrete be accompanied by an identification certificate in accordance with AS 1379.

These identification certificates shall be retained by the Contractor as a record of the ready-mixed concrete delivered and this information shall be available to the Engineer on request including records of where each batch was placed in the works.

1.6 TRANSPORTATION

The concrete shall be transported from the ready-mixed truck to its final position as rapidly as possible by means which will prevent segregation or loss of materials and contamination and in such a way that the proper placing and compaction of the concrete will not be adversely affected. The plastic concrete is to be discharged to the formwork within the following time periods for concrete of various temperatures.

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Concrete Temperature at time of placement	Maximum Elapsed Time from charging of mixer to discharge
Less than 10°C	not permitted
10°C - 24°C	120 minutes
24°C - 27°C	90 minutes
27°C - 32°C	45 minutes
greater than 32°C	not permitted

SECTION 2: CONCRETE PLACING

2.1 GENERAL

2.1.1 Scope

This section of the specification for concrete sets out the requirements for the placing of concrete in all concrete members.

2.1.2 Responsibility

The Contractor shall be responsible for the placing of the concrete in accordance with this specification and the associated contract documents and in such a manner that the performance requirements of this specification are met.

2.1.3 Definitions

Engineer - a person qualified for Corporate Membership of the Institution of Engineers, Australia, or with equivalent qualifications and competent to practice in the design and construction of concrete structures.

Approved - written confirmation of acceptance from the Engineer.

2.1.4 Inspections

The Contractor shall give sufficient notice, and in any case not less than 24 hours, to the Engineer of the placing of any concrete.

2.2 PUMPED CONCRETE MIXES

Pumping may be used for placing concrete with the approval of the Engineer and the knowledge of the manufacturer. The Contractor shall ensure that the equipment to be used will permit the concrete to be placed with the properties specified under the performance requirements of this specification.

2.3 PLACING

The concrete shall not be placed if the slump as measured in accordance with this specification is not within the required limits.

There shall be no addition of water or any other material to the concrete prior to discharge without the approval of the Concrete Delivery Supervisor (see Clause 1.4 - Quality Control). Water shall not be added to the concrete after commencement of discharge from the agitator. The concrete shall not be placed at a time or under such conditions which will not permit the requirements of this specification to be met.

The concrete shall be placed in such a manner as to avoid segregation or loss of materials.

The concrete placing shall be carried out continuously between construction joints and in such a manner that a plastic concrete edge is maintained. Where the location of construction joints is shown on the contract drawings the construction joints shall neither be relocated or eliminated without the approval of the Engineer. Where no

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construction joints are shown on the contract drawings and such are required their location and design shall be to the approval of the Engineer.

Before concrete is deposited against the hardened concrete at construction joints, the joint surfaces of the hardened concrete shall be thoroughly roughened and cleaned so that all loose or soft material, all foreign matter and all laitance are removed. The joint surface shall be dampened with clean water and coated with neat cement slurry.

The concrete shall be placed in horizontal layers not more than 300mm thick and each layer shall be compacted before the preceding layer has taken its initial set.

Concrete placing shall be such as to avoid likely causes of plastic cracking and the Contractor shall take account of any changes in mix design likely to affect the performance of the plastic or the hardened state concrete.

2.4 COMPACTION

The concrete shall be thoroughly compacted by means of mechanical vibration.

The Contractor shall ensure that at least one vibrator in working order is held in reserve at all times.

2.5 CONCRETING IN HOT AND COLD WEATHER

2.5.1 General

The formwork and reinforcement shall be maintained at temperatures between 5°C and 32°C.

2.5.2 Hot Weather Placing

When the air temperature exceeds 32°C, the concrete shall be placed at a temperature not exceeding 32°C.

2.5.3 Cold Weather Placing

When the air temperature is below 5°C, the concrete shall be placed at a temperature not less than 5°C.

2.7 PROTECTION

Freshly cast concrete shall be protected from premature drying and excessively hot or cold temperatures. The Contractor is to take due regard of climatic conditions likely to increase the likelihood of plastic cracking such as hot, dry or windy conditions. He is to inform the supplier of the conditions under which the concrete will be placed. If the temperature of the surrounding air is higher than 32°C, the Contractor shall apply aliphatic alcohol, using spraypacks, to the exposed surface of the concrete in accordance with the manufacturers specification. This is to occur immediately after initial screeding. In addition, suitable barriers shall be erected to protect the freshly placed plastic concrete from wind and sun until the concrete has hardened sufficiently to allow covering. Freshly finished concrete shall be protected from physical or thermal shock and traffic likely to damage the surface, including damage from rain.

SECTION 3: CONCRETE SAMPLING AND TESTING

3.1 GENERAL

3.1.1 Scope

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This specification sets out the requirements for the concrete sampling and testing for all post-tensioned concrete slabs. This is to be read in conjunction with the structural Engineer's specification, if applicable, and where there is a conflict, the more stringent requirement is to be adopted.

3.1.2 Responsibility

All aspects of sampling, site treatment and testing of concrete specimens shall be carried out by NATA registered laboratory and personnel.

Where concrete is liable to rejection, the costs of any further checking or testing that may be permitted by the Engineer shall be borne by the Contractor.

The Contractor shall register the project with the manufacturer to receive production assessment information in accordance with Clause 1.5 - Quality Control.

Project assessment, as described in AS 1379 shall apply, except where modified by this specification, and samples and specimens shall be taken at the site.

3.1.3 Definitions

Engineer - a person qualified for Corporate Membership of the Institution of Engineers, Australia, or with equivalent qualifications and competent to practice in the design and construction of concrete structures.

Approved - written confirmation of acceptance from the Engineer.

Early age testing - testing undertaken before 28 days

3.2 SAMPLING

The sampling and testing of concrete shall be in accordance with AS 1012, "Methods of Testing Concrete" for 28 day compressive strength and clause 19.6.2.8 of AS 3600 for early age compressive strength.

3.2.1 Location of Sampling

All concrete samples shall be taken at the point of discharge from the agitator. Where required by the Engineer additional sampling shall be carried out at the point of discharge into the forms.

Concrete samples for early age compressive strength tests shall be taken close to the end of the concrete pour.

3.2.2 Method of Sampling

Identification shall be carried out in accordance with AS 1012, Part 1.

3.2.3 Frequency of Sampling

3.2.3.1 Early Age Strength Samples

For early age testing the minimum frequency of sampling shall be one sample per 50m³, or part thereof, of a concrete grade placed on any one day.

3.2.3.2 28 day Strength Samples

For 28 day testing the minimum frequency of sampling of the concrete of each type and grade shall be in accordance with the following table:

Number of Batches per day	Number of Samples
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1	1
2 to 5	2
6 to 10	3
11 to 20	4
for each additional 10	1 additional sample

Where requested by the Engineer, testing facilities are to be available on site at agreed times during a concrete pour.

3.3 TEST SPECIMENS

3.3.1 General

Generally at least two specimens shall be taken from the sample of each grade for strength testing and other specimens as required to represent a particular property., prior to testing in accordance with the relevant section of AS 1012.

Records shall be kept and submitted to the Engineer of all aspects of the Project Assessment. These records shall provide the full history of sampling and testing of all specimens and shall accord with Clause 1.10 of AS 1012 - Part 8.

3.3.2 Details of Test Specimens

3.3.2.1 Characteristic Compressive Strength f'_c at 18 hours and 5 days

At least two specimens 200mm high and 100 mm diameter shall be made concurrently from each of the samples required. These test specimens shall be stored and cured on site under similar conditions to that of the concrete pour in accordance with clause 19.6.2.8 of AS 3600 and tested in accordance with the relevant clauses of AS 1012.

3.3.2.2 Characteristic Compressive Strength f'_c and Characteristic Flexural Strength f'_{cf} at 28 days

At least two specimens 200mm high and 100 mm diameter for each test shall be made concurrently from each of the samples required and these shall be taken and tested in accordance with the relevant clauses of AS 1012.

3.3.3 Slump

The slump of the concrete shall be determined in accordance with AS 1012 Part 3. The Criterion for compliance shall be as specified in Section 1 of this specification.

3.3.4 Drying Shrinkage

In addition to at least two initial sets of results on trial mixes, the manufacturer shall sample and test for drying shrinkage each type of concrete supplied, at least every month during the course of the project or for every 1000 cubic metres placed, and provide reports.

For assessment of shrinkage three specimens shall be taken in accordance with AS 1012 Part 13 from the concrete sampled in accordance with AS 1012, Part 1. The assessment of drying shrinkage shall be on the basis of the maximum of the three specimen test results. The criterion for compliance shall be as specified in clause 1.3.4 of this specification.

3.4 TEST RESULTS

NATA Test Certificates, or facsimile copies of these, shall be forwarded to the Engineer immediately they are available. The results of these tests shall also be kept in tabulated form on the site.

SECTION 4: ACCEPTANCE CRITERIA

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4.1 GENERAL

Concrete which has been specified to satisfy certain performance requirements and which has been tested for such performance in accordance with Section 3, shall be deemed to comply if the criteria specified in this section are satisfied. When the concrete fails to satisfy these criteria it will be liable to rejection.

The Engineer may permit concrete which is liable to rejection to be retained on the following basis:

- i. An appraisal of the statistical information related to the concrete strength
- ii. A structural investigation
- iii. Additional tests (such as outlined in Section 21 of AS 3600)
- iv. Approved remedial work.

The costs of this further checking, testing or remedial work shall be borne by the Contractor.

Where concrete work has been rejected it shall be removed to the extent determined by the Engineer.

4.2 ACCEPTANCE CRITERIA

4.2.1 Characteristic Compressive Strength f'_c and Characteristic Flexural Strength f'_{ct} , f'_{cf}

The concrete shall be deemed to comply with the strength requirements of this specification if its characteristic strength complies with AS 1379.

4.2.2 Slump

The slump shall be deemed to comply if it lies within the specified tolerances. Concrete found to have slump outside these tolerances shall be removed from the site unless the Engineer's nominated representative allows adjustment by water addition prior to discharge. Under no circumstances is the total amount of water added to exceed the designed volume of water for the mix to achieve its required properties.

4.2.3 Drying Shrinkage

The criterion for compliance with the drying shrinkage requirements of the specification shall be that no test result for drying shrinkage of the three specimens shall exceed the specified value.

4.3 OTHER REJECTION CRITERIA

Hardened concrete shall also be liable to rejection if any of the following defects occur:

- i. It does not comply with AS 3600 Clause 19.1.10.2.
- ii. A construction joint has been made at a location or in a manner not in accordance with this specification.
- iii. The construction tolerances have not been met
- iv. The reinforcing steel has been displaced from its correct location.
- v. Waterstops, inserts and other items embedded in concrete have been displaced from their correct position.
- vi. The required surface finish has not been achieved.
- vii. The concrete work can be shown to be otherwise defective.

SECTION 5: FINISHES TO UNFORMED CONCRETE

5.1 GENERAL

All concrete finishes shall be in accordance with the Architect's and Engineers specification.

SECTION 6: CONCRETE CURING AND PROTECTION

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6.1 CURING

6.1.1 Generally

Freshly cast concrete shall be protected from premature drying and excessively hot or cold temperatures. The Contractor shall take particular precautions to avoid the likelihood of plastic cracking prior to curing by considering the requirements of clause 2.7 of this specification. The concrete shall be maintained at a reasonably constant temperature with minimum moisture loss for the curing period.

6.1.2 Curing Methods

During the curing period one of the following methods shall be adopted by the Contractor for the curing of the unformed surfaces. Where formed surfaces are exposed during the curing period then these also shall be cured by one of these methods for the remainder of the curing period. PVA compounds shall not be used.

- i. Ponding or continuous sprinkling with water for a minimum of 5 days.
- ii. The use of an absorptive cover kept continuously wet.
- iii. The use of an approved curing compound conforming to AS 3799, applied to the manufacturers specification.

6.2 CURING PERIOD

Curing shall commence immediately after initial set of the concrete, but in no case later than two hours after the finishing operation has been completed. Curing shall continue until the cumulative number of days or fractions thereof, not necessarily consecutive, during which the temperature of the air in contact with the concrete is above 10°C has totaled seven days for ordinary Portland Cement Concrete. For concrete made with high early strength cement the curing shall continue for three days. Rapid drying out at the end of the curing period shall be prevented.

6.3 COLD WEATHER CURING

Precautions shall be taken to prevent the plastic concrete from freezing at any time. When the temperature of the surrounding air during curing is less than 10°C the temperature of the concrete shall be maintained at a temperature between 10°C and 20°C for the required curing period. Salts or chemicals shall not be used for the prevention of freezing.

6.4 HOT WEATHER CURING

When the temperature of the surrounding air during curing is higher than 32°C the concrete shall be cured only by means of method (i) of Curing Methods in clause 6.1.2.

6.5 CURING COMPOUNDS

When curing compounds are to be used, the Contractor shall provide documentary evidence from the manufacturer of:-

- i. Tests showing a satisfactory efficiency index
- ii. Tests showing that the adhesion of the proposed applied finish will not be adversely affected by the compound.
- iii. Proof that the compound will not react detrimentally with the concrete.

The compound shall not be used until approval is obtained from the Engineer

The curing compound shall be applied in accordance with the manufacturers written directions in such a manner that a uniform coating is achieved. When dry, the coating should be continuous, flexible and without visible breaks or pinholes, and should remain as unbroken film for at least 7 days after application.

6.6 PROTECTION AGAINST DAMAGE AFTER PLACEMENT

The concrete shall be protected from damage due to load over- stresses, heavy shocks and excessive vibrations, particularly during the curing period. Construction loads shall not be placed on self-supporting structures which will overstress them.

All finished concrete surfaces shall be protected from damage due to any cause, such as construction activities, rain and running water.