

Master Specification

Part ST-SC-S7

Supply of Concrete

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ST-SC-S7 Supply of Concrete

1 General

- a) This Master Specification Part specifies the requirements for the design, supply, sampling and testing of special class concrete and normal class in excess of 32 MPa, including:
 - i) the documentation requirements, as set out in section 2;
 - ii) the concrete materials requirements, as set out in section 3;
 - iii) the self-compacting concrete requirements, as set out in section 4;
 - iv) the concrete properties requirements, as set out in section 5;
 - v) the sampling and testing requirements, as set out in section 6;
 - vi) the high durability concrete requirements, as set out in section 7;
 - vii) the test procedures requirements, as set out in section 8;
 - viii) the Hold Point requirements, as set out in section 9; and
 - ix) the verification requirements and records, as set out in section 10.
- b) This Master Specification Part does not apply to normal class concrete N20, N25 and N32, which must comply with the requirements of ST-SC-S1 "Normal Class Concrete".
- c) The supply of special class concrete and normal class in excess of 32 MPa concrete must comply with the with the Reference Documents, including:
 - i) AS 1012 Methods of testing concrete;
 - ii) AS 1141 Methods of sampling and testing aggregates;
 - iii) AS 1379 Specification and supply of concrete;
 - iv) AS 1478 Chemical admixtures for concrete, mortar and grout;
 - v) AS 2758.1 Aggregates and rock for engineering purposes, Part 1: Concrete aggregates;
 - vi) AS 3582 Supplementary cementitious materials;
 - vii) AS 3972 General purpose and blended cements;
 - viii) AS 5100.5 Bridge design, Part 5: Concrete;
 - ix) ASTM C1621 / C1621M-09b Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring;
 - x) TfNSW Specification TS 01733.2 Concrete Work For Bridges - DC (IC-DC-B80) (available from: <https://www.rms.nsw.gov.au>);
 - xi) VicRoads Code of Practice RC 500.16 Selection of Test Methods for Testing of Materials and Work;
 - xii) VicRoads Technical Note TN 030: Alkali Silica Reaction in Concrete; and
 - xiii) VicRoads Technical Note TN 073: Self Compacting Concrete.

2 Documentation

2.1 Construction Documentation

In addition to the requirements of PC-CN3 “Construction Management”, the Construction Documentation must include the following documents, procedures and instructions relating to the supply of concrete:

- a) details of 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) drying shrinkage at 56 days;
 - viii) level of control, accuracy, and method of determination of both the coarse and fine aggregate moisture content;
 - ix) documented evidence that the concrete mix will comply with all requirements specified from either previous production of the concrete mix (the test results must not be more than 12 months old) or full details of a trial concrete mix undertaken in accordance with AS 1012.2 Methods of testing concrete, Method 2: Preparing concrete mixes in the laboratory; and
 - x) evidence that the aggregate will not be susceptible to alkali aggregate reactivity in accordance with section 3.4c);
 - xi) project specific mix design where required by Table ST-SC-S7 5-1; and
- b) detailed procedures for concrete production, delivery, material testing and concrete testing.

2.2 Quality Management Records

In addition to the requirements of PC-QA1 “Quality Management Requirements” or PC-QA2 “Quality Management Requirements for Major Projects” (as applicable), the Quality Management Records must include the verification records required by Table ST-SC-S7 10-1.

3 Concrete materials

3.1 General

The Contractor must ensure 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 concrete mix design, the Construction Documentation must be updated and resubmitted prior to manufacture of the changed mix in accordance with the requirements of PC-CN3 “Construction Management”.

3.2 Cement

- a) Cement must:
 - i) comply with AS 3972 General purpose and blended cements;
 - ii) for each batch of concrete be from one manufacturer and of one brand and type; and

- iii) not be used in the Works or Temporary Works if it is more than 3 months old unless it is re-tested to demonstrate compliance with the requirements of AS 3972 General purpose and blended cements.
- b) White cements must not be used.

3.3 Admixtures

- a) Admixtures must:
 - i) comply with AS 1478.1 Chemical admixtures for concrete, mortar and grout, Part 1: Admixtures for concrete;
 - ii) be dispensed using equipment complying with AS 1379 Specification and supply of concrete;
 - iii) not contain calcium chloride; and
 - iv) not contain any chemical in a concentration which could have a detrimental effect on the concrete durability or any other concrete property.
- b) Admixture addition on Site is permitted, provided the batch plant delivery docket indicates the exact quantity to be added and dispensed complying with AS 1379 Specification and supply of concrete. Adequate provision must be made for safe handling, prevention and handling of spills and environmental harm. Admixture addition quantity must be recorded for future reference as part of the Quality Management Records.

3.4 Aggregate

- a) Fine and coarse aggregate for concrete must comply with the requirements of AS 2758.1 Aggregates and rock for engineering purposes, Part 1: Concrete aggregates. The maximum sizes of coarse aggregates used must not exceed the values shown in Table ST-SC-S7 3-1.
- b) Aggregate particle shape must comply with section 8.
- c) The aggregate, when used in the proposed mix design, must not be susceptible to alkali aggregate reactivity and the Contractor must provide evidence to verify this as part of the Construction Documentation. For further information, refer to VicRoads Technical Note TN 030: Alkali Silica Reaction in Concrete.

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
	All sections whose least dimension is up to 300 mm	20 mm
Reinforced concrete	All sections whose least dimension is >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

3.5 Water

- a) Water addition on Site is allowed, provided the batch plant delivery docket includes the maximum water volume allowed to meet concrete mix properties stated in this Master Specification Part and the concrete mix design. If water is added on Site, quantities must be recorded for future reference as part of Quality Management Records. Measuring accuracy must be equivalent to batch plant addition.

- b) The addition of water must be in accordance with AS 1379 Specification and supply of concrete.

3.6 Soluble salts

- a) 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) must not be greater than:
 - i) 0.10% for prestressed concrete;
 - ii) 0.15% for reinforced concrete; or
 - iii) 0.03% for post-tensioning grout.
- b) 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) must not be greater than 5%. Sulphate and chloride-ion content must be determined by testing of hardened concrete in accordance with AS 1012 Methods of testing concrete.

4 Self-compacting concrete

- a) Self-compacting concrete (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 TN 073: Self Compacting Concrete, or TfNSW Specification TS 01733.2 Concrete Work For Bridges - DC (IC-DC-B80).
- b) Self-compacting concrete must 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. Self-compacting concrete must be produced using high range polycarboxylate type water reducers or conventional superplasticizers with a viscosity modifying admixture which includes a viscosity modifying capability.

5 Concrete properties

5.1 Concrete class

- a) Unless shown on the Design Drawings, all supplied concrete must be special-class concrete. The range of permissible cementitious content and the range of permissible water-cement ratio for each particular grade of concrete must be in accordance with Table ST-SC-S7 5-1.
- b) The exposure classification must be as shown on the Design Drawings.
- c) Minimum Portland cement replacement levels for concrete to reduce embodied carbon (for example with supplementary cementitious materials) are specified in ST-SD-D1 "Design of Structures". These minimum levels must be achieved, unless an alternative approach to minimising whole of life embodied carbon in concrete elements has been either:
 - i) approved as part of a Design Departure, and subsequently noted in the relevant Design Report or Design Drawing; or
 - ii) where the design has been provided by the Principal, an alternative approach has been stated in either the Design Report or Design Drawings.
- d) Blended cement material proportions must comply with AS 5100.5 Bridge design, Part 5: Concrete.
- e) In order to facilitate achievement of emission reduction objectives, the use of a 56-day concrete strength requirement in lieu of 28-day strength may be permitted for concrete elements where early strength gain is not critical. Submission of such elements where a 56-day strength is specified will constitute a **Hold Point**.

Table ST-SC-S7 5-1 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	55	470 - 550	0.32 - 0.36
B1 / B2 / C1 / C2	65	500 - 600	0.28 - 0.34
U	Project specific mix design to be submitted for approval as part of the Construction Documentation		

5.2 Self-compacting concrete

- a) Self-compacting concrete must be homogeneous and free of balls of unmixed material.
- b) Self-compacting concrete must only be used for the manufacture of precast concrete members or the construction of cast in situ piles.
- c) The properties of fresh self-compacting concrete must comply with AS 1012.3.5 Methods of testing concrete, Method 3.5: Determination of properties related to the consistency of concrete - Slump flow, T500 and J-ring test.

6 Sampling and testing

6.1 General

- a) All special class concrete supplied in accordance with this Master Specification Part must be subject to Project assessments.
- b) Project assessments conducted for concrete must meet the following requirements:
 - i) the Contractor must undertake the following sampling and testing in addition to that specified in AS 1379 Specification and supply of concrete:
 - A. a slump test (or slump flow if self-compacting concrete is used) at a frequency no less than the sampling frequency in accordance with Table ST-SC-S7 6-1; and
 - B. sampling in accordance with Table ST-SC-S7 6-1;
 - ii) samples must be selected randomly; and
 - iii) 3-cylinder specimens must be obtained from each sample, to be tested as follows:
 - A. one tested at 7 days (to give an indication of the likely 28-day strength only); and
 - B. the remaining 2-cylinder specimens tested at 28 days or at 56 days where 56-day concrete strength is permitted (conformance testing).
- c) Where the Contractor proposes to conduct in-house testing for determination of concrete strength for lifting or transfer, evidence must be provided as part of the Quality Management Records, showing that:
 - i) the testing equipment is adequately calibrated and maintained;
 - ii) the testing processes are appropriate; and
 - iii) the testing personnel are adequately trained.
- d) Drying shrinkage tests must be undertaken for special class concrete in accordance with AS 1379 Specification and supply of concrete.

- e) Tolerances for slump tests must be in accordance with AS 1379 Specification and supply of concrete. Truck loads not complying with this must be rejected and must not be incorporated into the Works.

Table ST-SC-S7 6-1 Sampling frequency (per day)

No. of batches (trucks) supplied to the project	No. of samples to be taken
1	1
2 - 5	2
>5	2 plus 1 additional sample for each additional 5 batches (or part thereof)

6.2 Mortars and grouts

In relation to mortars and grouts:

- a) 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;
- b) cementitious mortars and grouts must have a minimum 28-day compressive strength of not less than 40 MPa;
- c) cementitious grouts must be, as a minimum, Type C Class dual shrinkage compensating;
- d) only whole bags of material can be used;
- e) test certificates, material data sheets and health and safety data sheets must be available for all mortar and grout materials and submitted as part of the Quality Management Records;
- f) mortar and grout applications must be cured in accordance with the requirements of ST-SC-C7 "Placement of Concrete"; and
- g) the following testing requirements apply:
 - i) 3 75 mm test cubes must be taken from the first batch of material mixed, then 3 75 mm cubes for every 100 kg of material used thereafter to test for compressive strength;
 - ii) test cubes must be cured for 7 days;
 - iii) 2 cubes must be tested at 7 days and the third cube at 28 days to confirm compliance with the minimum compressive strength requirements as specified on the Design Drawings and the material manufacturer's technical data sheet; and
 - iv) test cubes must be made, cured and tested in accordance with AS 1012.8.3 Methods of testing concrete, Method 8.3: Methods of making and curing concrete - Mortar and grout specimens.

7 High durability concrete

- a) This section 7 only applies where high durability concrete is used. Concrete in exposure classification B2, or more severe, must also satisfy the requirements for high durability concrete.
- b) Testing for high durability concrete must be in accordance with AS 1012.21 Methods of testing concrete, Method 21: Determination of water absorption and apparent volume of permeable voids in hardened concrete. The result of the test is a volume of permeable voids (VPV) value.
- c) The test acceptance of a concrete mix design must be carried out on test specimens taken from a concrete sample of age 28 days (or 56 days where 56-day concrete strength is specified), which has undergone standard moist curing in accordance with AS 1012 Methods of testing concrete. The sample must consist of 2 cylinders. The VPV value of each of the test cylinders must be not greater than the specified value in Table ST-SC-S7 7-2. Frequency of sampling and testing must be as for Table ST-SC-S7 7-1.

- d) The maximum VPV values at 28 days (or 56 days where 56-day concrete strength is specified), for each concrete grade for both test cylinders and concrete test cores cut from cast in situ and sprayed concrete, must be in accordance with Table ST-SC-S7 7-2.
- e) For the purpose of satisfying the requirements of this section 7, VPV test results must be rounded down to the nearest whole number for the corresponding concrete grade.

Table ST-SC-S7 7-1 High durability sampling frequency for VPV testing

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 and every 3 after
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

Table ST-SC-S7 7-2 Maximum VPV values

Concrete grade	Maximum VPV values at 28 days (%) or at 56 days where 56-day concrete strength is specified		
	Test cylinders (compacted by vibration)	Test cylinders (compacted by rodding)	Test cores
S32	14	15	17
S40	13	14	16
S50 in exposure classification C1	12	13	15
S55 in exposure classification C2	11	12	14
S65	10	11	13

8 Test procedures

The Contractor must use the test procedures in accordance with Table ST-SC-S7 8-1 and Table ST-SC-S7 8-2 to verify conformance with this Master Specification Part.

Table ST-SC-S7 8-1 Test procedures

Test	Test procedure
Determination of water absorption and apparent volume of permeable voids in hardened concrete	AS 1012.21 Methods of testing concrete, Method 21: Determination of water absorption and apparent volume of permeable voids in hardened concrete
Slump test	AS 1379 Specification and supply of concrete, related to the consistency of concrete — Slump flow, T500 and J-ring test
Compressive strength of concrete specimens	AS 1012.9 Methods of testing concrete, Method 9: Compressive strength tests — Concrete, mortar and grout specimens
Self-compacting concrete - Slump flow, T500 time (measure of viscosity) and passing ability	AS 1012.3.5 Methods of testing concrete, Method 3.5: Determination of properties related to the consistency of concrete — Slump flow, T500 and J-ring test

Table ST-SC-S7 8-2 Test procedures

Section reference	Subject	Property	Procedure	Frequency	Acceptance limits
3.4a)	Aggregate properties (project assessment only)	Particle shape	As specified in AS 2758.1 Aggregates and rock for engineering purposes, Part 1: Concrete aggregates	At least once for each aggregate type	As specified in AS 2758.1 Aggregates and rock for engineering purposes, Part 1: Concrete aggregates
		Water absorption	As specified in AS 2758.1 Aggregates and rock for engineering purposes, Part 1: Concrete aggregates	At least once for each aggregate type	<2.5%
4a)	Self-compacting concrete	Slump flow	AS 1012.3.5 Methods of testing concrete, Method 3.5: Determination of properties related to the consistency of concrete - Slump flow, T500 and J-ring test	Refer Table ST-SC-S7 6-1	550 - 750 mm spread. Aggregate must be evenly distributed throughout the concrete paste and must not exhibit signs of segregation
		T500 time (measure of viscosity)	AS 1012.3.5 Methods of testing concrete, Method 3.5: Determination of properties related to the consistency of concrete - Slump flow, T500 and J-ring test	Refer Table ST-SC-S7 6-1	A spread of 500 mm within 2 - 5 seconds. The final spread must not exceed 750 mm diameter
		Passing ability	AS 1012.3.5 Methods of testing concrete, Method 3.5: Determination of properties related to the consistency of concrete - Slump flow, T500 and J-ring test	Refer Table ST-SC-S7 6-1	≤10mm. The concrete must not exhibit signs of segregation
5 and 6 Concrete properties		Cement and water content	Determined from identification certificate (refer AS 1379 Specification and supply of concrete)	Each truck load	Table ST-SC-S7 5-1
		Slump	Refer AS 1379 Specification and supply of concrete	Each truck load	Refer AS 1379 Specification and supply of concrete
		Compressive strength - Production assessment	Refer AS 1379 Specification and supply of concrete	Refer AS 1379 Specification and supply of concrete	Refer AS 1379 Specification and supply of concrete
		7-day compressive strength - Project assessment	Refer AS 1379 Specification and supply of concrete	Refer Table ST-SC-S7 6-1 and section 6	Report only
		28-day compressive strength (or 56 days where 56-day concrete strength is specified) - Project assessment	Refer AS 1379 Specification and supply of concrete	Refer Table ST-SC-S7 6-1 and section 6	Refer AS 1379 Specification and supply of concrete
		Drying Shrinkage	Refer to AS 1379 Specification and Supply of Concrete	3 tests from proposed mix design	Measured drying shrinkage values are less than that specified in design documents
7	High durability concrete	VPV	AS 1012.21 Methods of testing concrete, Method 21: Determination of water absorption and apparent volume of permeable voids in hardened concrete	Refer Table ST-SC-S7 7-1	Refer Table ST-SC-S7 7-2

9 Hold Points

Table ST-SC-C7 9-1 details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.

Table ST-SC-C7 9-1 Hold Points

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
5.1e)	The use of a 56-day concrete strength requirement in lieu of 28-day strength	Documentation	5 Business Days review

10 Verification requirements and records

The Contractor must supply written verification as part of the Quality Management Records that the requirements listed in Table ST-SC-S7 10-1 been complied with.

Table ST-SC-S7 10-1 Verification records

Section reference	Subject	Record to be provided
3.3b)	Admixture addition on Site	Record of the admixture addition quantity
3.5a)	Water addition to concrete on Site	Record of the quantity of water added to concrete on Site
6.1c)	In-house testing of concrete properties	Evidence of satisfactory equipment and processes and trained personnel
6.2e)	Test certificates, material data sheets and health and safety data sheets for all mortar and grout materials	Identification certificates in accordance with AS 1379 Specification and supply of concrete
6	7-day compressive strength	If the result is <65% of the specified 28-day compressive strength (or 56 days compressive strength where 56-day concrete strength is specified), a Non-Conformance Report outlining the Contractor's proposed disposition is to be provided within 2 days of completion of the test
8	Test procedures	Evidence that the test procedures have been used to verify conformance with the requirements of this Master Specification Part