Development manual planning scheme policy (PSP)

SC6.4.18 Concrete works

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SC6.4.18.1 Introduction

(1) Scope

(a) This section provides details for the supply and placement of concrete, including sprayed concrete,and ancillary requirements including excavation, preparation of foundations, forming up, placement of reinforcement and backfilling for work shown on the drawings. These works include kerb and channel, New Jersey type safety barriers, drainage pits and other supplementary structures, headwalls and wingwalls, box culverts, box culvert base slabs, driveways, footpaths, median toppings, retaining walls, footings, paving edge strips and works of a similar nature.

(b) The work also includes supply and placement of miscellaneous minor concrete work for water and sewerage construction such as valve chambers, thrust and anchor blocks, bulkheads, pumping stations, bedding, encasement and cast-in-situ access chambers.

(c) Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in Section SC6.4.23 Construction management, quality management, inspection and testing.

(2) Reference and source documents

Reference and source documents that must be read in conjunction with this section are as follow:

Editor's note - Documents referenced in this section are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

(a) SC6.4 Development manual planning scheme policy sections:

Section SC6.4.6 Road works, and traffic control
Section SC6.4.7 Clearing, grubbing, and earthworks
Section SC6.4.9 Stormwater quantity
Section SC6.4.17 Structures
Section SC6.4.23 Construction management, quality management, inspection and testing

(b) Australian Standards:

AS1012	Methods of testing concrete - Method 1*: Sampling of fresh concrete*
AS1012.3.1	Methods of testing concrete - Method 3.1: Determination of properties related to the consistency of concrete - Slump test,
AS1012.8.1	Methods of testing concrete - Method 8.1: Method of making and curing concrete - Compression and indirect tensile test specimens,
AS1012.8.2	Methods of testing concrete - Method 8.2: Flexure test specimens,
AS1012.9	Methods of testing concrete - Method 9: Compressive strength tests—Concrete, mortar and grout specimens and
AS1012.14	Methods of testing concrete - Method 14: Method for securing and testing cores from hardened concrete for compressive strength and mass per unit volume
AS1141.14	*Methods for sampling and testing aggregates - Method 14: Particle shape, by proportional caliper*
AS1141.21	*Methods for sampling and testing aggregates - Method 21: Aggregate crushing value*
AS1141.23	*Methods for sampling and testing aggregates - Method 23: Los Angeles*

	value
AS1141.24	*Methods for sampling and testing aggregates - Method 24: Aggregate soundness—Evaluation by exposure to sodium sulfate solution*AS1289.3.3.1 *Methods of testing soils for engineering purposes - Method 3.3.1: Soil classification tests - Calculation of the plasticity index of a soil*
AS1289.5.1.1	*Methods of testing soils for engineering purposes - Method 5.1.1: Soil compaction and density Tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort*
AS1289.5.4.1	*Methods of testing soils for engineering purposes - Method 5.4.1: Soil compaction and density Tests - Compaction control test - Dry density ratio, moisture variation and moisture ratio)*
AS1379	*Specification and supply of concrete*
AS1478.1	*Chemical admixtures for concrete, mortar and grout – Part 1: Admixtures forconcrete*
AS/NZS1554.3	*Structural steel welding - Part 3: Welding of reinforcing steel*
AS/NZS1859	*Reconstituted wood-based panels (set)*
AS2082	*Timber—Hardwood—Visually stress graded for structural purposes*AS/NZS2271 *Plywood and blockboard for exterior use*
AS2758.1	Aggregates and rock for engineering purposes - Part 1: *Concrete aggregates*
AS3600	*Concrete structures*
AS3610	*Formwork for concrete*
AS3799	*Liquid membrane-forming curing compounds for concrete*
AS3972	*General Purpose and blended cements*
AS/NZS4671	*Steel reinforcing materials*
AS/NZS4680	*Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*

(c) Other:

Transport for NSW	*Shotcrete design guidelines*

SC6.4.18.2 Excavation and foundations

(1) General

The foundation where specified, shall be formed at the required depth below the finished surface levels shown on the drawings. Rock foundations shall be neatly excavated to form a bed for the concrete and shall be thoroughly scraped and cleaned. Soil foundation shall, as far as possible, be excavated neatly from the solid material to coincide with the under surface of the concrete. Compaction requirements must meet the appropriate compliance standards as specified in Section SC6.4.7 Clearing, grubbing, and earthworks.

All soft, yielding, or other unsuitable material shall be replaced with sound material approved by the Superintendent, and the subgrade shall be compacted to provide a minimum relative compaction as specified in Section SC6.4.7. Clearing, grubbing, and earthworks. If the subgrade is dry, it shall be sprinkled with as much water as it will readily absorb before the concrete is placed.

Preparation of the foundation is required in accordance with foundation type, as follows:

(a) concrete working base - remove projections above the plane surface, and loose material; and

(b) graded prepared subgrade - blind with sufficient sand to create a smooth surface free from hard projections. Wet the sand just before laying the underlay.

Editor's Note - Provision of a vapour barrier for external slabs on ground prevents water loss to the subgrade and has the potential to reduce slab curling at edges and corners.

AS2870 Section 5.5 provides additional requirements and detailing of damp-proof membranes for concrete slabs and footings exposed to either saline or acid sulphate soils. AS2870 Section C5.5 and CCAA T56 provide information on concrete exposed to saline soils.

Polymeric film underlay must be installed over the prepared foundation. Lap joints at least 200 mm and seal the laps and penetrations with waterproof adhesive tape. Face the laps away from the direction of concrete pour. Take the underlay up vertical faces past the damp proof course where applicable, and tape fix at the top. Patch or seal punctures or tears before pouring concrete. Cut back as required after concrete has gained strength and forms have been removed.

The Contractor shall supply all necessary sheeting and bracing to safely support the excavation in accordance with statutory requirements. The excavation shall be kept free of water.

Prior to the construction of footings for cast-in-situ concrete walls on earth foundations, cover the latter with a mass concrete blinding slab. Unless otherwise specified, place precast concrete wall sections on a fresh mass concrete bedding layer while it is still in a plastic state. Ensure the following is adhered to:

(a) for earth foundation, place concrete not less than 50 mm thick; and

(b) for rock foundation, place the concrete at least 50 mm above the highest points of rock.

Place neither forms nor other materials on the bedding layer within 48 hours of the concrete being placed.

(2) Kerb and channel

Kerb and channel may be constructed in fixed forms, by extrusion or by slip forming, in accordance with AS2876.

The foundation, concrete quality, curing and testing details shall be in accordance with AS2876 except where placed on pavement courses, where the requirements of the respective pavement course must prevail. Kerb and channel will be constructed to the profile nominated on the drawings.

The top and face of the finished kerb and channel shall be true to line and the top surface shall be of uniform width, free from humps, sags, or other irregularities. Kerb and channel shall have a steel float finish.

The level at any point on the surface of the kerb invert shall be within ±6 mm of the design level. When a straight edge 3 m long is laid on top of or along the face or invert of the kerb, the surface shall not vary more than 5 mm from the edge of the straight edge, except at kerb laybacks, grade changes or curves or at gully pits requiring gutter depression. The drainage invert shall be free draining and shall not pond water.

Unless shown otherwise on the drawings, contraction joints, shall be formed every 5 m of kerb invert length for a minimum of 50% of cross-sectional area. The joint shall be tooled 20 mm in depth to form a neat groove of 5 mm minimum width.

Unless shown otherwise on the drawings, expansion joints, 15 mm in width for the full depth of the kerb and channel, shall be constructed where the kerb invert abuts against kerb gully pits, both sides of kerb laybacks/ramps for vehicular or pedestrian access, retaining walls and overbridges.

Expansion joints shall consist of a preformed jointing material of bituminous fibreboard.

Where kerb and channel is cast adjacent with a concrete pavement the same type of contraction, construction and expansion joints specified in the concrete base shall be continued across the kerb and channel.

All house stormwater outlets shall be provided and/or extended, to match the existing type and size of pipe, through the kerb as shown on the drawings providing correctly graded drainage outlet into channel. Pipework shall be in accordance with the requirements for UPVC pipes in Section SC6.4.9 Stormwater quantity or as directed by the Superintendent for other types of pipe.

At all driveway crossings, where shown on the drawings, or where directed by the Superintendent, barrier kerb shall be discontinued to provide for vehicular or pedestrian access. At such locations, kerb laybacks/ramps must be constructed in accordance with the drawings and standards. Footpath crossovers shall be constructed to meet the laybacks as shown on the drawings or reinstated to match existing materials where not otherwise shown.

After the new kerb and channel has been constructed and not earlier than 3 days after placing, the spaces on both sides of the kerb and/or gutters shall be backfilled and reinstated in accordance with the drawings, or as instructed by the Superintendent.

Backfill material behind the kerb shall consist of granular material, free of organic material, clay, and rock more than 50 mm diameter, or material as approved by the Superintendent.

Backfill material behind the kerb shall be compacted in layers not greater than 150 mm thick, to a relative compaction of 95% when tested in accordance with AS1289.5.4.1, for standard compactive effort. The whole of the work shall be finished in a neat and workmanlike manner, free draining and free from surface undulations and trip hazards.

Pavement material adjacent to new gutter shall be backfilled in accordance with the drawings or as directed by the Superintendent.

Where specified in drawings, kerb only work shall be pinned as detailed in standard drawings.

(3) New jersey type barriers, driveways, and footpaths

For New Jersey type barriers, driveways, and footpaths a subbase of approved quality and of minimum 150 mm compacted thickness, unless otherwise shown on the drawings, shall be placed over the subgrade. The surface shall then be checked for uniformity, line and level, and all irregularities shall be made good.

The subbase material shall be compacted to provide a minimum relative compaction as determined by AS1289.5.4.1 of 100% for standard compactive effort as specified in Section SC6.4.7 Clearing, grubbing, and earthworks.

The finished subbase shall not deviate more than 15 mm under a straight edge 3 m long, subject to any necessary allowance on vertical curves.

(4) Drainage pits, and other supplementary structures

Where the excavation is in sound rock, and the Superintendent so directs, part of the concrete lining of gullypits and other structures may be omitted, provided that a neatly formed pit of the required dimensions is constructed, and provided that the wall of the pit adjacent to and parallel with the road is constructed of formed concrete in all cases.

(5) Retaining walls, headwalls, and wingwalls

In the case of rock foundations for retaining walls, headwalls and wingwalls, the excavation shall be carried into the rock for a minimum depth of 150 mm. Where cut-off walls are to be provided, the depth of cut-off in rock foundations may be reduced to 100 mm.

Prior to the construction of cast-in-situ concrete walls on earth foundations, the latter shall be covered by a mass concrete bedding layer at least 50 mm thick and finished to a uniform surface. No forms or other materials shall be placed upon the bedding layer within a period of 48 hours after the concrete has been placed.

Unless otherwise specified, precast concrete wall sections shall be placed on a fresh mass concrete bedding layer while it is still in plastic state. In the case of soil foundations, the concrete shall be not less than 50 mm thick, and where the foundation is in rock, the concrete shall be of such thickness as is required to provide a uniform surface at least 50 mm above the highest points of rock.

SC6.4.18.3 Formwork

(1) General

Formwork shall be provided in accordance with AS3610 to produce hardened concrete to the lines, levels and shapes shown on the drawings or specified elsewhere. It shall have adequate strength to carry all applied loads, including the pressure of fresh concrete, vibration loads, weight of workers and equipment, without loss of shape. Forms shall be mortar tight and designed to allow removal without risk of damage to the completed structure. Joints in the formwork shall be perpendicular to the main axis of the shape of the concrete.

Where concrete is placed in earth excavations, side forms shall be provided to prevent contact between concrete and the in-situ earth.

Design of formwork for high sections shall be such that it shall not be necessary to drop concrete freely from a greater height than 1.2 m or to move concrete along the formwork after deposition.

Formwork material used shall be sound and suitable for the purpose intended and surface finish specified.

Provision shall be made for the accurate location and firm support of fittings, bolts, anchorages, and formers of holes as shown on the drawings. Temporary fittings used for the support of the formwork shall be arranged to permit removal without damage to the concrete. The use of wires and or bolts extending to the surface of the concrete shall not be permitted except where shown on the drawings.

Forms for edges of concrete shall be filleted and for re-entrant angles chamfered as shown on the drawings.

Temporary openings shall be provided where necessary for cleaning out of formwork and inspection before concreting.

(2) Approval of formwork design

For box culverts and reinforced concrete retaining walls, detailed drawings, design calculations, description and/or samples of materials proposed for use shall be submitted for the Superintendent's concurrence before manufacture of the formwork is commenced.

Formwork greater than 1.5 m high should be certified by the RPEQ responsible for the formwork design.

(3) Provision for drainage

Where shown on the drawings, or where directed by the Superintendent, weepholes of 50 mm diameter shall be provided in retaining walls and wingwalls.

(4) Construction

The type and quality of material selected for formwork and the workmanship used in construction shall be such that the surface finish specified shall be obtained. Construction shall be such that the erection tolerances shall be obtainable.

Timber for formwork shall be well seasoned, free from defects and, where in contact with fresh concrete, free from loose knots.

Timber forms for exposed surfaces shall be constructed from plywood or particle board with hardwood or approved softwood studs and wales. The plywood used for forms shall comply with AS2271, the hardwood shall comply with AS2082 and the particle board with AS/NZS1859.

Formwork for exposed surfaces shall be made from panels having uniform widths of not less than 1 m and uniform lengths of not less than 2 m, except where the dimensions of the member formed are less than the specified panel dimensions. Plywood panels shall be placed with the grain of the outer plies perpendicular to the studding or joists. Where form panels are attached directly to the studding or joists the panel shall be not less than 15 mm thick. Form panels less than 15 mm thick, otherwise conforming to these requirements may beused with a continuous backing of dressed material of 20 mm minimum thickness. All form panels shall be placed in a neat, symmetrical pattern.

Forms for all surfaces which will be completely enclosed or permanently hidden below the ground may be constructed from dressed or undressed timber, steel, plywood, or particle board.

Mild steel form surfaces in contact with concrete shall have all bolt and rivet heads counter-sunk and all welds ground back to even and smooth surfaces.

(5) Erection

(a) General

(i) Dimensions and position of forms shall be carefully checked after the forms are erected. Forms shall be aligned accurately and the location of all fittings, hold formers, etc. checked prior to placing concrete. Departure of the forms from the surfaces shown on the drawings shall not exceed 1/300 of the space between supports for any surface visible in the completed work and 1/150 for hidden work. For tolerances in plan position and levels, finishing of unformed surfaces and treatment of formed surfaces refer to Clause SC6.4.18.5.

(ii) Joints as erected shall be mortar tight.

(iii) The interior surface of the forms shall be treated to ensure non-adhesion of the mortar. Commercial quality form oil or grease will be acceptable, but the oil or grease used on forms against surfaces to be exposed shall not stain or discolour the concrete surface. The coating shall be uniformly spread in a thin film and any surplus shall be removed prior to placing concrete. In the case of unlined timber forms, the timber shall be thoroughly wetted before oiling. Forms shall be treated before placing reinforcement to ensure that the form release agent will not contaminate the surface of the reinforcing steel or construction joints.

(iv) Formwork hardware shall be treated with a form release agent and so arranged that it may be removed from the concrete without excessive jarring or hammering.

(b) Approval by the Superintendent

(i) The formwork shall be inspected by the Superintendent, and the placing of reinforcement in the spaces formed, where specified, shall not commence until the formwork is approved by the Superintendent.

(ii) Placing of concrete shall not commence until the reinforcement, where specified, has been

accepted by the Superintendent, and all dirt, chips, hardened concrete, mortar, and all foreign matter removed from the forms.

(iii) When an inspection is requested by the Contractor, a notice of not less than 24 hours, excluding Saturdays, Sundays, and public holidays, shall be given to the Superintendent.

SC6.4.18.4 Materials for concrete

(1) Cement

Cement shall be Type GP Portland Cement complying with AS3972.

When submitting details of the nominated mix in accordance with Clause SC6.4.18 (4), the Contractor shall nominate the brand and source of the cement. On approval of the nominated mix by the Superintendent, the Contractor shall only use the nominated cement for the work.

Documentary or other acceptable evidence of the quality of the cement shall be furnished by the Contractor if required by the Superintendent.

If the Contractor proposes to use cement which has been stored for a period more than 3 months from the date of testing, a re-test shall be required at the Contractor's expense before the cement is used.

All cement shall be transported in watertight containers and shall be protected from moisture until used. Caked or lumpy cement shall not be used.

(2) Water

Water shall be free from injurious amounts of materials harmful to concrete and to its reinforcement and neither salty nor brackish.

Water which is not potable for human beings shall not be used in reinforced concrete.

(3) Fine aggregate

Fine aggregates shall consist of clean, hard, tough, durable uncoated grains, uniform in quality, and shall conform to the requirements of AS2758.1 in respect of bulk density, water absorption (maximum 5%) material finer than 2 micrometres, impurities, and reactive materials.

Fine aggregates shall be evenly graded within the absolute limits shown in Table SC6.4.18.1 Fine aggregate grading and shall not deviate from the proposed grading by more than the amounts in Table. SC6.4.18.1.

Table SC6.4.18.1 - Fine Aggregate Grading

Australian StandardSieve	Proportion Passing(% of Mass)	Deviation from Proposed Grading (% of Mass of Sample)
9.50 mm	100	
4.75 mm	90 - 100	±5
1.18 mm	40 - 85	±10
300 µm	8 - 30	±10
150 µm	2 - 10	±5
75 µm	0 - 4	±3

(4) Coarse aggregate

Coarse aggregate shall consist of clean, hard, durable, crushed stone, crushed river gravel, screened river gravel or metallurgical furnace slag and shall conform to the requirements of AS2758.1 in respect of particle density, bulk density, water absorption (maximum 2.5%), material finer than 75 micrometres, weak particles, light particles, impurities and reactive materials, iron unsoundness and falling or dusting unsoundness. In all other respects, the coarse aggregate shall comply with this section. If required, coarse aggregate shall be washed to satisfy these requirements.

The percentage of wear shall be determined by AS1141.23, and the loss of weight shall not exceed 30%.

When required by the Superintendent, coarse aggregate shall be tested for conformance for any or all of the properties set out below:

(a) Crushing Value - AS1141.21

The aggregate crushing value shall not exceed 25%;

(b) Soundness - AS1141.24

The loss of mass when tested with sodium sulphate shall not exceed 12%; and

(c) Particle Shape - AS1141.14

The proportion of misshapen particles (2:1 ratio) shall not exceed 35%.

Coarse aggregate shall be evenly graded within the absolute limits shown in Table SC6.4.18.2 Coarse aggregate grading and shall not deviate from the grading of the samples submitted under Clause SC6.4.18 (4) Testing of materials by more than shown.

Table SC6.4.18.2 - Coarse Aggregate Grading

Australian Standard Sieve (mm)	Proportion Passing (% of Mass)			Deviation Proposed Grading (% of Mass of Sample)
	40 mm Nominal	20 mm Nominal	Extrusion Concrete	
	For Wallsexceeding 150 mm thickness	For all other structures		
53.0	100			±10
37.5	95 - 100			±10
26.5		100		±5
19.0	30 - 70	95 - 100		±5
13.2			100	
9.50	10 - 35	25 - 35		
4.75	0 - 10	0 - 10		
2.36	0 - 2	0 - 2		

(5) Admixtures

Chemical admixtures and their use shall comply with AS1478.1. Admixtures shall not contain calcium chloride,calcium formate, or triethanolamine or any other accelerator. Admixtures or combinations of admixtures other than specified below, shall not be used.

During the warm season, (October to March inclusive), a set retarding admixture approved by the Superintendent shall be used to control slump within the limits stated in Clause SC6.4.18.5 (4) Consistency. The dosage shall be varied to account for air temperature and haul time in accordance with the manufacturer's recommendations. A copy of the NATA endorsed Certificate of Compliance with AS1478.1 shall be submitted to the Superintendent, together with the proposed “dosage chart” in accordance with Clause SC6.4.18.4 (6) Testing of materials. If the Contractor proposes to vary the admixture between the warm and cool seasons such variation shall require approval by the Superintendent by providing the necessary, certificate of compliance.

(6) Testing of materials

The Contractor shall submit to the Superintendent a copy of a NATA Certified Laboratory Test Report on the quality and gradings of the aggregates proposed to be used in the work.

The materials shall only be used after receipt of the Superintendent's notification of acceptance, and then only as long as the materials accord with the specification.

SC6.4.18.5 Handling and treatment of concrete

(1) Measuring

All materials shall be measured by weight, except that:

(a) water may be measured by volume with an approved adjustable water measuring and discharging device;

(b) cement may be measured by bags as packed by the manufacturer in which case batches shall be proportioned on the basis of one or more unbroken bags of cement, and for this purpose one bag of cement shall be assumed to weigh 40 kg. Bulk cement shall be weighed in an individual hopper and shall be kept separate from the aggregates until the components of the batch are discharged from the batching hopper; and

(c) measurement by volume for smaller works may be undertaken with the prior approval of the Superintendent.

The proportions set out in Table SC6.4.18.3 make allowance for moisture contents of aggregates of 6% for fine aggregates and 1% for coarse aggregates. Where the moisture content of aggregates exceeds 8% or 3% respectively, the proportions of the mix shall be changed to compensate for the excess water in the aggregate.

(2) Measuring by weight, on-site mixing

Where concrete is to be mixed on site, and where mix control is likely to be less efficient than at a central batching plant, the weights of cement, fine and coarse aggregate shown in Table SC6.4.18.3 Materials in batch containing 1 bag (40 kg) cement may be used as a guide to produce the classes of concrete specified. Small changes in the proportions of fine and coarse aggregate may be required to improve density or workability of the concrete. The use of proportions shown in Table SC6.4.18.3 shall not relieve the Contractor of his obligation to provide concrete of the specified compressive strength.

Table SC6.4.18.3 - Materials in Batch Containing 1 bag (40kg) Cement

MPa	Cement (Kg)	Fine Aggregates (kg)	Coarse Aggregates (kg)	Total Aggregates (kg)
10	40	130	250	380
15	40	100	190	290
20	40	88	126	214

The proportions set out in Table SC6.4.18.3 make allowance for moisture contents of aggregates of 6% for fine aggregates and 1% for coarse aggregates. Where the moisture content of aggregates exceeds 8% or 3% respectively, the proportions of the mix shall be changed to compensate for the excess water in the aggregate.

(3) Measuring by volume, on-site mixing

Where measurement by volume is approved, the proportions of the materials shall be such as are required to produce a mix free of voids and having the specified strength at 28 days.

The nominal proportions given in Table SC6.4.18.4 Volume batching may be used as a guide for volume batching.

Table SC6.4.18.4 - Volume Batching

MPa	Parts by Volume		
	Cement	Fine Aggregate	Coarse Aggregate
10	1	3	6
15	1	2.25	4.5
20	1	2	3

The volumes of fine and coarse aggregates for each batch shall be measured in boxes or bins. The aggregates shall be measured loose (I.e., without compaction) in the boxes and shall be struck off level. Measurements byshovels or like methods will not be permitted. Batch proportions shall be so arranged that each batch contains1 bag of cement. One 40 kg bag of cement shall be assumed to have a volume of 27.5 litres.

(4) Consistency

A sufficient quantity of water shall be added to the mix so that the consistency of the concrete is such that it can be placed in the forms, compacted and worked into all corners without permitting the ingredients to segregate, or excess free water to collect on the surface. If required by the Superintendent, the Contractor shall determine the consistence of the concrete in accordance with AS1012.3.1. Except for extruded concrete, the nominated slump shall not exceed 80 mm, plus the field tolerance of ±15 mm.

In the case of concrete placed by an extrusion machine, the water in the mix shall be only sufficient to produce a slump of 10 mm to 15 mm.

(5) Mixing and delivery

(a) General

(i) Concrete may be mixed either at the site or at a central mixing plant. All concrete shall be mixed with mechanically operated mixers. In an emergency, hand mixing may be permitted. Submit proposal for concrete mixing other than premixed concrete for approval

by Superintendent.

(ii) Any concrete which exhibits signs of segregation shall not be used.

(b) Machine mixing at site

(i) The mixing of concrete shall be done in a batch mixer which will ensure a uniform distribution of the materials throughout the batch.

(ii) The mixer shall be of such capacity that one or more whole bags of cement may be used per batch of concrete. The volume of the mixed material shall not exceed the manufacturer's rated capacity of the mixer.

(iii) The mixing time for each batch shall not be less than 1.5 minutes after all ingredients are assembled in the mixer, and prior to any portion of the batch being removed.

(iv) The entire contents of a batch shall be discharged from the mixer before any materials are placed therein for the succeeding batch.

(c) Mixing in an emergency

(i) In the case of breakdown of the mechanical mixing equipment, hand mixing in small quantities to complete a section of the work or reach a suitable construction joint is permitted.

(ii) Hand mixing shall be done on a water-tight platform of sufficient size to allow the mixing of at least two batches simultaneously. The amount of cement used shall be 10% more than the amount specified for machine mixed concrete.

(iii) The fine aggregate and cement shall first be mixed until a uniform colour is obtained, and then spread on the mixing platform in a thin layer. The coarse aggregate, which shall have been previously drenched with water, shall then be spread over the fine aggregate and cement in a uniform layer, and the whole mass turned over as further water is added with a rose sprinkler. After the water is added, the mass shall be turned at least three times, not including shovelling into barrows or forms, until the mixture is uniform in colour and appearance. hand mixed batches shall not exceed 0.25 m^3 each.

(d) Ready mixed concrete

(i) The concrete shall be mixed and delivered in accordance with the requirements of AS1379 relating to:

1. mixing and delivery; and

2. use of non-agitating equipment,

(ii) The water used for flushing the chutes and for cleaning shall be discharged in an area acceptable to the Superintendent. The chutes shall be long enough to permit delivery to the whole of the area enclosed by the forms.

(6) Placing and compacting concrete

No concrete shall be mixed or placed, without the approval of the Superintendent, while the air temperature is, or is likely to be within 24 hours, below 5°C or while the shade temperature exceeds 38°C. All concrete shall be placed in the dry. Prior to placing concrete, the area shall be clean and moist but free from any ponding of water.

The concrete shall be mixed in the quantities required for immediate use and shall be placed in position as rapidly as possible. Any concrete which has developed initial set, or which does not reach the forms within 30 minutes after the water has been added (except when transported in agitator trucks) shall not be used.

The concrete shall be deposited in the forms, without separation of the aggregates. Concrete shall not be dropped freely from a height greater than 1.2 m or be deposited in large quantities at any point and moved or worked along the forms. Conveying equipment, including open troughs and chutes, where used, shall be made of metal, or have metal linings. Where used on steep slopes, troughs and chutes shall be equipped with baffles,or be placed in short lengths in such a way that the direction of flow of the concrete is changed. The concrete shall be placed in horizontal layers in one continuous operation between the ends of the work and/or construction joints. Care shall be taken to fill every part of the forms and to work the coarser aggregate back from the face. The freshly placed concrete shall be compacted by continuous spading, slicing or by vibrator units. Vibrators shall not be left in one position for more than 30 seconds and shall not be permitted to rest on reinforcement.

Exposed surfaces of the concrete shall be struck off and finished with a wooden float. Where shown on the drawings corners and edges shall be left neatly rounded or chamfered. Re-entrant angles shall be neatly filleted.

Concrete shall not be moved after it has been in the forms for more than 10 minutes.

In the case of concrete placed by an extrusion machine, small quantities of cement/sand/slurry, comprised of two parts of plasterer's sand and one part of cement (by volume), together with sufficient water to bring it to a semi-fluid condition, shall be placed in the special receptacle in the machine, if the machine is so equipped and shall be fed onto the surface of the concrete at a rate sufficient to produce a smooth and uniform finish.

(7) Finishing of unformed surfaces

(a) Surfaces other than wearing surfaces

Unformed surfaces shall be compacted and tamped so as to flush mortar to the surface, screeded off and finally dressed with a wooden float to an even surface. Care shall be taken to drain or otherwise remove promptly any water which comes to the surface. A capping of mortar will not be permitted.

All future contact surfaces shall be left rough, with the coarse aggregate at the surface firmly embedded but not forced below the surface.

(b) Wearing surfaces

Where a concrete wearing surface is shown on the drawings the concrete shall be thoroughly compacted and the surface screeded off by a vibrating screed, or hand screeded where the distance between forms perpendicular to the direction of screed is no greater than 2 m. Immediately following compaction and screeding the concrete shall be tested for high or low spots and any necessary corrections made. The surface shall be finished true and uniform and free from any glazed or trowelled finish and shall be finally dressed with a wooden template or float, or by the use of belting in an approved manner. The departure from grade shall not exceed 5 mm in any 3 m length.

Where an asphaltic concrete wearing surface is specified, the surface of the concrete, after being compacted, screeded, and corrected, shall be dressed with a wooden float and finally broomed to produce a rough surface.

(c) Finished levels and location

The unformed surface of concrete structures not adjacent to road pavements shall not vary more than 25 mm in plan position and not more than 25 mm from the specified levels. In the case of barriers, drainage pits, culvert slabs and other structures adjacent to road pavements, the finished concrete shall not vary more than 10 mm from the specified levels and alignment.

Barriers, footpaths and similar shall not deviate from level or alignment by more than 5 mm from a straight-edge 3 m long, subject to any necessary allowances on vertical and horizontal curves.

(8) Curing and protection

All exposed surfaces of the freshly placed concrete shall be kept moist either using plastic sheeting, damp sand, or commercial curing compounds, in accordance with AS3799, for a minimum period of 3 days. During this time the work must be adequately protected from the effects of excessive surface evaporation, rain, running water, vandalism, and other causes likely to damage the concrete. All costs involved in making good orreplacing any work that has been damaged due to the above factors shall be borne by the Contractor.

Curing for concrete shall generally be in accordance with the appropriate surface exposure classification in AS3600.

If it is proposed to use a liquid membrane-forming curing compound, the following information to be submitted:

(a) certified test results for water retention to AS3799 Appendix B; and

Editor's Note - It is likely that polyvinyl alcohol (PVA-based) products will not comply with water retention requirements.

(b) evidence of compatibility with concrete, and with applied finishes including toppings and render, if any, including methods of obtaining the required adhesion.

For visually important surfaces, evidence that an acceptable final surface colour will be obtained.

(9) Removal of forms

All forms shall remain in place, after placement of concrete, for minimum periods specified hereinafter. These periods may be extended by the Superintendent if the air shade temperature falls below 10 °C during the periods specified.

Mass retaining walls. headwalls, wing walls, gully pits, sumps, and similar drainage structures.	48 hours
Footpaths, driveways, and similar	17 hours
Sides of reinforced concrete walls when height of each day pour is:	
Under 0.6 m	1 day
0.6 m – 3 m	2 days
3 m – 6 m	3 days
6 m – 9 m	5 days
Supporting forms under deck slabs of culverts	10 days

To permit the satisfactory finishing of barriers, forms shall be removed in not less than 12 hours nor more than 48 hours after placing concrete, depending upon weather conditions.

Care shall be taken in removing forms so that the concrete will not be cracked, chipped, or otherwise damaged.The use of crowbars or other levering devices exerting pressure on the fresh concrete to loosen the forms will not be permitted.

No superimposed load shall be allowed on any part of a structure until the concrete has reached at least 70% of the design strength.

Hole formers such as pipes and bars shall be removed as soon as the concrete has hardened sufficiently for this to be done without damage to the concrete.

(10) Treatment of formed surfaces

All concrete surfaces shall be true and even, free from stone pockets, depressions, or projections beyond the surface. All arises, shall be sharp and true, and mouldings shall be evenly mitred or rounded. Care shall be exercised in removing forms to ensure this result. Formed concrete surfaces shall be presented for inspection by the Superintendent within 1 day of stripping of formwork and finishes in accordance with the classes of surface finish in AS3610 as follows:

(a) Non-visible surfaces - Class 4.

(b) Visible surfaces - Class 2.

As soon as the forms are removed from mass or reinforced concrete work, all rough places, holes, and porous spots shall be repaired by removing defective work and filling with stiff cement mortar having the same proportions of cement and fine aggregate as used in the concrete and shall be brought to an even surface witha wooden float.

Any tie wires or other fitments extending to outside surfaces, shall be cut back after removal of forms, to a depth of at least 40 mm with sharp chisels or cutters. All cavities caused by removal of fitments or tie wires shall be wetted and carefully packed with cement mortar, as above.

The surfaces of bolt cavities, tie wire holes, and all defects in concrete shall be coated prior to the placing of mortar, grout, or fresh concrete, with an approved bonding agent, in lieu of wetting with water. The method of application of such agent and the conditions in which it is to be used shall generally be as laid down by the manufacturer.

The formed surfaces of concrete structures not adjacent to road pavements shall not vary more than 25 mm in plan position and not more than 25 mm from the specified levels. In the case of drainage pits and other structures adjacent to road pavements, the finished concrete shall not vary more than 10 mm from the specified levels and alignment.

(11) Joints

Submit proposed methods, timing, and sequence of sawing joints for approval by Superintendent a minimum of 7 days prior to works commencing.

Where horizontal construction joints are found to be necessary in walls, or cast-in-situ drainage structures the joints may be made at the base of walls and at other locations in the walls where approved by the Superintendent. In order to provide for bond between the new concrete and the concrete which has already set, the surface on which the new concrete is to be placed shall be thoroughly cleaned of loose material, foreign matter and laitance. The surface shall be roughened or keyed and saturated with water. After any excess water has been removed, the surface shall be thinly coated with a neat cement grout.

Retaining walls shall be provided with vertical expansion joints as shown on the drawings. The expansion joints shall consist of jointing material of approved quality, and of thickness shown on the drawings, and a depth sufficient to fill the joint. The jointing material shall be neatly cut to fit the surface of the concrete.

Where barriers are extruded or cast in place, narrow transverse vertical grooves, 20 mm deep, shall be formed neatly in the surface of the freshly placed concrete to produce contraction joints for the control of cracking. The contraction joints shall be at intervals of 3 m.

In barriers, unless shown otherwise on the drawings, expansion joints, 15 mm in width for the full depth of the barrier, shall be constructed at intervals not exceeding 15 m and where the barrier abuts against gully pits. Expansion joints shall consist of a preformed jointing material of bituminous fibreboard.

In footpaths, median toppings, and driveways, unless otherwise shown on the drawings, expansion joints, 15 mm in width for the full depth of paving, shall be constructed at intervals not exceeding 15 m and where the pavement abuts against gutters, pits, and structures. Expansion joints shall consist of a preformed jointing material of bituminous fibreboard.

All unreinforced paving shall be provided with narrow vertical grooves, 20 mm deep to induce contraction joints for the control of cracking. The joints shall be formed in the freshly placed concrete in a neat regular pattern to form "slabs" no bigger than 2 m^2. The ratio of the longest side to the shortest side shall not exceed 1.6.

Spacing of joints shall not to exceed 25 times the depth of the concrete to avoid intermediate cracking.

(12) Strength of concrete

When tested in accordance with AS 1012.9, the concrete shall have a characteristic compressive strength not less than that shown on the drawings or if not shown shall have a compressive strength not less than that specified in Table SC6.4.18.5 Concrete Strength Requirements for the class of work. The cement content restrictions shown in Table SC6.4.18.5 refer to Portland cement. Where General Purpose Blended cements are utilised, the acceptable minima are indicated in brackets.

The characteristic strength shall be determined from the average of not less than two specimens, moulded from each class of concrete being used in the work, and selected to represent the whole of the concrete placed at the time of moulding.

In general, two pairs of test specimens shall be moulded for each 15 m^3 of concrete, or part thereof, one pair being intended for the 7-day test if required and the other pair for a 28-day test.

Table SC6.4.18.5 - Concrete Strength Requirements

Use	Characteristic Strength MPa	Minimum Portland Cement per m^3 (Minimum GB Blended Cement)	Coarse Aggregate Nominal Size	Characteristic Cylinder Strength Required	
				7 days	28 days
		kg	mm	MPa	MPa
Foundations, mass retaining walls	20	270 (330)	40	15	20
Mass concrete footings, pitching, linings etc.	20	270 (330)	20	15	20
Miscellaneous minor concrete work	20	270 (330)	20	15	20
Reinforced concrete culverts,	32	320	20	24	32

drainage structures,		(380)			
Driveways footpaths, headwalls, base slabs, sign structures. Large footings, retaining walls	50	350 (455)	20	36	50
Extruded concrete	25	270 (330)	14	15	20
Safety Barriers	40	330 (380)	20	24	40

Editor's Note - The total cement and Portland cement quantities indicated as minima are aimed at providing suitably durable concrete for exterior public works under normal circumstances.

The strengths specified at 28 days shall be increased by multiplying by factors as shown in Table SC6.4.18.6 Concrete age conversion factors for tests at ages more than 28 days.

Table SC6.4.18.6 - Concrete Age Conversion Factors

*Age of test specimen in days of date of testing	Factor
28	1.00
35	1.02
42	1.04
49	1.06
56	1.08
70	1.10
84	1.12
112	1.14
140	1.16
168	1.18
196	1.20
224	1.22
308	1.24
365 and greater	1.25
*For intermediate ages the factor shall be determined on a pro-rata basis	

If the test specimens fail to achieve the specified characteristic strength, the Contractor may, with the approval of the Superintendent, arrange for cores to be taken from the work. If the average strength of such cores complies with the specified requirements nominated in Table SC6.4.18.5 Concrete strength requirements, the concrete will be accepted.

If cores taken fail to satisfy the strength requirements, the concrete shall be removed.

(13) Sampling concrete

Equipment and facilities shall be provided by the Contractor for the taking and storage of samples of any materials or concrete being used or intended to be used in the work.

Concrete test specimens shall be cylinders 300 mm long and 150 mm diameter, moulded concurrently in the presence of the Superintendent or Superintendent's representative, in accordance with AS1012.8, from samples taken in accordance with AS1012.1.

SC6.4.18.6 Reinforcement for concrete

(1) Fibre reinforced concrete

Footpath/bikeways/driveways.

The concrete shall be reinforced with a mixed dose of High-Performance Polymer and Discreet Graded Fibrillated filament fibres. These fibres shall be provided as a coarse filament in an engineered contoured sinusoidal profile of not less than 600 denier and discreet graded fibrillated filament fibres of not greater than 6 denier. These fibres are to be manufactured from virgin polypropylene and added to the concrete by the concrete company, at the rate of 4.6 kg/m^3. The 4.6 kg consists of 3.8 kgs of HPP and 0.8 kgs of discrete Graded Fibrillated filament fibres.

Two bags of "Novomesh" HPP as supplied by Tapex Concrete Fibres Qld or approved equivalent added per m^3, will be deemed suitable for council's use. Where footpaths/bikeways are not subject to wheel loads one bag of fibres per m^3 will suffice. Any alternate product must have prior written approval obtained from Council.

(2) Steel reinforcement

Steel reinforcement shall comply with AS/NZS4671 *Steel reinforcing materials*. The type and size of bars shall be as shown on the drawings.

If changes are proposed to reinforcement shown on the drawings, submit details to Superintendent for approval two days prior to commencing works.

Steel reinforcement shall be free from loose or thick rust, grease, tar, paint, oil, mud, mill scale, mortar, or any other coating, but shall not be brought to a smooth polished condition.

Damaged galvanising must be repaired in accordance with AS/NZS4680 Section 8 and notification of repairs made to the Superintendent for approval.

The Contractor shall supply evidence satisfactory to the Superintendent that steel reinforcement complies with AS/NZS4671. Test certificates shall show the results of mechanical tests and chemical analysis.

Where the material cannot be identified with a test certificate, samples shall be taken, and testing arranged by the Contractor. The samples shall be selected randomly and consist of three specimens each at least 1.2 m in length. The cost of all samples and tests shall be borne by the Contractor.

Plastic bar chairs or plastic tipped wire chairs shall be capable of withstanding a load of 200 kg mass on the chair for one hour at 23 ± 5°C without malfunction. The Contractor shall demonstrate that the proposed chairs conform with these requirements.

(3) Bending

Reinforcement shall be formed to the dimensions and shapes shown on the drawings. It shall not be bent or straightened in a manner that will injure the material, and bars with kinks or bends not shown on the drawings will not be accepted. Heating of reinforcement for purposes of bending will only be permitted if uniform heat is applied. Temperature shall not exceed 450°C and the heating shall extend beyond the portion to be bent. Heated bars shall not be cooled by quenching.

(4) Splicing

(a) General

All reinforcement shall be furnished in the lengths indicated on the drawings. If splicing is required, it shall be in accordance with the provisions of AS/NZS4671.

The cost of any test ordered in connection with splices not shown on the drawing shall be borne by the Contractor.

(b) Lapped splices

Laps in reinforcing bars, wire or fabric shall be as shown on the drawings. Laps not shown on the drawings shall be as follows for unhooked bars:

(i) Plain bars, Grade 250 40 bar diameters.

(ii) Deformed bars, Grade 400 35 bar diameters.

(iii) Hard-drawn wire 50 bar diameters.

Splices in reinforcing fabric shall be so made that the overlap, measured between outermost transverse wires of each sheet of fabric is not less than the spacing of those wires plus 25 mm.

(5) Marking

Bars of identical shape shall be made up in bundles of three and securely tied together by soft iron wire. Each bundle shall have a stout metal label of not less than 40 mm diameter attached to it. Each metal label shall be punched with the appropriate marking in accordance with the steel list shown on the drawings. If called for on the drawings the marking shall incorporate a prefix, and bars with different prefixes shall be stored separately.

(6) Storage

Reinforcement shall be stored above the surface of the ground and shall be protected from damage and from deterioration by exposure.

(7) Delivery and receipt of reinforcement

Unless the Contractor elects to have the reinforcement inspected at the site, no reinforcement shall be delivered to the site until all tests and inspections have been satisfactorily completed and permission to deliver has been granted by the Superintendent.

The Contractor shall give 10 working days' notice to the Superintendent for carrying out inspection and testing. The Superintendent will carry out the inspection and testing with reasonable expediency, but the Contractor shall not be entitled to an extra for any delays in this connection.

(8) Placing

Reinforcement shall be accurately placed as shown on the drawings and shall be securely held by blocking from the forms, by supporting on concrete or plastic chairs, or metal hangers, and by wiring together at all intersections or at 0.5 m centres, whichever is the greater distance, using annealed iron wire of diameter not less than 1.25 mm. Steel shall not be supported on metal supports which extend to the surface of concrete, on wooden supports, or on pieces of coarse aggregate. Reinforcement shall have the minimum cover shown on the drawings or otherwise approved by the Superintendent.

The Superintendent may approve the use of tack welding instead of wire ties on reinforcing wire. All welding of reinforcing steel shall be in accordance with AS1554.3. Tack welding of cold-worked and hard grade bars shall not be permitted.

The reinforcement in each section of the work shall be approved by the Superintendent before any concrete is deposited in the section and adequate time shall be allowed for inspections and any corrective work which may be required. Notice for inspection shall not be less than one normal working day.

Splices shall be staggered where practicable and when not shown on the drawings they shall be arranged as directed by the Superintendent.

Bars forming a lapped splice shall be securely wired together in at least two places, unless welded.

The clear cover of any bar, including stirrups, to the nearest concrete surface shall be as shown on the drawings. Where not so indicated it shall be as stated below:

(a) concrete normally in contact only with air:

(i) slabs: 40 mm;

(ii) other than slabs: 45 mm; and

(b) concrete in contact with earth or fresh water:

(i) slabs of box culverts: 50 mm; and

(ii) other than culverts: 50 mm.

(9) Cores, fixings, and embedded items generally

Cores, fixings, and embedded items identified on shop drawings showing the proposed locations, clearances, and cover, and indicating proposed repositioning of reinforcement must be presented for inspection by the Superintendent.

If cutting or coring of hardened concrete is proposed, provide details to the Superintendent for approval.

For adjoining elements to be fixed to or supported on the concrete, provide for the required fixings. If required, provide for temporary support of adjoining elements during construction of the concrete.

If in external or exposed locations, galvanize anchor bolts and embedded fixings, or propose alternative materials such as stainless steel.

Fix cores and embedded items to prevent movement during concrete placing. In locating cores, fixings, and embedded items, reposition but do not cut reinforcement, and maintain cover to reinforcement.

Isolate embedded items so that water cannot track to concrete providing minimum cover to reinforcement.

SC6.4.18.7 Backfilling

(1) General

Backfilling at barriers, paving, etc., and minor concrete works shall not commence until after the concrete has hardened and not earlier than three days after placing.

No superimposed load on any part of what will become a load bearing structure within 21 days after placing concrete shall occur unless the structure is effectively and independently supported to the satisfaction of theSuperintendent (approval must be sought at a minimum of 3 working days prior to loading upon evidence of early strength) or until the Contractor can demonstrate that 85% of the design strength of the concrete has been achieved.

Selected backfill shall be placed against retaining walls and cast-in-place box culverts for a horizontal distance equal to one-third of the height of the wall. It shall consist of granular material,

free from clay and stone larger than 50 mm gauge. The Plasticity Index of this selected backfill material shall not be less than 2 or more than 12 when tested in accordance with AS1289.3.3.1. The material must be placed in layers not exceeding 150 mm and must be compacted to provide a relative compaction as specified in Section SC6.4.7 Clearing, grubbing, and earthworks, Clause SC6.4.7.11.

(2) Treatment at weepholes

Drainage adjacent to weepholes shall be provided by either a layer of broken stone or river gravel consisting of clean, hard, durable particles graded from 50 mm to 10 mm such that:

(a) the maximum particle dimension shall not exceed 50 mm; and

(b) no more than 5% by mass shall pass the 9.5mm A.S. sieve.

The broken stone or river gravel, enclosed in a filter fabric suitable for drainage without scour, shall be continuous in the line of the weepholes, extend at least 300 mm horizontally into the fill and extend at least 450mm vertically above the level of the weepholes.

Alternatively, the Contractor may provide a synthetic membrane of equivalent drainage characteristics at no extra cost to the Principal. It shall be stored and installed in accordance with Manufacturer's instructions. The use of a synthetic membrane shall be subject to the Superintendent's approval.

SC6.4.18.8 Sprayed concrete

(1) References and source documents

Reference and source documents that must be read in conjunction with this section are as follow:

Transport for NSW – *Shotcrete Design Guidelines*.

(2) General

Sprayed concrete is concrete pneumatically applied at high velocity on to a surface. Application may be either a wet or dry process. A sound homogeneous product shall be provided with surface finish reasonably uniform in texture and free from blemishes.

The minimum depth of sprayed concrete to be applied shall be 75 mm.

Sprayed concrete lining in open drains shall be coloured to match the adjoining rock colour.

Sprayed concrete shall have a minimum cement content of 380 kg/m^3 as discharged from the nozzle and shall have a minimum compressive strength of 25 MPa at 28 days when tested by means of 75 mm diameter cores taken from in-place sprayed concrete.

Cores shall be secured, accepted, cured, capped, and tested in accordance with AS1012.14. Equipment and facilities shall be provided by the Contractor for the taking of cores from the work. The Contractor shall arrange for a laboratory with appropriate NATA registration for the curing and testing of the cores. Copies of test results shall be forwarded to the Superintendent.

The cost of all work and material required in the taking, handling, delivery and testing of cores shall be borne by the Contractor.

At least 14 days prior to applying any sprayed concrete the Contractor shall submit to the Superintendent details of his proposed procedure, plant, materials and mix proportions. Materials shall comply with AS3600.

(3) Test panels

Not less than 7 days before applying concrete, the Contractor shall prepare at least three test panels for each mix proposed, in conditions similar to those in the works and in the presence of the Superintendent. The test panels shall be made by applying a 75 mm thickness of sprayed concrete to a hardboard panel approximately750mm square. The sprayed concrete shall be applied to the panels in the same manner, using materials including steel reinforcing fabric, equipment, pressures and curing that will be used in the Works. The panels shall be submitted to the Superintendent for examination.

The Contractor shall cut four 75 mm diameter cores from one test panel for each proposed mix approximately 48 hours after the panel has been sprayed. The cores shall be tested as for cores from in place sprayed concrete. One core shall be compression tested at 3 days, one core at 7 days and the remaining two cores at 28 days.

Should any of the cores reveal defects such as lack of compaction, dry patches, voids, or sand pockets or should the test panel exhibit an unacceptable surface finish, the Contractor shall modify the mix design and/or method of placement and prepare fresh test panels for testing and inspection.

Sprayed concrete shall not be applied to the Works until the Contractor produces test panels for the approval of the Council.

(4) Surface preparation

Earth surfaces shall be graded, trimmed, and compacted and shall be dampened prior to applying the sprayed concrete. The Contractor shall take any precautions necessary to prevent erosion when the sprayed concrete is applied.

Rock surfaces shall be cleaned of loose material, mud and other foreign matter that might prevent bonding of the sprayed concrete onto the rock surface. The rock surface shall be dampened prior to applying the sprayed concrete.

Corrugated steel pipes shall be cleaned of loose material, mud. and any other foreign matter.

The Contractor shall remove free water and prevent the flow of water which could adversely affect the quality of the sprayed concrete.

(5) Application of sprayed concrete

Application shall begin at the bottom of the area being sprayed and shall be built up making several passes of the nozzle over the working area. The nozzle shall be held so that the stream of material shall impinge as nearly as possible perpendicular to the surface being coated. The velocity of discharge from the nozzle, the distance of the nozzle from the surface and the amount of water in the mix shall be regulated to produce a dense coating with minimum rebound of the material and no sagging. Rebound material shall be removed after the initial set by air jet or other suitable means from the surface as work proceeds and disposed of.

Spraying shall be discontinued if wind causes separation of the nozzle stream. Concrete shall not be sprayed in air temperatures less than 5 °C.

Construction joints shall be kept to a minimum. A joint shall be formed by placing or trimming the sprayed concrete to an angle between 30° and 45° to the sprayed concrete surface. The joint edge shall be cleaned and wetted by air-water jet before recommencing concrete spraying.

When spraying around reinforcement, concrete is to be sprayed behind the reinforcement before concrete is allowed to accumulate on the face of the reinforcement.

Adjoining surfaces not requiring sprayed concrete shall be protected from splash and spray rebound. Splash or rebound material on these adjoining surfaces shall be removed by air-water jet or other suitable means as work proceeds.

(6) Curing

Curing shall commence within one hour of the application of sprayed concrete and may be by water or by colourless wax emulsion curing compound complying with AS3799 and applied in accordance with manufacturer's specifications.

In water curing, the surface of the sprayed concrete shall be kept continuously wet for at least 7 days.

SC6.4.18.9 Summary of limits and tolerances

The limits and tolerances applicable to the various clauses in this section are summarised in Table SC6.4.18.7 – Summary of limits and tolerances below:

Table SC6.4.18.7 - Limits and Tolerances Concrete Works

Item	Activity	Limits/Tolerances
(1)	**Foundation** Relative Compaction	95% RDD (standard compactive effort) within 0.3 m below subgrade
(2)	**Barriers, Footpaths etc.** (a) Finished Subbase (b) Relative Compaction of subbase	To be trimmed and compacted so that the levels do not vary more than 15 mm under a straight-edge 3 m long. 100% (standard compactive effort)
(3)	**Formwork** Position of Forms	Forms shall be aligned accurately so that departure of the forms from the surfaces specified on the drawings shall not exceed 1/300 of the space between supports for any surface visible in the completed work and 1/150 for hidden work.
(4)	**Fine Aggregate** Grading	To be evenly graded within the absolute limitsand shall not deviate from the grading of sample aggregate as per Table.SC6.4.18.1
(5)	**Coarse Aggregate** (a) Percentage of wear (b) Crushing Value (c) Soundness (d) Particle Shape	 Loss of weight shall not exceed 30% Crushing value shall not exceed 25% The loss of mass when tested with sodium sulphate shall not exceed 12% The proportion of misshapen particles (2:1 ratio) shall not exceed 35%

	(e) Grading	To be evenly graded within the absolute limits and shall not deviate from the grading of sample aggregate as per Table SC6.4.18.2
(6)	**Aggregate Moisture Content**	Where moisture content of fine aggregate exceeds 8%, or moisture content of coarse aggregate exceeds 3%, the proportion of mix shall be changed.
(7)	**Consistency**	In accordance with AS1012.3, Method 1 the slump shall not exceed the nominated slump ±15 mm. In the case of concrete placed by extrusion machine, the slump will be between 10 mm and 15 mm.
(8)	**Ready-Mixed Concrete** Mixing & Delivery	The time taken from the introduction of water until the concrete is completely discharged shall be not more than 1.5 hours. Where non-agitating equipment is used the concrete shall be completely discharged not more than 30 minutes after the addition of water.
(9)	**Placing & Compacting of Concrete**	Concrete shall not be placed without the approval of the Superintendent if the air temperature within 24 hours is likely to be below 5°C or the shade temperature is likely to exceed 38°C.
(10)	Finishing of Unformed / Formed Concrete Surfaces (a) Wearing Surface (b) Finished Surfaces (i) Not Adjacent to Roads (ii) Adjacent to Roads (iii) Culvert Inverts	to be finished true and uniform so that departure from designed grade shall not exceed 5 mm in any 3 m length. ≤25mm Plan position ≤25mm Level ≤10mm Alignment ≤10mm Level ≤25mm Alignment ≤10mm Level