



# **Construction Specification for Civil Works**

**C271 – Minor Concrete Works**

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## GENERAL

### C271.01 SCOPE

The work to be executed under this Specification consists of the supply and placement of concrete, including sprayed concrete, and ancillary requirements like excavation, preparation of foundations, forming up, placement of reinforcement and backfilling for work shown on the approved design drawings but not having individual Specifications. These works include New Jersey type barriers, drainage pits and other supplementary structures, headwalls, box culverts, box culvert base slabs, driveways, footpaths, median toppings, retaining walls, footings, paving edge strips and works of a similar nature.

**Applicable Work**

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.

Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in *CQC-Quality Control Requirements Sub-Annexure B11*.

**Quality**

### C271.02 DEFINITIONS

**The Works** – Defined as follows:

**The Works**

- **Developer Infrastructure Works** - work includes subdivisions and any public infrastructure work associated with an approved Development in the ARC local government area requiring a construction certificate.
- **Contracted Works** – infrastructure work undertaken by a Principal Contractor or subcontractor formally appointed by ARC and supervised by ARC.
- **Internal Works** - infrastructure work undertaken by ARC's day labour workforce.

**Constructor** – Defined as the organisation responsible for construction of the Works and the Principal Contractor as defined in the *Work Health and Safety Act 2011*.

**Constructor**

**ARC Representative** – Defined as follows:

**ARC Representative**

- **Developer Infrastructure Works** – Nominated ARC officer(s) for the approved Development.
- **For Contracted Works** – the Superintendent.
- **For Internal Works** – ARC Asset Owner.

**Constructor's Representative** – Defined as follows:

**Constructor's Representative**

- **Contracted Works** – the Principal Contractor's nominated representative as per the relevant contract.
- **Internal Works** – ARC officer responsible for delivery.

**Developer's Representative**– Defined as the person or organisation appointed by the Developer to administer the Constructor responsible for the delivery of Developer Infrastructure Works.

**Developer's Representative**

### C271.03 REFERENCE DOCUMENTS

Documents referenced in this Specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.

**Documents Standards Test Methods**

Where not otherwise specified in the relevant Armidale Regional Council (ARC) Construction Specifications or the approved design drawings, the Constructor shall use the latest versions of the Reference documentation, including amendments and supplements, listed in the ARC Construction Specifications at the time of the Works approval.

**Currency**

**(a) Armidale Regional Council (ARC) Specifications**

CQC - Quality Control Requirements

**ARC  
Specifications**

**(b) Australian Standards**

References in this Specification or on the approved design drawings to Australian Standards are noted by their prefix AS or AS/NZS.

**Australian  
Standards**

- AS 1012.1 - Sampling fresh concrete.
- AS 1012.3.1 - Determination of properties related to the consistency of concrete - Slump test.
- AS 1012.8 - Making and curing concrete compression, indirect tensile and flexure test specimens in the laboratory or in the field.
- AS 1012.9 - Determination of the compressive strength of concrete specimens.
- AS 1012.14 - Securing and testing cores from hardened concrete for compressive strength.
- AS 1141.14 - Particle shape by proportional calliper.
- AS 1141.21 - Aggregate crushing value.
- AS 1141.23 - Los Angeles value.
- AS 1141.24 - Soundness (by use of sodium sulphate solution).
- AS 1289.3.3.1 - Calculation of the plasticity index of a soil.
- AS 1289.5.4.1 - Compaction control test - Dry density ratio, moisture variation and moisture ratio.
- AS 1379 - The specification and manufacture of concrete.
- AS 1478.1 - Chemical admixtures for concrete, mortar and grout – Part 1: Admixtures for concrete.
- AS 1554.3 - Welding of reinforcing steel.
- AS/NZS 1859 - Reconstituted wood-based panels.
- AS 2082 - Visually stress-graded hardwood for structural purposes.
- AS 2271 - Plywood and blockboard for exterior use.
- AS 2758.1 - Concrete aggregates.
- AS 3600 - Concrete structures.
- AS 3610 - Formwork for concrete.
- AS 3799 - Liquid membrane-forming curing compounds for concrete.
- AS 3972 - Portland and blended cements.
- AS 4671 - Steel reinforcing materials

## EXCAVATION AND FOUNDATIONS

### C271.04 GENERAL

The subgrade, or subbase where specified, shall be formed at the required depth below the finished surface levels shown on the approved design 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, or of the subbase material (where specified).

**Foundations**

All soft, yielding or other unsuitable material shall be replaced with sound material approved by the ARC Representative and the subgrade shall be compacted to provide a minimum relative compaction of 92% as determined by AS 1289.5.4.1 for modified compactive effort. If the subgrade is dry it shall be sprinkled with as much water as it will readily absorb, before the concrete is placed.

**Unsuitable Material**

The Constructor 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.

**Shoring**

### C271.05 NEW JERSEY TYPE BARRIERS, DRIVEWAYS AND FOOTPATHS

For New Jersey type barriers, driveways and footpaths, a subbase of approved quality and of minimum 150mm compacted thickness, unless otherwise shown on the approved design 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.

**Subbase**

The subbase material shall be compacted to provide a minimum relative compaction as determined by AS 1289.5.4.1 of 97% for standard compactive effort or 95% for modified compactive effort as appropriate.

**Compaction**

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

**Subgrade and Subbase Tolerances**

### C271.06 DRAINAGE PITS AND OTHER SUPPLEMENTARY STRUCTURES

Where the excavation is in sound rock, and the ARC Representative so directs, part of the concrete lining of gully pits 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.

**Pit Walls**

### C271.07 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 150mm. Where cut-off walls are to be provided, the depth of cut-off in rock foundations may be reduced to 100mm.

**Rock Foundations**

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 50mm 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.

**Earth Foundations**

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 50mm 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 50mm above the highest points of rock.

**Pre-cast Concrete**



## FORMWORK

### C271.08 GENERAL

Formwork shall be provided in accordance with AS 3610 to produce hardened concrete to the lines, levels and shapes shown on the approved design 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.

**Formwork Requirements**

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

**Side Forms**

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

**Placement of Concrete**

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

**Material**

Provision shall be made for the accurate location and firm support of fittings, bolts, anchorages and formers of holes as shown on the approved design 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 approved design drawings.

**Formwork Fittings**

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

**Edge Treatment**

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

**Cleaning and Inspection**

### C271.09 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 concurrence of the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works) before manufacture of the formwork is commenced.

**Approval to Design**

### C271.10 PROVISION FOR DRAINAGE

Where shown on the approved design drawings, weepholes of 50mm diameter shall be provided in retaining walls and wingwalls.

**Weep Holes**

### C271.11 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.

**Formwork Material**

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

**Timber Requirements**

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 AS 2271, the hardwood shall comply with AS 2082 and the particle board with AS/NZS 1859.

**Timber Standards**

Formwork for exposed surfaces shall be made from panels having uniform widths of not less than 1m and uniform lengths of not less than 2m, except where the dimensions of the member formed are less than the specified panel dimensions.

**Formwork Panels for Exposed**

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 15mm thick. Form panels less than 15mm thick, otherwise conforming to these requirements may be used with a continuous backing of dressed material of 20mm minimum thickness. All form panels shall be placed in a neat, symmetrical pattern.

**Surfaces**

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.

**Hidden Surfaces**

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.

**Mild Steel Surfaces**

## **C271.12 ERECTION**

### **(a) General**

**Formwork  
Position  
Tolerances**

- (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 approved design 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, refer to Clauses C271.25 and C271.28.

- (ii) Joints as erected shall be mortar tight.

**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.

**Coating of  
Internal  
Surfaces**

- (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.

**Release Agent**

### **(b) Approval by the ARC Representative and/or Developer's Representative**

**Reinforcement  
Placement**

- (i) The formwork shall be inspected by the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works) and the placing of reinforcement in the spaces formed, where specified, shall not commence until the formwork is approved by the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works).

- (ii) Placing of concrete shall not commence until the reinforcement, where specified, has been accepted by the ARC Representative, and all dirt, chips, hardened concrete, mortar and all foreign matter removed from the forms.

**Concrete  
Placement**

- (iii) When an inspection is requested by the Constructor, a notice of not less than 24 hours, excluding Saturdays, Sundays and Public Holidays, shall be given to the ARC Representative.

**Notice of  
Inspection**

## MATERIALS FOR CONCRETE

### C271.13 CEMENT

Cement shall be Type GP Portland Cement complying with AS 3972 and shall be from a source included in the New South Wales Government Cement Quality Assurance Scheme.

**NSW QA Scheme**

When submitting details of the nominated mix in accordance with Clause C271.18, the Constructor shall nominate the brand and source of the cement. On approval of the nominated mix by the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works), the Constructor shall only use the nominated cement for the work.

**Nominated Brand and Source**

Documentary or other acceptable evidence of the quality of the cement shall be furnished by the Constructor, if required by the ARC Representative.

**Proof of Quality**

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

**Storage Time**

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

**Transport and Storage**

### C271.14 WATER

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

**Quality**

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

**Potability**

### C271.15 FINE AGGREGATE

Fine aggregates shall consist of clean, hard, tough, durable uncoated grains, uniform in quality, and shall conform to the requirements of AS 2758.1 in respect of bulk density, water absorption (maximum 5%) material finer than 2 micrometres, impurities and reactive materials.

**Quality**

Fine aggregates shall be evenly graded within the absolute limits shown in Table C271.1, and shall not deviate from the proposed grading by more than the amounts in Table C271.1.

**Grading Requirements**

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

**Table C271.1 - Fine Aggregate Grading**

### C271.16 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 AS 2758.1 in respect of particle density, bulk density, water absorption (maximum 2.5%), material finer than 75 micrometres, weak particles, light

**Quality**

particles, impurities and reactive materials, iron unsoundness and falling or dusting unsoundness. In all other respects, the coarse aggregate shall comply with this Specification. If required, coarse aggregate shall be washed to satisfy these requirements.

The percentage of wear shall be determined by AS 1141.23, and the loss of weight shall not exceed 30%.

**Wear Test**

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

**Additional Tests**

- (i) **Crushing Value - AS 1141.21**  
The aggregate crushing value shall not exceed 25%.
- (ii) **Soundness – AS 1141.24**  
The loss of mass when tested with sodium sulphate shall not exceed 12%.
- (iii) **Particle Shape – AS 1141.14**  
The proportion of mis-shapen particles (2:1 ratio) shall not exceed 35%.

Coarse aggregate shall be evenly graded within the absolute limits shown in Table C271.2 and shall not deviate from the grading of the samples submitted under Clause C271.18 by more than shown.

**Grading Requirements**

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

**Table C271.2 - Coarse Aggregate Gradings**

**C271.17 ADMIXTURES**

Chemical admixtures and their use shall comply with AS 478.1. 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.

**Quality and Use**

During the warm season, (October to March inclusive), a lignin or lignin-based ('ligpol') set-retarding admixture (Type Re or Type WRRe) approved by the ARC Representative shall be used to control slump within the limits stated in Clause C271.22. 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 AS 1478.1 for Type Re or Type WRRe shall be submitted to the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works), together with the proposed 'dosage chart' in accordance with Clause C271.18.

**Retarder for Warm Season**

During the cool season, (April to September inclusive), only a lignin or lignin based set-retarding admixture containing not more than 6% reducing sugars (Type WRRe complying with AS 1478.1) may be used in the mix.

**Retarder for Cool Season**

### C271.18 TESTING OF MATERIALS

The Constructor shall submit to the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works) a copy of a NATA Certified Laboratory Test Report on the quality and gradings of the aggregates proposed to be used in the work.

**Constructor's Responsibility**

The materials shall only be used after receipt of the notification of acceptance from the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works) and then only so long as the materials conform with this Specification.

**Use of Material**

## HANDLING AND TREATMENT OF CONCRETE

### C271.19 MEASURING

All materials shall be measured by weight, except that:

**Measurement of Material**

- (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 40kg. 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.
- (c) Measurement by volume for smaller works may be undertaken with the prior approval of the ARC Representative.

### C271.20 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 C271.3 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 C271.3 shall not relieve the Constructor of their obligation to provide concrete of the specified compressive strength.

**Mixing by Weight on Site**

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

**Table C271.3 - Materials in Batch containing 1 bag (40Kg) Cement**

The proportions set out in Table C271.3 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.

**Variation in Aggregate Moisture Content**

### C271.21 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.

**Mixing by Volume on Site**

The nominal proportions given in Table C271.4 may be used as a guide for volume batching.

**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

**Table C271.4 - Volume Batching**

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 by shovels or like methods will not be permitted. Batch proportions shall be so arranged that each batch contains one bag of cement. One 40kg bag of cement shall be assumed to have a volume of 27.5 litres.

**Batch Measurement**

### C271.22 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 ARC Representative, the Constructor shall determine the consistence of the concrete in accordance with AS 1012.3.1. Except for extruded concrete, the nominated slump shall not exceed 80mm, plus the field tolerance of  $\pm 15$ mm.

**Consistency Requirements**

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

**Extruded Concrete Consistency**

### C271.23 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.
- (ii) Any concrete which exhibits signs of segregation shall not be used.

**Mechanical Mixing**

**Segregation of Concrete**

#### (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 (1) 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.

**Mixer Requirements**

**Mixer Capacity**



- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>(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.</li> <li>(iv) The entire contents of a batch shall be discharged from the mixer before any materials are placed therein for the succeeding batch.</li> </ul>   | <p><b>Mixing Time</b></p> <p><b>Total Mix Discharge</b></p>  |
| <p><b>(c) Mixing in an Emergency</b></p>   |  |
| <ul style="list-style-type: none"> <li>(i) In the case of breakdown of the mechanical mixing equipment, hand mixing in small quantities so as to complete a section of the work or reach a suitable construction joint is permitted.</li> <li>(ii) Hand mixing shall be done on a water-tight platform of sufficient size to allow the mixing of at least two (2) batches simultaneously. The amount of cement used shall be 10% more than the amount specified for machine mixed concrete.</li> <li>(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 (3) times, not including shovelling into barrows or forms, until the mixture is uniform in colour and appearance. Hand-mixed batches shall not exceed 0.25m<sup>3</sup> each.</li> </ul> | <p><b>Hand Mixing</b></p> <p><b>Hand Mixing Conditions</b></p> <p><b>Hand Mixing Procedure</b></p>   |
| <p><b>(d) Ready-Mixed Concrete</b></p>   |  |
| <ul style="list-style-type: none"> <li>(i) The concrete shall be mixed and delivered in accordance with the requirements of AS 1379 relating to: <ul style="list-style-type: none"> <li>(A) Mixing and Delivery; and</li> <li>(B) Use of Non-Agitating Equipment.</li> </ul> <p>with the exception that in (A), the time taken from the introduction of water until the concrete is completely discharged shall be not more than 1.5 hours, and in (B), not more than 30 minutes.</p> </li> <li>(ii) The water used for flushing the chutes and for cleaning shall be discharged in an area acceptable to the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works). The chutes shall be long enough to permit delivery to the whole of the area enclosed by the forms.</li> <li>(iii) The mix design of concrete containing steel fibre reinforcement, including the quantity of steel fibre reinforcement, must be in accordance with the fibre manufacturer's recommendations.</li> </ul>   | <p><b>Mixing Standard and Discharge Times</b></p> <p><b>Cleansing and Positioning of Chutes</b></p> <p><b>Mix Design for Steel Fibre Reinforced Concrete</b></p> |

**C271.24 PLACING AND COMPACTING CONCRETE**

No concrete shall be mixed or placed, without the approval of the ARC Representative, 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.

**Air Temperature Requirements**

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.

**Placement within Time Limit**

The concrete shall be deposited in the forms, without separation of the aggregates. Concrete shall not be dropped freely from a height greater than 1.2m, 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.

**Placement in  
Forms,  
Vibrating**

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

**Exposed  
Surfaces**

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

**Initial Set**

In the case of concrete placed by an extrusion machine, small quantities of cement-sand slurry, comprised of two (2) parts of plasterer's sand and one (1) 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.

**Slurry for  
Extruded  
Concrete**

## **C271.25 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.

**Finish for  
Unformed  
Surfaces**

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

**Future  
Contact  
Surfaces**

### **(b) Wearing Surfaces**

Where a concrete wearing surface is shown on the approved design 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 2m. 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 5mm in any 3m length.

**Finish for  
Wearing  
Surfaces**

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.

**Surface to  
receive  
Asphalt**

### **(c) Finished Levels and Location**

The unformed surface of concrete structures not adjacent to road pavements shall not vary more than 25mm in plan position and not more than 25mm from the specified levels. In the case of barriers, drainage pits and other structures adjacent to road pavements, the finished concrete shall not vary more than 10mm from the specified levels and alignment. Barriers, footpaths and similar shall not deviate from level or alignment by more than 5mm from a straight-edge 3m long, subject to any necessary allowances on vertical and horizontal curves.

**Surface  
Tolerance**



**C271.26 CURING AND PROTECTION**

All exposed surfaces of the freshly placed concrete shall be kept moist either by the use of plastic sheeting, damp sand or commercial curing compounds, in accordance with AS 3799, for a minimum period of three (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 or replacing any work that has been damaged due to the abovementioned factors shall be borne by the Constructor.

**Curing Requirements**

Curing for concrete shall generally be in accordance with the appropriate surface exposure classification in AS 3600.

**Exposure Classification**

**C271.27 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 ARC Representative if the air shade temperature falls below 10°C during the periods specified.

**Walls, Sumps etc.**

- Mass retaining walls, headwalls, wingwalls,  
gully pits, sumps, and similar drainage structures: 48 hours
- Footpaths, driveways and similar: 48 hours
- Sides of reinforced concrete walls when height of each day pour is:
  - (i) under 0.6 metres 1 day
  - (ii) 0.6m to 3m 2 days
  - (iii) 3m to 6m 3 days
  - (iv) 6m to 9m 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.

**Barriers**

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.

**Protection of Concrete**

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

**Superimposed Load**

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.

**Removal of Hole Formers**

**C271.28 TREATMENT OF FORMED SURFACES**

All concrete surfaces shall be true and even, free from stone pockets, depressions or projections beyond the surface. All rises 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 have finishes in accordance with the classes of surface finish in AS 3610 as follows:

**Quality of Surfaces**

- (i) Non-visible surfaces - Class 4
- (ii) 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 with a wooden float.

**Repair of Defects**

Any tie wires or other fitments extending to outside surfaces, shall be cut back after removal of forms, to a depth of at least 40mm 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.

**Removal of the Wires**

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.

**Coating with Bonding Agent**

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

**Surface Tolerance**

### **C271.29 JOINTS**

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 ARC Representative. 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.

**Horizontal Construction Joint**

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

**Vertical Expansion Joints**

Where barriers are extruded or cast in place, narrow transverse vertical grooves, 20mm 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 3m.

**Barrier Contraction**

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

**Barrier Expansion**

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

**Footpath Expansion**

All unreinforced paving shall be provided with narrow vertical grooves, 20mm 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 2m<sup>2</sup>. The ratio of the longest side to the shortest side shall not exceed 1.6.

**Contraction Joints**

### **C271.30 STRENGTH OF CONCRETE**

When tested in accordance with AS 1012.9, the concrete shall have a compressive strength not less than that shown on the approved design drawings or if not shown, shall have a compressive strength not less than that specified in Table C271.5 for the particular class of work. The cement content restrictions shown in Table C271.5 refer to Portland cement. Where General Purpose Blended cements are utilised, the acceptable minima are indicated in brackets.

**Strength Requirement**

The strength shall be determined from the average of not less than two (2) 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.

**Determination of Strength**

In general, two (2) pairs of test specimens shall be moulded for each 15m<sup>3</sup> of concrete, or part thereof, one (1) pair being intended for the 7 day test if required and the other pair for a 28 day test.

**Moulding of  
Cylinders**

Use	MPa	Minimum Portland Cement per cu metre (Minimum GP Blended Cement)	Coarse Aggregate Nominal Size	Cylinder Strength Required	
				7 days	28 days
				MPa	MPa
Foundations, mass retaining walls	20	270 (330)	40	15	20
Mass concrete footings, pitching, linings etc.	20	270 (330)	20	15	20
Drainage structures, driveways footpaths, New Jersey barrier, miscellaneous minor concrete work	20	270 (330)	20	15	20
Reinforced concrete culverts, headwalls, base slabs, sign structure large footings, retaining walls	32	320 (380)	20	24	32
Extruded concrete	20	270 (330)	14	15	20

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.

**Table C271.5 - Concrete Strength Requirements**

The strengths specified at 28 days shall be increased by multiplying by factors as shown in Table C271.6 for tests at ages in excess of 28 days.

**Strength Age  
Factor**

*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

**Table C271.6 – Tests at Ages in Excess of 28 Days**

If the test specimens fail to achieve the specified strength, the Constructor may, with the approval of the ARC Representative, arrange for cores to be taken from the work. If the average strength of such cores complies with the specified requirements nominated in Table C271.5, the concrete will be accepted.

**Cores and Test Acceptance**

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

**Failure of Cores**

### **C271.31 SAMPLING CONCRETE**

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

**Constructor's Responsibility**

Concrete test specimens shall be cylinders 300mm long and 150mm diameter, moulded concurrently in the presence of the ARC Representative, in accordance with AS 1012.8, from samples taken in accordance with AS 1012.1.

**Moulding of Test Cylinders**

## **STEEL REINFORCEMENT FOR CONCRETE**

### **C271.32 MATERIAL**

Steel reinforcement shall comply with the requirements of AS 4671.

**Standards**

Steel fibre reinforcement must be of a type recommended by the fibre manufacturer for the intended use.

**Steel Fibre Reinforcement**

The type and size of bars shall be as shown on the approved design drawings.

**Type and Size**

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

**Quality**

The Constructor shall supply evidence satisfactory to the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works) that steel reinforcement complies with AS 4671. Test certificates shall show the results of mechanical tests and chemical analysis.

**Documentary Evidence**

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

**Further Sampling  
Constructor's Cost**

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

**Bar Chairs**

### **C271.33 BENDING**

Reinforcement shall be formed to the dimensions and shapes shown on the approved design 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 approved design 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.

**Cutting and Bending**

### **C271.34 SPLICING**

#### **(a) General**

All reinforcement shall be furnished in the lengths indicated on the approved design drawings. If splicing is required, it shall be in accordance with the provisions of AS 4671.

**Plan Lengths**

The cost of any test ordered in connection with splices not shown on the approved design drawings shall be borne by the Constructor.

**Constructor's Cost**

**(b) Lapped Splices**

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

**Lap Dimensions**

- (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 25mm.

**Splice Dimensions**

**C271.35 MARKING**

Bars of identical shape shall be made up in bundles of three (3) and securely tied together by soft iron wire. Each bundle shall have a stout metal label of not less than 40mm diameter attached to it. Each metal label shall be punched with the appropriate marking in accordance with the steel list shown on the approved design drawings. If called for on the approved design drawings, the marking shall incorporate a prefix, and bars with different prefixes shall be stored separately.

**Marking Details**

**C271.36 STORAGE**

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

**Protection of Reinforcement**

**C271.37 DELIVERY AND RECEIPT OF REINFORCEMENT**

Unless the Constructor 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 ARC Representative and/or Developer's Representative (for Developer Infrastructure Works).

**Test Before Delivery**

The Constructor shall give five (5) working days' notice to the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works) for carrying out inspection and testing. The ARC Representative will carry out the inspection and testing within two (2) days after notification.

**Notice to Test**

**C271.38 PLACING**

Reinforcement shall be accurately placed as shown on the approved design 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 0.5m centres, whichever is the greater distance, using annealed iron wire of diameter not less than 1.25mm. 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 approved design drawings.

**Reinforcement Position**

The ARC Representative may approve the use of tack welding instead of wire ties on reinforcing wire. All welding of reinforcing steel shall be in accordance with AS 1554.3. Tack welding of cold-worked and hard grade bars shall not be permitted.

**Tack Welding**

The reinforcement in each section of the work shall be approved by the ARC Representative 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 four (4) normal working hours.

**Inspection Required**

Splices shall be staggered where practicable and when not shown on the approved design drawings they shall be arranged as directed by the ARC Representative.

**Splices**

Bars forming a lapped splice shall be securely wired together in at least two (2) places, unless welded. **Lapped Splice**

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

- (a) Concrete normally in contact only with air:
  - (i) Slabs: 40mm
  - (ii) Other than slabs: 45mm
- (b) Concrete in contact with earth or fresh water:
  - (i) Slabs of box culverts: 50mm
  - (ii) Other than culverts: 50mm

In no cases shall the cover be less than 1½ times the diameter of the bar.

## BACKFILLING

### C271.39 GENERAL

Backfilling at barriers, paving, etc, and minor concrete works shall not commence until after the concrete has hardened and not earlier than three (3) days after placing.

No filling shall be placed against retaining walls, headwalls or wingwalls within 21 days after placing of the concrete, unless the walls are effectively supported by struts to the satisfaction of the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works), or when the Constructor can demonstrate that 85% of the design strength of the concrete has been achieved. **Adjacent to Walls**

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 50mm gauge. The Plasticity Index of this selected backfill material shall not be less than 2 or more than 12 when tested in accordance with AS 1289.3.3.1. The material shall be placed in layers not exceeding 150mm and shall be compacted to provide a relative compaction of not less than 92% as determined by AS 1289.5.4.1 for modified compactive effort. **Selected Backfill**

### C271.40 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 50mm to 10mm such that: **Size & Type of Backfill Material**

- (a) The maximum particle dimension shall not exceed 50mm.
- (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 300mm horizontally into the fill and extend at least 450mm vertically above the level of the weepholes. **Extent of Material**

Alternatively, the Constructor may provide a synthetic membrane of equivalent drainage characteristics at the Constructor's cost. It shall be stored and installed in accordance with Manufacturer's instructions. The use of a synthetic membrane shall be subject to the approval of the ARC Representative. **Synthetic Membrane**



## SPRAYED CONCRETE

### C271.41 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. **Definition**

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

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

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

Cores shall be secured, accepted, cured, capped and tested in accordance with AS 1012.14. Equipment and facilities shall be provided by the Constructor for the taking of cores from the work. The Constructor 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 ARC Representative and/or Developer's Representative (for Developer Infrastructure Works). **Test Cores**

The cost of all work and material required in the taking, handling, delivery and testing of cores shall be borne by the Constructor. **Constructor's Cost**

At least fourteen (14) days prior to applying any sprayed concrete, the Constructor shall submit to the ARC Representative and/or Developer's Representative (for Developer Infrastructure Works) details of their proposed procedure, plant, materials and mix proportions. Materials shall comply with AS 3600. **Constructor's Responsibility**

### C271.42 TEST PANELS

Not less than ten (10) days before applying concrete, the Constructor shall prepare at least three (3) test panels for each mix proposed, in conditions similar to those in the works and in the presence of the ARC Representative. The test panels shall be made by applying a 75mm thickness of sprayed concrete to a hardboard panel approximately 750mm 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 ARC Representative for examination. **Test Panels**

The Constructor shall cut four 75mm diameter cores from one (1) 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 (1) core shall be compression tested at three (3) days, one core at seven (7) days and the remaining two cores at 28 days. **Cores**

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 Constructor shall modify the mix design and/or method of placement and prepare fresh test panels for testing and inspection. **Defective Core**

Sprayed concrete shall not be applied to the Works until the Constructor produces test panels for the approval of the ARC Representative. **Approval**

### C271.43 SURFACE PREPARATION

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

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. **Rock**

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

The Constructor shall remove free water and prevent the flow of water which could adversely affect the quality of the sprayed concrete. **Water Flow**

#### **C271.44 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 so as 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. **Procedure**

Spraying shall be discontinued if wind causes separation of the nozzle stream. **Wind Problem**

Concrete shall not be sprayed in air temperatures less than 5°C. **Air Temperature**

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. **Construction Joints**

When spraying around reinforcement, concrete is to be sprayed behind the reinforcement before concrete is allowed to accumulate on the face of the reinforcement. **Spraying around 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. **Protection of Adjoining Surfaces**

#### **C271.45 CURING**

Curing shall commence within one (1) hour of the application of sprayed concrete and may be by water or by colourless wax emulsion curing compound complying with AS 3799 and applied in accordance with manufacturer's specifications **Commencement**

In water curing, the surface of the sprayed concrete shall be kept continuously wet for at least seven (7) days. **Water Curing**



## LIMITS AND TOLERANCES

### C271.46 SUMMARY OF LIMITS AND TOLERANCES

The limits and tolerances applicable to the various clauses in this Specification are summarised in Table C271.7 below:

Item	Activity	Limits/Tolerances	Spec Clause
<b>1</b>	<b>Subgrade</b>		
	(a) Relative Compaction	≥ 92% (modified compactive effort).	C271.04
<b>2</b>	<b>Barriers, Footpaths etc.</b>		
	(a) Finished Subbase	To be trimmed and compacted so that the levels do not vary more than 15mm under a straight-edge 3m long.	C271.05
	(b) Relative Compaction of Subbase	≥ 95% (modified compactive effort). ≥ 97% (standard compactive effort).	C271.05
<b>3</b>	<b>Formwork</b>		
	(a) Position of Forms	Forms shall be aligned accurately so that departure of the forms from the surfaces specified on the approved design 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.	C271.12
<b>4</b>	<b>Fine Aggregate</b>		
	(a) Grading	To be evenly graded within the absolute limits and shall not deviate from the grading of sample aggregate as per Table C271.1.	C271.15
<b>5</b>	<b>Coarse Aggregate</b>		
	(a) Percentage of wear	Loss of weight shall not exceed 30%.	C271.16
	(b) Crushing Value	Crushing value shall not exceed 25%.	C271.16
	(c) Soundness	The loss of mass when tested with sodium sulphate shall not exceed 12%.	C271.16
	(d) Particle Shape	The proportion of mis-shapen particles (2:1 ratio) shall not exceed 35%.	C271.16
	(e) Grading	To be evenly graded within the absolute limits and shall not deviate from the grading of sample aggregate as per Table C271.2.	C271.16
<b>6</b>	<b>Aggregate Moisture Content</b>		
	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.	C271.20
<b>7</b>	<b>Consistency</b>		
	Consistency	In accordance with AS 1012.3 Method 1, the slump shall not exceed the nominated slump ±15mm.	C271.22

Item	Activity	Limits/Tolerances	Spec Clause
	Concrete placed by extrusion machine	The slump will be between 10mm and 15mm.	C271.22
<b>8</b>	<b>Ready-Mixed Concrete</b>		
	(a) Mixing & Delivery	The time taken from the introduction of water until the concrete is completely discharged shall be not more than 1.5 hours.	C271.23
		Where non-agitating equipment is used, the concrete shall be completely discharged not more than 30 minutes after the addition of water.	
<b>9</b>	<b>Placing &amp; Compacting of Concrete</b>		
	Placing & Compacting of Concrete	Concrete shall not be placed without the approval of the ARC Representative if the air temperature within 24 hours is likely to be below 5°C or the shade temperature is likely to exceed 38°C.	C271.24
<b>10</b>	<b>Finishing of Unformed/ Formed Concrete Surfaces</b>		
	(a) Wearing Surface	To be finished true and uniform so that departure from designed grade shall not exceed 5mm in any 3m length.	C271.25(b)
	(b) Finished Surfaces		
	(i) Not Adjacent to Roads	≤ 25mm Plan position. ≤ 25mm Level.	C271.25(c) C271.27
	(ii) Adjacent to Roads	≤ 10mm Alignment. ≤ 10mm Level.	

**Table C271.7 - Summary of Limits and Tolerances**

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