

Structures

Master Specification

ST-SC-S7 Supply of Concrete

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ST-SC-S7 Supply of Concrete

1 General

- 1.1 This Part specifies the requirements for the design, supply, sampling and testing of special class concrete and normal class in excess of 32MPa. Refer to ST-SC-S1 "Normal Class Concrete" for the supply of N20, N25 and N32 normal class concrete.
- 1.2 The following standards, documents and guidelines (including the most recent revisions and amendments) are referenced in this Part:
- a) AS 1012 Methods of testing concrete.
 - b) AS 1141 Methods of sampling and testing aggregates.
 - c) AS 1379 Specification and supply of concrete.
 - d) AS 1478 Chemical admixtures for concrete.
 - e) AS 2758.1 Aggregates and rock for engineering purposes - Concrete aggregates.
 - f) AS 3582 Supplementary cementations materials for use with portland and blended cement.
 - g) AS 3972 Portland and blended cements.
 - h) ASTM C1621 / C1621M-09b Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring.
 - i) Vicroads Technical Note 30: Alkali Silica Reaction in Concrete, available from: <https://www.vicroads.vic.gov.au>
 - j) Vicroads Technical Note 73: Self Compacting Concrete, available from: <https://www.vicroads.vic.gov.au>
 - k) RMS QA Bridgeworks Specification B80 Concrete Work for Bridges, available from: <https://www.rms.nsw.gov.au>
 - l) Vicroads Standard Specification 610 Structural Concrete, available from: <https://www.vicroads.vic.gov.au>
 - m) Vicroads Code of Practice RC500.16 Selection of Test Methods for Testing of Materials and Work, available from: <https://www.vicroads.vic.gov.au>
- 1.3 Unless specified otherwise, the definitions in AS 1379 apply to this Part.

2 Quality Requirements

- 2.1 At a minimum, the Contractor's Quality Plan shall include the following documents, procedures and instructions:
- a) the concrete mix design, including:
 - i) the source, type and proportions of the constituent materials;
 - ii) aggregate gradings and saturated surface-dry densities;
 - iii) chemical admixtures details and manufacturer's recommended method of use;
 - iv) the nominated slump and where a superplasticizer is used the final slump;
 - v) if self-compacting concrete is proposed, details of the mix, T500 (measure of viscosity) and passing ability;
 - vi) the maximum water content and maximum water / cementitious material ratio;
 - vii) level of control, accuracy and method of determination of both the coarse and fine aggregate moisture content; and

- viii) documented evidence that the mix will comply with all requirements specified from either previous production of the mix (the test results shall not be more than 12 months old) or full details of a trial mix undertaken in accordance with AS 1012.2.
 - b) detailed procedures for concrete production, delivery, material testing and concrete testing; and
 - c) if not provided beforehand, the documentation shall be submitted at least 28 days prior to the commencement of site work.
- 2.2 Provision of the procedures and documentation listed in this Clause shall constitute a **Hold Point**.
- 2.3 The Contractor is responsible for ensuring that the concrete mix design will achieve all of the requirements specified for plastic and hardened concrete. In the event of any change to the mix design, the above documentation shall be resubmitted prior to manufacture of the changed mix.

3 Concrete Materials

Cement

- 3.1 Cement shall comply with AS 3972. Cement for each batch of concrete shall be from one manufacturer and of one brand and type. Cement more than 3 months old shall not be used in the Works unless it is re-tested to demonstrate compliance with the requirements of AS 3972.

Admixtures

- 3.2 Admixtures shall:
- a) comply with AS 1478.1;
 - b) be dispensed using equipment complying with Clause 3.4 “Liquid Dispensing Equipment” of AS 1379;
 - c) not contain calcium chloride; and
 - d) not contain any chemical in a concentration which could have a detrimental effect on the concrete durability or any other concrete property.

Aggregate

- 3.3 Fine and coarse aggregate for concrete shall comply with the requirements of AS 2758.1 unless otherwise specified. The maximum sizes of coarse aggregates used shall not exceed the values shown in Table ST-SC-S7 3-1.

Table ST-SC-S7 3-1 Maximum Aggregate Size

Type of Concrete	Location	Maximum Size of Coarse Aggregate Permissible
All cases	Clear cover	0.75x clear cover
Prestressed Concrete	All cases	20 mm
Reinforced Concrete	All sections whose least dimension is up to 300mm	20 mm
	All sections whose least dimension is greater than 300 mm	40 mm
	Piles and closely reinforced sections	20 mm or 0.66x the minimum clear distance between parallel reinforcing bars, whichever is lesser
Unreinforced Concrete	All cases	55 mm

- 3.4 Particle shape shall comply with Clause 9 “Verification Requirements and Records”.
- 3.5 The aggregate, when used in the proposed mix design, shall not be susceptible to alkali aggregate reactivity and the Contractor shall provide evidence to verify this. For further information, refer to VicRoads Technical Note 30: Alkali Silica Reaction in Concrete.

Soluble Salts

- 3.6 The acid-soluble chloride-ion content of concrete as placed (expressed as the percentage of the total mass of cementitious material in the concrete mix) shall not be greater than:
- a) 0.1% for prestressed concrete;
 - b) 0.15% for reinforced concrete;
 - c) 0.03% for post-tensioning grout.
- 3.7 The sulphate content of concrete as placed (expressed as the percentage by mass of acid-soluble SO₃ to the total cementitious material in the concrete mix) shall not be greater than 5%. Sulphate and chloride-ion content shall be determined by testing of hardened concrete in accordance with AS 1012.20.

Self-Compacting Concrete

- 3.8 Self-Compacting Concrete (SCC) (also called self-consolidating concrete or super-workable concrete) is concrete that is able to flow and consolidate under its own weight, completely fill the formwork or bore hole even in the presence of dense reinforcement, whilst maintaining homogeneity and without the need for additional compaction. For further information, refer to VicRoads Technical Note 73: Self Compacting Concrete, or Annexure G of RMS QA Bridgeworks Specification B80.
- 3.9 SCC shall incorporate the various cementitious materials, coarse and fine aggregate and any additional fine materials, water and chemical admixtures in such proportions as required, to achieve the rheological characteristics of flow and self-compaction and an absence of segregation. SCC shall be produced using high range polycarboxylate type water reducers or conventional superplasticizers with a viscosity modifying admixture which include a viscosity modifying capability.

4 Concrete Properties

Concrete Class

- 4.1 Unless specified otherwise, all concrete supplied in accordance with this Contract is Special-Class Concrete. The range of permissible cementitious content and the range of permissible water-cement ratio for each particular grade of concrete shall be in accordance with Table ST-SC-S7 4-1.

Table ST-SC-S7 4-1 Cement and Water Content

Exposure Classification	Concrete Strength Grade (MPa)	Minimum - Maximum cementitious Content (kg/m ³)	Minimum - Maximum Water/Cement Ratio
B1	32	330 – 500	0.40 - 0.50
B1	40	400 – 500	0.40 - 0.45
B2	40	400 – 500	0.32 - 0.45
B2	50	400 – 500	0.32 - 0.45
C1	50	450 – 550	0.32 - 0.40
C2	50	470 – 550	0.32 - 0.36
U	Project specific mix design to be submitted for approval		

- 4.2 The exposure classification shall be as shown on the drawings.
- 4.3 Partial or total replacement of Portland cement with supplementary cementitious materials is a means of reducing embodied carbon in concrete (refer Part PC-ST1 Sustainability in Design and PC-ST2 Sustainability in Construction).
- 4.4 Minimum Portland cement replacement levels for concrete are specified in Master Specification ST-SD-D1, Clause 4 Sustainability in Design. These minimum levels must be achieved, unless an alternative approach to minimising whole of life embodied carbon has been specified in the 100% design report and/or drawings. Blended cement material proportions shall comply with AS5100 Part 5. High rates of Portland cement replacement can impact on early strength gain - in order to facilitate achievement of emission reduction objectives, the use of a 56-day concrete strength requirement in

lieu of 28-day strength is permitted for concrete elements where early strength gain is not critical. Submission of such elements where a 56-day strength is specified shall constitute a **Hold Point**.

Self-Compacting Concrete

- 4.5 SCC shall be homogeneous and free of balls of unmixed material. SCC shall only be used for the manufacture of precast concrete members and / or the construction of cast in-situ piles. The properties of fresh SCC shall comply with AS 1012.3.5

5 Sampling and Testing

- 5.1 All concrete shall be subject to Project Assessment unless specified otherwise on the drawings.
- 5.2 For Project Assessment, the following sampling and testing shall be undertaken in addition to that specified in AS1379:
- a slump test (or Slump Flow if self-compacting concrete is used) on each truck load of concrete delivered to site; and
 - sampling in accordance with Table ST-SC-S7 5-1.

Table ST-SC-S7 5-1 Sampling Frequency (per day)

No. of batches (trucks) supplied to the Project	No. of samples to be taken
1	1
2 – 5	2
> 5	For each additional 5 batches: One additional sample

- 5.3 Samples shall be selected randomly.
- 5.4 Three cylinder specimens shall be obtained from each sample, to be tested as follows:
- one tested at 7 days (to give an indication of the likely 28 day strength only); and
 - the remaining 2 cylinder specimens tested at 28 days (conformance testing).
- 5.5 If the Contractor proposes to conduct in-house testing for determination of concrete strength for lifting or transfer, evidence shall be provided showing that:
- the testing equipment is adequately calibrated and maintained;
 - the testing processes are appropriate; and
 - the testing personnel are adequately trained.

Mortars and Grouts

- 5.6 All mortars and grouts must be cementitious, shrinkage compensating proprietary products with a consistency appropriate for the required use, and able to be placed and compacted to achieve full encapsulation. Cementitious mortars and grouts must have a minimum 28 day compressive strength of not less than 40 MPa.
- 5.7 Cementitious grouts must be, as a minimum, Type C Class dual shrinkage compensating.
- 5.8 Only whole bags of material must be used. Test certificates, material data sheets and health and safety data sheets must be available for all materials. The mortar and grout applications must be cured in accordance with the requirements of ST-SC-C7 "Placement of Concrete".
- 5.9 Three 75 mm test cubes must be taken from the first batch of material mixed, then three 75 mm cubes for every 100 kg of material used thereafter to test for compressive strength. The cubes must be cured for seven days. Two (2) cubes must be tested at seven days and the third cube at 28 days to confirm compliance with the minimum compressive strength requirements as specified on the drawings and the material manufacturer's technical data sheet. Test cubes must be made, cured and tested in accordance with AS 1478.2.

6 High Durability Concrete

- 6.1 This clause only applies where high durability concrete has been specified on the drawings. Concrete in Exposure Classification B2, or more severe, shall also satisfy this Part.
- 6.2 Testing for High Durability Concrete shall use AS1012.21 - Determination of water absorption and apparent volume of permeable voids in hardened concrete. The result of the test is a VPV value.
- 6.3 The test acceptance of a concrete mix design shall be carried out on test specimens taken from a concrete sample of age 28 days, which has undergone standard moist curing in accordance with AS 1012. The sample shall consist of 2 cylinders. The VPV value of each of the test cylinders shall be not greater than the specified value in Table ST-SC-S7 6-2. Frequency of sampling and testing must be as for Table ST-SC-S7 6-1.

Table ST-SC-S7 6-1 High Durability Sampling Frequency

Component	No. of Samples to be Taken
Initial Mix Design	1 per mix design
Piles	1 from first concrete pour 1 in each subsequent 30 piles
Pile Caps	1 from first concrete pour 1 from fourth pile cap pour
Skirts and Fender Beams	1 from first concrete pour for each element
Piers	1 from first concrete pour 1 from fourth pier pour
Abutments	1 from each abutment pour
Superstructure	1 from first concrete pour for each element

- 6.4 The maximum VPV values at 28 days, for each concrete grade for both test cylinders and concrete test cores cut from cast in situ and sprayed concrete, are as for Table ST-SC-S7 6-2.

Table ST-SC-S7 6-2 Maximum VPV Values

CONCRETE GRADE	MAXIMUM VPV VALUES AT 28 DAYS (%)		
	Test cylinders (compacted by vibration)	Test cylinders (compacted by rodding)	Test cores
S32	14	15	17
S40	13	14	16
S50 (Exposure Classification C1)	12	13	15
S50 (Exposure Classification C2)	11	12	14

- 6.5 For the purpose of satisfying the requirements of this clause, VPV test results are rounded down to the nearest whole number for the corresponding concrete grade.

7 Test Procedures

- 7.1 The Contractor shall use the following test procedures (refer https://www.dpti.sa.gov.au/contractor_documents) to verify conformance with the Specification as Table ST-SC-S7 7-1:

Table ST-SC-S7 7-1 Test Procedures

Test	Test Procedure
Determination of water absorption and apparent volume of permeable voids in hardened concrete	AS 1012.21
Slump test	AS 1012.3
Compressive strength of concrete specimens	AS 1012.9
Self-Compacting Concrete – Slump Flow, T500 Time (measure of viscosity) and passing ability	AS 1012.3.5

8 Hold Points

8.1 The following is a summary of hold Points referenced in this Part:

Document Ref.	Hold Point	Response Time
2.2	Submission of mix design and procedures	2 working days
4.4	Submission of elements where 56-day concrete strengths are specified	5 working days

9 Verification Requirements and Records

Test Records

9.1 The Contractor shall undertake the testing specified in this Clause and supply written evidence of compliance with the lot package.

Table ST-SC-S7 9-1 Test Procedures

Document Ref.	Subject	Property	Procedure	Frequency	Acceptance Limits
3.3	Aggregate properties (Project assessment only)	Particle shape	As specified in AS 2758.1, Clause 8.3	At least once for each aggregate type	As specified in AS 2758.1, Clause 8.3
		Water absorption	As specified in AS 2758.1, Clause 7.3	At least once for each aggregate type	< 2.5%
3.8	Self-Compacting Concrete	Slump flow	AS 1012.3.5	Refer Table ST-SC-S7 5-1	550-750mm spread. Aggregate shall be evenly distributed throughout the concrete paste & shall not exhibit signs of segregation
		T500 time (measure of viscosity)	AS 1012.3.5	Refer Table ST-SC-S7 5-1	A spread of 500 mm within 2 – 5 seconds. The final spread shall not exceed 750 mm diameter
		Passing Ability	AS 1012.3.5	Refer Table ST-SC-S7 5-1	The concrete shall not exhibit signs of segregation.
4 & 5	Concrete Properties	Cement and Water Content	Determined from identification certificate (refer AS1379 Clause 1.7.3)	Each truck load	Table ST-SC-S7 4-1
		Slump	Refer AS1379	Each truck load	Refer AS1379 Clause 5.2
		Compressive Strength – Production Assessment	Refer AS1379	Refer AS1379	Refer AS1379

Document Ref.	Subject	Property	Procedure	Frequency	Acceptance Limits
6	High Durability Concrete	7 day Compressive Strength – Project Assessment	Refer AS1379	Refer Table ST-SC-S7 5-1 & Clause 5	Report only
		28 day Compressive Strength – Project Assessment	Refer AS1379	Refer Table ST-SC-S7 5-1 & Clause 5	Refer AS1379
		VPV	AS1012.21	Refer Table ST-SC-S7 6-1	Refer Table ST-SC-S7 6-2

Other Records

9.2 The Contractor shall supply the following records:

Table ST-SC-S7 9-2 Verification Records

Document Ref.	Subject	Record to be Provided
5	In-house testing of concrete properties	Evidence of satisfactory equipment and processes and trained personnel
5	Concrete delivery information	Identification certificates in accordance with AS1379 Clause 1.7.3 "Identification Certificate"
5	7 day compressive strength	If the result is <65% of the specified 28 day compressive strength, a report outlining the Contractor's proposed disposition is to be provided within 2 days of completion of the test.