SECTION 684 ‑ SPRAYED CONCRETE‑

##This section cross-references Sections 175, 204, 610, 611 and 689.

If any of the above sections are relevant, they should be included in the specification.

If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent:

684.01 GENERAL

This section specifies the supply of materials, construction and testing of sprayed concrete, for both the wet and dry processes of application.

Wet process sprayed concrete using pre-mixed concrete may be used for structural applications such as retaining walls, soil nail walls, tunnel linings, supporting in situ excavated material, surface improvement and short-term support. Wet process sprayed concrete construction using pre-mixed concrete shall comply with the requirements of Section 610.

Both the wet and dry processes of application may be used for concrete repair works and for the construction of overlays for cathodic protection (CP) of concrete structures, using proprietary spray applied cementitious mortars. Concrete repair works using proprietary spray applied cementitious mortars shall comply with the requirements of Section 689.

684.02 STANDARDS

Australian Standards are referenced in an abbreviated form (e.g. AS 1012).

(a) Australian Standards

AS 1012 Methods of testing concrete

AS 1478.1 Chemical admixtures for concrete, mortar and grout – Admixtures for grout

AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

(b) Other Standards

ASTM A820 Standard specification for seel fibres for fibre reinforced concrete

(c) VicRoads Test Methods

RC 377.01 Determination of the Fibre Content of Fresh Concrete (Wash-out Method)

684.03 DEFINITIONS

**Sprayed concrete:** mortar or concrete pneumatically projected from a nozzle (sprayed) at high velocity onto a receiving surface where the sprayed material undergoes simultaneous placement and compaction to produce a dense homogeneous mass. As with conventional concrete the properties of sprayed concrete can be modified and further enhanced through the addition of additives or admixtures, such as silica fume, air-entraining admixtures, fibers and accelerators.

**Wet process application (i.e. shotcrete):** the technique where the pre-mixed concrete or cementitious mortar is pumped down a hose to the exit nozzle, where compressed air is introduced via a separate hose to continuously propel the mix onto the prepared substrate. Any conventional concrete mix which is designed as a pump mix can generally be placed with the wet process.

**Dry process application (i.e. gunite):** the technique where a dry mixture of cement, additives and aggregates or bagged pre-mixed proprietary formulated mortar is conveyed to a nozzle, where mixing with pressurised water occurs to produce the suitable consistency for the concrete to stick to the sprayed surface without slumping or rebounding excessively.

**Rebound:** part of the sprayed concrete which having struck the receiving surface does not adhere and deposits onto the ground or adjacent surfaces as wastage.

**Overspray:** material outside the intended receiving surface.

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**Sloughing/sagging:** subsidence of the freshly applied sprayed concrete from its initial point of projection on the receiving surface.

**Layer:** the thickness of sprayed concrete built up from a number of passes of the nozzle over the working area.

**Nozzle:** the equipment consisting of a pipe with a mixing unit into which the various constituents are introduced and fitted at the end of the delivery hose from which the sprayed concrete is projected onto the receiving surface.

**Nozzle operator:** the person controlling the nozzle and the application of the sprayed concrete.

**Aspect ratio:** the length of a fibre divided by its diameter.

**Concrete cover:** distance between the outside of the reinforcing steel and the nearest permanent surface of the sprayed concrete, or between the outside of the reinforcement and the nearest point on the receiving surface.

684.04 MATERIALS

(a) Wet Process Spray Applied Pre-mixed Concrete (wet-mixed shotcrete) - for structural application

 Materials, concrete mix design and tests for spray applied pre-mixed concrete shall comply with the requirements of Section 610.

(b) Wet and Dry Process Spray Applied Cementitious Mortars - for patch repair and CP overlay

 Proprietary spray applied cementitious mortars shall comply with the requirements of Section 689.

(c) Reinforcement

 Steel reinforcement shall comply with the requirements of Section 611.

 Steel reinforcement and tie wire placed in sprayed applied concrete retaining walls, soil nail walls, tunnel linings, supporting in situ excavated material and surface improvement shall be hot-dip galvanised in accordance with the requirements of AS/NZS 4680.

 Contact between galvanised steel reinforcement and black steel shall not be allowed.

(d) Fibres

 Where steel or other fibres are nominated to be incorporated in the sprayed concrete, the Contractor shall submit details of the quality and source of fibre for review by the Superintendent at least four weeks prior to the commencement of work. Fibres shall be supplied from one manufacturer and be of the same brand and type.

 Fibres shall be added to the concrete in such a manner to ensure that they are uniformly distributed, balling does not occur, and the concrete mix remains workable, pumpable and sprayable.

 (i) Steel Fibres

 Steel fibres shall comply with the requirements of ASTM A820 for Type I, cold drawn wire, or Type II, cut sheet.

 All fibres shall be deformed and have a minimum tensile strength of 800 MPa and an aspect ratio between 40 and 70.

 Fibres shall be stored in dry sealed containers until ready for use and shall be free from corrosion, oil, grease, chlorides and harmful materials which may reduce the efficiency of mixing or spray process, or which may reduce the bond between the fibres and the sprayed concrete.

 Loose steel fibres shall be added through a 100 mm sieve onto a conveyor belt during the aggregate addition or to the mixer prior to the addition of aggregate, and mixed in the usual manner.

 Glued steel fibres shall not be added through a sieve.

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 (ii) Synthetic Fibres

 Synthetic fibres shall be in accordance with an acceptable national or international standard.

 Synthetic fibres in the form of fine micro polypropylene monofilament fibres shall be used in the sprayed concrete mix where mitigation of the effects of explosive spalling of sprayed concrete is required for fire protection.

(e) Admixtures

 Chemical admixtures shall comply with the requirements of AS 1478.1.

 The Contractor shall submit a detailed procedure for the addition and mixing of admixtures into both wet-mixed and dry-mixed sprayed concrete.

 Accelerators and other admixtures that are added to concrete at the nozzle or at the delivery hose shall be dispensed by calibrated mechanical means at dosage rates not exceeding the maximum recommended by the manufacturer. All chemical admixtures added to wet process pre-mixed concrete at the nozzle or at the delivery hose shall be included as part of the concrete mix design reviewed in accordance with the requirements of Section 610.

 Hydration control admixtures that suspend the hydration of sprayed concrete until the addition of the activator shall not cause a decrease in concrete strength with age.

(f) Water

 Water shall comply with the requirements of clause 610.09.

684.05 ADDITIONAL CONCRETE MIX DESIGN AND OPERATIONAL DETAILS

(a) Fibre Content

 The fibre content of fresh concrete shall be determined in accordance with the VicRoads fibre wash-out test method RC 377.01 as described in the VicRoads Code of Practice RC 500.16.

 (i) Steel Fibre Content

 The steel fibre dosage incorporated in the concrete mix design shall comply with the nominal values stated in Table 684.051.

 Steel fibre content determined from fresh concrete taken from the mixer shall comply with the amount of steel fibre stated in the sprayed concrete mix design and the allowed variation as stated in clause 684.08(c).

**Table 684.051 Nominal Steel Fibre Dosage**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Aspect Ratio** | 40 | 45 | 50 | 55 | 60 | 65 | 70 |
| **Nominal Dosage (kg/m3)** | 65 | 50 | 40 | 35 | 30 | 25 | 25 |

 (ii) Synthetic Fibre Content

 Synthetic fibre content determined from fresh concrete taken from the mixer shall comply with the synthetic fibre dosage stated in the sprayed concrete mix design and the allowed variation as stated in clause 684.08(c).

(b) Drying Shrinkage

 Further to clause 610.07(j), drying shrinkage of the concrete specimens made from the trial concrete mix after 8 weeks drying period, or in the interim after 3 weeks, shall comply with the requirements of Table 684.052. Where no exposure classification is stated, requirements for exposure classification B1 shall apply.

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**Table 684.052 Maximum Shrinkage Strain of the Nominated Trial Concrete Mix Design**

|  |  |
| --- | --- |
| **Exposure Classification** | **Maximum shrinkage strain, microstrain****Drying period** |
| **3 Weeks** | **8 Weeks** |
| A | 680 | 900 |
| B1, B2 | 560 | 800 |
| C1, C2 | 550 | 750 |

(c) Maximum Time for the Application of Sprayed Concrete

 Further to the requirements of clause 610.13(f) for completion of concrete discharge, where a hydration control admixture is added to the concrete mix to achieve the required time for the application of the sprayed concrete, the approved application time shall not be exceeded.

684.06 COMPETENCY OF PERSONNEL INVOLVED IN SPRAYED CONCRETE

Personnel undertaking the sprayed concrete works including the nozzle operator, supervisor and finisher, shall have a minimum of 5 years experience in sprayed concrete application and a demonstrated competency for substrate preparation, sprayed concrete placement techniques and inspection, sprayed concrete material quality, equipment operation, encapsulation of steel reinforcement, finishing and curing.

The nozzle operator shall have a demonstrated competence and ability to produce sprayed concrete complying with the specification and have prequalification to the sprayed concrete procedure requirements as stated in clause 684.07

The sprayed concrete supervisor shall be trained and qualified on all aspects of sprayed concrete application techniques and shall be present at each stage of the works. Installation personnel shall be trained and skilled in the application procedures to be used.

Documented evidence shall be available to demonstrate experience, qualification, skills and training of personnel.

684.07 PREQUALIFICATION OF SPRAYING PROCEDURE

(a) General

**HP The Contractor shall submit details of the proposed sprayed concrete operations, including the proposed type of sprayed concrete, mix design, substrate preparations, method of application, equipment and nozzle operators for review by the Superintendent not less than 4 weeks prior to commencement of the sprayed concrete Works.**

 The Contractor shall produce evidence of the nozzle operators previous experience in the application of sprayed concrete. The nozzle operators shall have demonstrated their competence and ability to produce sprayed concrete complying with the specification.

(b) Preparation of Test Panels

 Two test panels 750 mm x 750 mm and the greater of the specified thickness or 150 mm shall be constructed by the Contractor for each nominated nozzle operator prior to commencing full scale Works, for the purpose of checking the suitability of the proposed mix design, materials, plant and equipment, the method of working and the competence of the operator intended for the Works.

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 The test panels shall be representative of the spraying operation(s) to be adopted, the in situ material(s), the location and the actual orientation (i.e. vertical, overhead etc.) of the sprayed concrete member at the Works.

 Spraying of concrete into the test panels when placed horizontally on the ground shall not be allowed.

 Additional panels will be required if the Contractor should change the mix design, plant and equipment or operator. The test panels shall be stored and cured under similar conditions to the sprayed concrete placed in the Works and in accordance with the requirements of this specification.

 Where reinforcement in the form of steel fabric, steel reinforcement or titanium anode mesh for CP is to be used in the permanent Works, the same reinforcement detailing and number of layers or titanium anode mesh shall be provided in the test panel.

(c) Sampling and Testing of Panels

 The Contractor shall cut a sample of 8 cores from each test panel, at right angles to the plane of the panel approximately 48 hours after the panel has been sprayed. Cores shall not be taken within 125 mm of the edges of the panel.

 The Contractor shall ensure that 2 of the cores per sample are cut from concrete adjacent to steel reinforcement for the purpose of visual assessment of the quality of the sprayed concrete adjacent to steel reinforcement.

 For compressive strength testing, one core per sample shall be tested at 3 days, one at 7 days and two at 28 days after application of the sprayed concrete. The required compressive strength for each set of two 28 day cores shall comply with the requirements of clause 684.08(e)(ii). The 3 day and 7 day tests shall be used to confirm strength development over time.

 Two cores per sample shall be tested for VPV values at 28 days in accordance with the requirements of Section 610. VPV test results shall comply with the acceptance criteria as set out in Table 610.061 for test cores.

(d) Prequalification

 Where it is shown that the same materials, mix designs, equipment, procedures and personnel have given satisfactory results in similar works, the Superintendent may accept the construction of test panels concurrently with the first sprayed concrete placed in the Works.

**HP Sprayed concrete shall not be placed in the permanent Works until:**

 **(i) the Superintendent has reviewed all prequalification procedures, work method statement(s) (WMSs), inspection and test plan(s) (ITPs), the results of testing, and visual inspection of both the cores sampled and the test panels in accordance with the requirements of clause 684.08. Concrete shall not be sprayed until the mix design has been reviewed by the Superintendent.**

 **(ii) the Contractor submits documented evidence of conducting quality tool box meetings of all concrete construction personnel on all aspects of the prequalification procedure, WMS, the ITPs, quality control checklist(s) and all specification requirements.**

**HP The prequalified sprayed concrete procedure shall be adhered to throughout the permanent sprayed concrete Works. Permanent sprayed concrete works shall only be carried out by the same nozzle operator who performed the prequalified procedure and produced the conforming test panels.**

**HP The prequalified nozzle operator and prequalified sprayed concrete procedure may only be changed after further prequalification and with the approval of the Superintendent.**

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684.08 TESTING AND ACCEPTANCE OF SPRAYED CONCRETE

(a) Sampling and Testing of Pre-Mixed Concrete

 The concrete supplied for the Works shall be sampled at the worksite and tested for compliance with Section 610. In addition, sampling and testing to determine fibre content shall be as stated in clause 684.08(c).

(b) Sampling - General

 Sprayed concrete from the test panels and the finished Works shall be sampled and tested by taking 75 mm diameter cores to confirm compliance with the required compressive strength, 28 day volume of permeable voids (VPV) values, thickness and visual verification of quality. Cores shall not contain reinforcing bars.

 The cores shall be cored through the whole thickness of the sprayed concrete and visually inspected to verify that the sprayed concrete is dense and homogeneous without segregation of aggregate and/or fibre or other visible imperfections as described in clause 684.15.

 Should any of the cores reveal defects such as lack of compaction, dry patches, voids or sand pockets, the Superintendent may require further tests or cores from the sprayed concrete.

 Core holes in finished Works shall be cleaned and repaired with a single component, shrinkage compensating proprietary cementitious material in accordance with Section 689. The exposed surface of the repaired hole shall be identical in texture and colour to the surrounding finished work concrete.

 The cores shall be secured, stored, cured and tested in accordance with AS 1012. All cores shall be clearly labelled to identify them with the location they represent. The strength and VPV requirements shall be in accordance with Section 610 and as detailed on the drawings.

 Where the length of core from finished Works is less than 150 mm, core strengths shall be corrected in accordance with the correction factors given in AS 1012.14.

 Coring from the Works shall not be undertaken unless steel reinforcement has been located either by prior knowledge of its exact location or by use of a calibrated cover meter supplemented by reference to the drawings. The location of the steel shall be clearly marked upon the surface of the concrete to ensure the accuracy of the coring activity.

 For concrete repair and CP overlay Works completed with proprietary spray applied cementitious mortars, compliance with the required compressive strength and 28 day VPV values shall be confirmed by the sampling and testing of cores from production test panels as specified in clause 684.07(c). Sampling and testing of cores for compressive strength and 28 day VPV values from the finished concrete repair and CP overlay works is not required.

(c) Sampling and Testing for Fibre Content

 Further to the requirements of clause 610.16(a) for sampling and testing of concrete, the fibre content shall be determined in accordance with the VicRoads fibre wash-out test method RC 377.01 and assessed for compliance in accordance with clause 684.05 by sampling at a frequency of one test per five batch loads of concrete. The concrete represented by the sample shall be deemed to comply if the fibre content as determined is within 1% of the fibre content in the approved mix design.

 **The worksheet and/or report for determination of fibre content shall be submitted for review by the Superintendent.**

(d) Sampling Frequency of Completed Structural Work

 The Contractor shall sample each day’s production, from production lots established to meet the requirements of Table 684.081. Each production lot shall consist of 6 cores, taken at locations which shall be representative of the work completed in a day's spraying operation. The actual core sites shall be selected in accordance with VicRoads Test Method RC 316.10, except that areas within 200 mm of the edges of construction and within one (1) metre of a lateral construction joint shall be excluded from the lot.

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 The minimum number of samples shall be in accordance with Table 684.081.

 **Table 684.081**

|  |  |
| --- | --- |
| **Volume of Sprayed Concrete per Day (m3)** | **Minimum Number of Production Test Lots of Six Cores** |
| 0 to 25 | 1 |
| 25 to 50 | 2 |
| For each additional 50 m3 of sprayed concrete constructed | One additional sample of six cores shall be taken |

 Each sample of cores shall be tested as follows:

 (i) Visual Inspection

 For each core the following shall be reported -

 • the height (layer thickness) of the core

 • the visual appearance and presence of defects such as lack of compaction, dry patches, voids or sand pockets.

 (ii) Compressive Strength - Test and Report

 • 1 core at 3 days

 • 1 core at 7 days

 • 2 cores at 28 days.

 The 3 day and 7 day tests shall be used to confirm strength development over time.

 Where soil nails are to be inserted through the sprayed concrete, the allocated core for the 3 day test shall be tested for compressive strength and the results assessed for compliance with the requirements prior to drilling proceeding.

 (iii) 28 Day Volume of Permeable Voids (VPV) Values

 • 2 cores at 28 days.

(e) Acceptance of Testing

 The work shall be assessed for compliance with the requirements for testing as follows:

 (i) Visual Inspection

 The average layer thickness shall not be less than that specified, and no individual layer thickness measurement shall be less than 0.85 times the minimum requirement.

 Areas where the visual appearance and presence of defects on core surfaces is unacceptable shall be inspected and assessed in detail to define portions requiring repair.

 (ii) Compressive Strength

 The required compressive strength for each set of two 28 day cores shall be satisfied if:

 (1) each core has a compressive strength equal to or greater than 0.85 times that specified; or

 (2) the average compressive strength is equal to or greater than 0.85 times that specified and the difference between the strength of individual cores is less than 20% of the average.

 (iii) 28 Day Volume of Permeable Voids (VPV) Values

 Test acceptance shall be in accordance with Section 610.

 Where layer thickness, visual appearance and compressive strength test results do not comply with the acceptance criteria, or where VPV test results do not comply with Table 610.061, the Contractor shall carry out rectification works. These Works shall achieve the specified level of durability, otherwise the sprayed concrete represented by that sample shall be removed and replaced.

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(f) Concrete Repair and CP Overlay Works Completed with Proprietary Spray Applied Cementitious Mortars

 (i) Production Test Panels

 During each day’s application of sprayed concrete, the Contractor shall construct samples comprising of one production test panel representative of the work completed in accordance with the requirements of clause 684.07(b) and (c). The minimum number of samples of production test panels shall be in accordance with Table 684.081.

 The production test panels shall be rigidly fixed alongside the position of application of sprayed concrete to the Works.

 The production test panels shall be stored and cured under similar conditions to the sprayed concrete placed in the Works and in accordance with the specification.

 Each production test panel shall be sampled for testing to the requirements of clause 684.07(c).

 Where test results for 28 day compressive strength or VPV test results for production test panels do not comply with the requirements of clause 684.08(e), the Contractor shall carry out rectification works. These works shall achieve the specified level of durability, otherwise the sprayed concrete represented by that sample shall be removed and replaced.

 (ii) Quality Control Testing

 Concrete repair works completed with proprietary spray applied cementitious mortar shall comply with the quality control testing requirements of clause 689.12(b), (c) and (d).

 CP overlay works completed with proprietary spray applied cementitious mortar shall comply with the visual inspection and soundness testing requirements of clause 684.08 and clause 684.15.

684.09 SUBSTRATE PREPARATION

(a) Surface of In Situ Material

 Excavation to the required line and grade shall be carried out in accordance with Section 204.

 The integrity of the surface of the in situ or excavated in situ material shall be maintained free of excessive wetting or drying prior to the application of the sprayed concrete.

 Action shall be taken to control groundwater by the installation of drains to prevent contact with the newly sprayed concrete surface or the development of hydrostatic pressures behind the sprayed concrete, effective for the design life.

 Loose and unsound material which may affect adhesion of the sprayed concrete to the in situ surface shall be removed and the surface shall be cleaned before applying sprayed concrete.  The surface shall be damp but without free water and prepared so that no abrupt changes in the thickness of the sprayed concrete occur.

(b) Concrete Surfaces

 Loose and unsound material shall be removed from the existing concrete surface. The concrete surface shall be thoroughly cleaned down to remove any traces of dirt, grease, oil, remnants of curing compounds and organic contaminants (i.e. moss, algae, etc.), or other substances that could interfere with the bond of the newly placed sprayed concrete. Where sprayed concrete is to be placed against a smooth concrete surface, the surface shall be roughened as a minimum to an exposed aggregate finish by suitable means in accordance with Section 610. The concrete substrate shall be adequately pre-wetted prior to the application of the sprayed concrete. The surface shall be prepared such that no abrupt changes in thickness of the sprayed concrete occur.

 For concrete repair and CP overlay works completed with proprietary spray applied cementitious mortars the concrete substrate shall be prepared in accordance with the requirements of Section 689.

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(c) Steelwork and Reinforcement

 Steelwork and reinforcement bars shall be free of loose or thick rust, oil, grease paint mud or any other harmful coating over the metal prior to the application of sprayed concrete.

 Reinforcement shall be firmly fixed to provide the cover, clearances and laps described in the drawings or as specified in Section 611.

684.10 APPLICATION OF SPRAYED CONCRETE

(a) Equipment

 The equipment used shall have adequate capacity and be capable of delivering the concrete constituents to the nozzle at a uniform rate such that the sprayed concrete leaves the nozzle in a continuous uninterrupted stream and at a velocity of discharge which will maximise compaction, minimise rebound and overspray and prevent sagging of the applied concrete.

 Equipment shall be capable of allowing the nozzle to be maintained perpendicular and at a distance of less than 1 m from the receiving surface, and except where necessary at the required angle which will produce a dense in situ concrete with maximum adherence of material onto the prepared substrate. Delivery hoses shall have an internal diameter for unimpeded flow of material without blockages, balling of fibre or segregation of aggregate and/or fibre.

 Chemical admixture dispensing equipment and meters shall be subject to regular maintenance and calibrated at three monthly intervals.

(b) Application

**HP The Contractor shall provide at least 2 days prior notice of each intention to place sprayed concrete.**

**HP Sprayed concrete shall not be placed until the evidence that the substrate preparation, reinforcement, and embedments has been reviewed by the Superintendent.**

 Sprayed concrete shall be applied as soon as is practical following the preparation of the substrate as specified in clause 684.09.

 The finished sprayed concrete shall be dense and homogeneous for its full thickness, without segregation of aggregate or fibres, and without collapsing, excessive rebound or other visible imperfections.

 Each layer of the sprayed concrete shall be built up by making several passes over the working area. During starting and stopping of the spraying operation or whenever flow becomes intermittent or irregular for any cause the nozzle operator shall direct the nozzle away from the work until it again becomes constant.

 Where a layer of sprayed concrete is to be covered by succeeding layers, it shall be allowed to set prior to application of the succeeding layer. The surface shall be checked for soundness, segregated, loose or otherwise uncompacted sprayed concrete removed, repaired as specified, cleaned, and wetted using a blast of air and water.

 For vertical and near vertical surfaces application shall commence at the bottom. For overhead surfaces sprayed concrete shall be applied from the shoulder to the crown.

 Layer thickness shall be limited to a maximum of 150 mm to ensure that the material does not sag or delaminate.

 The spray nozzle shall be held at such a distance and angle to ensure placement of concrete behind and around steel reinforcement before any concrete is allowed to accumulate on its front face. Sprayed concrete shall not be placed through more than one layer of steel fabric, reinforcing bars or titanium anode mesh in one application.

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 Any areas where rebound cannot escape or be blown free shall be filled with sound concrete. All overspray or rebound shall be removed, prior to the placement of sprayed concrete onto adjacent surfaces.

 Where the spraying process is adversely affected by wind or other adverse effects during application, spraying shall be discontinued unless special precautions can be implemented to ensure compliance with the requirements of this section.

 Curing compounds shall not be used when a further layer of sprayed concrete or other bonded finish is to be applied.

 Sprayed concrete shall only be applied in accordance with the requirements of Section 610 with respect to Temperature, Evaporation Limits and Concreting Operations.

684.11 FINISHING

The surface finish of sprayed applied structural concrete retaining walls, soil nail walls, tunnel linings, CP Overlay and other structural components forming part of permanent Works shall be steel floated and satisfy the requirements of Section 610 for Class 2 surface finish. The surface finish of concrete repair works completed with proprietary spray applied cementitious mortar shall be in accordance with Section 689.

Unless otherwise shown on the drawings other sprayed concrete surfaces shall be left as sprayed. All surface finishes shall be uniform in texture and colour and free from any blowholes or surface imperfections as defined in clause 689.04.

All freshly sprayed concrete shall be protected in accordance with the requirements of clause 610.17 which relate to Temperature, Evaporative Limits and Concreting Operations against harmful effects of weather including sun, wind, freezing or rapid drying, rapid temperature changes, rain or water until curing is implemented.

Any sprayed concrete, which is exposed to dripping water within the period from application to curing, shall be nonconforming.

684.12 CURING

Curing of sprayed concrete shall be in accordance with the requirements of Section 610.

**HP The Contractor shall submit details of the proposed method of curing the sprayed concrete to the Superintendent for review at least 4 weeks prior to commencement of the sprayed concrete Works. The Contractor shall not proceed with the spraying of concrete until the curing method(s) has been reviewed and approved by the Superintendent.**

684.13 TOLERANCES ON SURFACE OF SPRAYED CONCRETE

The tolerances listed below will be a basis for acceptance of the sprayed concrete Works.

Tolerances for sprayed applied structural concrete, which is used instead of conventionally placed structural concrete, shall satisfy the requirements of clause 610.46 and Table 610.462.

Tolerances for concrete repairs and CP overlay completed with proprietary spray applied cementitious mortars shall comply with the requirements of Section 689.

Where sprayed concrete is to be placed to a specified shape it shall be within ± 25 mm of that shape and contain no depression greater than 15 mm below a 2 metre straight edge. For sprayed concrete on natural surfaces or surfaces with undefined shape the thickness shall be within ‑ 0 mm + 15 mm of the nominal thickness.

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The Contractor shall utilise probes during application of sprayed concrete to enable the monitoring of the required thickness.

**The Contractor may propose alternative methods for the monitoring of sprayed concrete thickness during application, for the approval of the Superintendent.**

Cover to the steel reinforcement shall comply with the requirements of the drawings.

684.14 JOINTS

The positions and types of joints shall be as shown on the drawings.

All joints shall be formed square to the face of the panel.

684.15 INSPECTION AND SOUNDNESS OF FINISHED SPRAYED CONCRETE

The Contractor shall undertake a visual inspection and a soundness inspection of the finished sprayed concrete Works at the age of at least 28 days. Visual inspection shall be for defects such as lack of compaction, dry patches, voids or sand pockets. Soundness inspection shall be by tapping with a small (0.8 kg) hand-held hammer to locate ‘drummy’ or ‘hollow’ response areas that might indicate a possible lack of bond, delamination or other defect. The Contractor shall remove and rectify such defects in accordance with the requirements of Section 689.

684.16 REPAIR OF DEFECTIVE AREAS

Areas of the finished work that exhibit a lack of compaction or bonding, dry patches, voids and sand pockets, or have slumped or sagged, shall be removed and repaired with a single component, shrinkage compensating proprietary cementitious material in accordance with the requirements of Section 689 to achieve the specified level of durability. The exposed surface of the repaired defective area shall be similar in texture and colour to the surrounding sprayed concrete.

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