

Master Specification

Part ST-SC-C4

Sprayed Concrete Work

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ST-SC-C4 Sprayed Concrete Work

1 General

- a) This Master Specification Part specifies the requirements for the application of sprayed concrete, including:
 - i) the documentation requirements, as set out in section 2;
 - ii) the mix design and placement method requirements, as set out in section 3;
 - iii) the project assessment requirements, as set out in section 4;
 - iv) the application of sprayed concrete requirements, as set out in section 5; and
 - v) the Hold Point requirements, as set out in section 6.
- b) The application of sprayed concrete must comply with the Reference Documents, including:
 - i) AS 1012.14 Methods of testing concrete, Method 14: Method for securing and testing cores from hardened concrete for compressive strength and mass per unit volume;
 - ii) AS 3610 Formwork for concrete;
 - iii) AS 3799 Liquid membrane-forming curing compounds for concrete;
 - iv) CIA Z5 Shotcreting in Australia; and
 - v) Recommended Practice - Shotcreting in Australia, published by the Concrete Institute of Australia.
- c) Sprayed concrete must only be used where shown on the Design Drawings.

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:

- a) evidence of sustainability of proposed equipment;
- b) evidence of competence of personnel applying concrete, as required by section 5.2.1d); and
- c) the methods to establish and control the thickness, surface planes and finish line of the sprayed concrete, including frequency of monitoring, as required in section 5.2.6a).

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:

- a) evidence of the strength gain characteristics, and evidence that the sprayed concrete mix will reach the required characteristic compressive strength required by section 3g); and
- b) the results of all testing required by section 4e).

3 Mix design and placement method

- a) Concrete must comply with ST-SC-S7 “Supply of Concrete”.
- b) To verify the mix design and placement method, the Contractor must spray 2 test panels of dimensions 1000x1000x250 mm and provide reinforcing over half of the area of the test

panels. The test panels must be sprayed in the same position, with the same equipment, placing crew, concrete mix and reinforcement as proposed for the permanent Works. The test panels must be cured in the same manner as proposed for the permanent Works.

- c) In accordance with AS 1012.14 Methods of testing concrete, Method 14: Method for securing and testing cores from hardened concrete for compressive strength and mass per unit volume, the Contractor must secure:
 - i) 12 cores from the unreinforced section of the test panels required in section 3a), including 2 cores from each test panel at ages of 3, 7 and 28 days, where:
 - A. cores for testing at 3 and 7 days must be tested as soon as practical after extraction in the 'as received' moisture condition, and otherwise complying with AS 1012.14 Methods of testing concrete, Method 14: Method for securing and testing cores from hardened concrete for compressive strength and mass per unit volume;
 - B. cores taken at age 28 days must be dry conditioned and tested for compressive strength to AS 1012.14 Methods of testing concrete, Method 14: Method for securing and testing cores from hardened concrete for compressive strength and mass per unit volume; and
 - C. the test results from the cores taken at age 28 days, required in section 3c)i)B, must exceed the specified compressive strength; and
 - ii) a further 4 cores (2 from each test panel required in section 3b)) from the reinforced section of the panels at age 7 days for assessment of the placement of the concrete adjacent to the reinforcement, and hence qualification of placing equipment and operators.
- d) All cores must be nominally 100 mm diameter and must maintain a 2:1 (length:diameter) ratio. The reinforced cores must be retained by the Contractor until the later of Handover and Completion, and must be made available to Principal upon request.
- e) The Contractor must submit evidence of the concrete strength characteristics and test results required by section 3c), which will constitute a **Hold Point**. The proposed placing equipment, methodology and operators must not be used for the application of sprayed concrete until the Hold Point has been released.
- f) Failure of the 28-day test cores to achieve an average compressive strength greater than the required compressive strength, as per section 3c)i)C, will require modification to the placement processes or the mix design, and new test panels cast to verify placement and mix performance.
- g) The Contractor must provide evidence of the strength gain characteristics, and evidence that the sprayed concrete mix will reach the required characteristic compressive strength as part of the Quality Management Records.

4 Project assessment

- a) As the Works progress, the Contractor must spray unreinforced production test panels of dimensions 500x500x250 mm. The test panels must be sprayed in the same position as the permanent Works, using the same operators and must be produced at the rate of one test panel per 10 m³ of concrete, or 2 test panels per day, whichever is greater. Test panels must be cured by the same method as the permanent Works and stored on Site.
- b) 3 cores must be taken from each test panel, required in section 4a), at an age of 28 days, in accordance with AS 1012.14 Methods of testing concrete, Method 14: Method for securing and testing cores from hardened concrete for compressive strength and mass per unit volume, for testing for compressive strength.
- c) Cores required in section 4b) must be nominally 100 mm diameter and must maintain a 2:1 (length:diameter) ratio. Cores must be dry conditioned and the average compressive strengths of cores must be used for acceptance of the concrete in the Works. The cores taken from each panel must be considered as one sample.

- d) Slump testing and drying shrinkage testing must be undertaken in accordance with the project assessment requirements of ST-SC-S7 "Supply of Concrete".
- e) All results from the testing of the cores must be provided as part of the Quality Management Records.

5 Application of sprayed concrete

5.1 General

- a) Following placement of reinforcement and surface preparation and prior to spraying of concrete a **Hold Point** will apply. The spraying of concrete must not commence until this Hold Point has been released.
- b) The delivery equipment and placement procedures must comply with the requirements of the document "Recommended Practice - Shotcreting in Australia" published by the Concrete Institute of Australia.
- c) Where sprayed concrete Works are approved using fibre reinforcement only, reinforcement crossing construction joints must be used.

5.2 Placement of sprayed concrete

5.2.1 Equipment and techniques

- a) The equipment used for the placement of sprayed concrete must be capable of delivering materials to the nozzle at a uniform rate at a velocity of discharge which will produce a dense coating with maximum adherence of material, minimum rebound and with no sloughing or sagging.
- b) Equipment provided must allow the nozzle, at all times, to be maintained at a distance of 1 m normal to the surface on which sprayed concrete is to be applied.
- c) Spraying must be discontinued, or sufficient screening of the nozzle stream must be provided, if wind or air current causes separation of the nozzle stream during placement.
- d) Only personnel, who have successfully demonstrated their competency, by the production of test sections of sprayed concrete in both horizontal and vertical positions, may perform the sprayed concrete work.

5.2.2 Bonding to existing surface

Absorptive substrate surfaces must be dampened prior to placement of the sprayed concrete to facilitate bond and to reduce possibility of shrinkage cracking development from premature loss of the mixture water. The surface must be sufficiently cohesive to prevent erosion when sprayed concrete is applied.

5.2.3 Initial process

All corners and any area where rebound cannot escape or be blown free must be filled with sound material.

5.2.4 Air supply

Air supplied must be clean, dry and oil free. Air must be supplied in sufficient volumes and at pressures adequate for maintaining sufficient nozzle velocity to all parts of the Works, and if required, for simultaneous operation of a suitable blow pipe for cleaning away rebound material.

5.2.5 Placement around reinforcement

The nozzle must be held at such a distance and angle to place material behind the reinforcement before any material is allowed to accumulate on its face. Sprayed concrete must not be placed through more than one layer of reinforcing steel or mesh in one application, unless double layers of

reinforcement are part of the Works and suitable test panels have been produced in accordance with this Master Specification Part to verify concrete placement and mix performance.

5.2.6 Tolerances

- a) The methods to establish and control the thickness, surface planes and finish line of the sprayed concrete must be included as part of the Construction Documentation. This documentation must include a frequency of monitoring.
- b) The tolerances listed in this section 5.2.6 will be a basis for acceptance of the sprayed concrete works.
- c) Tolerances for sprayed applied structural concrete, which is used instead of conventionally placed structural concrete, must satisfy the requirements of ST-SC-C7 "Placement of Concrete".
- d) Where sprayed concrete is to be placed to a specified shape it must be within ± 25 mm of that shape and contain no depression > 5 mm below a 2 m straight edge.
- e) For sprayed concrete on natural surfaces or surfaces with undefined shape the thickness must be within -0 mm $+15$ mm of the nominal thickness.
- f) For sprayed concrete between piles the surface deviation must not exceed $L/200$, where "L" is the clear distance between the pile faces.
- g) Cover to the steel reinforcement must comply with the requirements of the Design Drawings. Unless otherwise noted on the Design Drawings the tolerances on cover to reinforcement must be as follows:
 - i) unformed surface: 0 to $+10$ mm;
 - ii) formed surface: 0 to $+10$ mm; and
 - iii) cast against ground: -10 to $+20$ mm.

5.2.7 Precautions

Sprayed concrete must not be placed if drying or stiffening of the mix takes place at any time prior to delivery to the nozzle. Rebound or previously expended material must not be used in the sprayed concrete mix. Before placement of sprayed concrete onto adjacent surfaces, all overspray or rebound must be removed. Any overspray or rebound on finished surfaces must be immediately removed before initial set has occurred.

5.3 Finishing

- a) Where the sprayed concrete surface is to be covered by other suspended surface treatments an off-nozzle finish is permitted.
- b) In all other applications other than those covered by section 5.3a) (e.g. where better alignment, appearance and smoothness are required), the sprayed concrete must be placed between guides to allow screeding. The tolerance on the finished surface must be as specified for a Class 3 finish in accordance with AS 3610-1995 Formwork for concrete. Following screeding, floating to the finish specified on the Design Drawings must be carried out.
- c) The finishing of the sprayed concrete must be:
 - i) for permanent Works: steel float; and
 - ii) for Temporary Works structures: wood float.

5.4 Joints

The Contractor must comply with the recommended practice for end-of-day, construction and expansion joints as set out in CIA Z5 Shotcreting in Australia. The unformed joint (Figure 9.12(a) of CIA Z5 Shotcreting in Australia) is not recommended and the screed joint (Figure 9.12(b) of CIA Z5

Shotcreting in Australia) or full depth construction or expansion joints must be used to terminate any section of spraying.

5.5 Curing

- a) Any curing compound used must comply with AS 3799 Liquid membrane-forming curing compounds for concrete.
- b) Surfaces which are to be bonded to further concrete must be cured by means which will preserve the bonding properties at the interface, unless grit blasting or scabbling is employed prior to concreting.

6 Hold Points

Table ST-SC-C4 6-1 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-C4 6-1 Hold Points

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
3e)	Evidence of concrete strength and test results	Documentation	5 Business Days review
5.1a)	Prior to spraying concrete	Construction quality	6 hours notification