DEVELOPMENT CONSTRUCTION SPECIFICATION

C271

MINOR CONCRETE WORKS

SPECIFICATION C271 - MINOR CONCRETE WORKS

SPECIFICATION C271
MINOR CONCRETE WORKS

GENERAL

C271.01 SCOPE

1. 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 Drawings but not having individual Specifications. These 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.

2. The work also includes supply and placement of sprayed concrete and 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.

C271.02 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

(a) Australian Standards

AS 1012.1	-	Sampling fresh concrete
AS 1012.3	-	Determination of properties related to the consistency of concrete
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 caliper.
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 1289.5.1.1	-	Determination of the dry density/moisture content relation of a soil using standard compactive effort.
AS 1289.5.2.1	-	Determination of the dry density/moisture content relation of a soil using modified compactive effort.
AS 1289.5.4.1	-	Compaction control test – Dry density ratio, moisture variation and moisture ratio.
AS 1302	-	Steel reinforcing bars for concrete.
AS 1303	-	Steel reinforcing wire for concrete.
AS 1304	-	Welded wire reinforcing fabric for concrete.
AS 1379	-	The specification and manufacture of concrete.
AS 1478	-	Chemical admixtures for concrete.
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.

(b) RTA Specification

3204 - Preformed joint fillers for concrete road pavements and structures.

(c) RTA Test Method

T 166 - Determination of relative compaction.

EXCAVATION AND FOUNDATIONS

C271.03 GENERAL

Foundations

1. The subgrade or subbase 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, or of the subbase material (where specified).

Unsuitable Material

2. All soft, yielding or other unsuitable material shall be replaced with sound material approved by Council's Development Engineer, and the subgrade shall be compacted to provide a minimum relative compaction of 95 per cent (standard compaction) as determined by AS 1289.5.4.1. If the subgrade is dry it shall be sprinkled with as much water as it will readily absorb, before the concrete is placed.

Shoring

3. The Contractor shall supply all necessary sheeting and bracing to support the excavation in accordance with the Workcover Authority of NSW Regulations. The excavation shall be kept free of water.

C271.04 NEW JERSEY TYPE BARRIERS, DRIVEWAYS AND FOOTPATHS

Subbase

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

Compaction

2. The subbase material shall be compacted to provide a minimum relative compaction as determined by Test Method T166 of 100 per cent for standard compactive effort or 98 per cent for modified compactive effort as appropriate.

Subgrade and Subbase Tolerances

3. The finished subbase shall not deviate more than 12mm under a straight edge 3-metres long, subject to any necessary allowance on vertical curves.

C271.05 NOT USED

C271.06 RETAINING WALLS, HEADWALLS AND WINGWALLS

Rock Foundations

1. 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.

Earth Foundations

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

3. Unless otherwise specified, precast concrete wall sections shall be placed on a bed of fresh concrete 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

C271.07 GENERAL

1. Formwork shall be provided in accordance with AS 3610 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 workmen 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

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

Side Forms

3. 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 metres or to move concrete along the formwork after deposition.

Placement of Concrete

4. Material used shall be sound and suitable for the purpose intended and surface finish specified.

Material

5. 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.

Formwork Fittings

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

Edge Treatment

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

Cleaning and Inspection

C271.08 APPROVAL OF FORMWORK DESIGN

1. If requested by the Development Control Engineer for box culverts and reinforced concrete retaining walls, detailed drawings, design calculations, description and/or samples of materials proposed for use shall be submitted to Council's Development Engineer for concurrence before manufacture of the formwork is commenced.

Approval to Design

C271.09 PROVISION FOR DRAINAGE

1. Where shown on the Drawings, or where directed by Council's Development Engineer, weepholes of 50mm diameter shall be provided in retaining walls and wingwalls.

Weep Holes

C271.10 CONSTRUCTION

1. 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

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

Timber Requirements

3. Timber forms for exposed surfaces shall be constructed from plywood or particleboard 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 particleboard with AS/NZS 1859.

Timber Standards

4. 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. 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 20 mm minimum thickness. All form panels shall be placed in a neat, symmetrical pattern.

Formwork Panels for Exposed Surfaces

5. 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 particleboard.

Hidden Surfaces

6. 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

C271.11 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 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.

(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 Council's Development Engineer

(i) Placing of concrete shall not commence until formwork and the reinforcement has been accepted by Council's Development Engineer, and all dirt, chips, hardened concrete, mortar and all foreign matter removed from the forms. Acceptance by Council's Development Engineer shall constitute a **HOLD POINT.**

Concrete Placement

HP

(ii) When an inspection is requested by the Contractor, a notice of not less than 48 hours, excluding Saturdays, Sundays and Public Holidays, shall be given to Council's Development Engineer.

Notice of Inspection

MATERIALS FOR CONCRETE

C271.12 CEMENT

1. 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. ***Quality***

2. When submitting details of the nominated mix in accordance with Clause C271.17, the Contractor shall nominate the brand and source (including works) of the cement. On approval of the nominated mix by Council's Development Engineer, the Contractor shall only use the nominated cement for the work. ***Nominated Brand and Source***

3. The Contractor shall furnish documentary or other acceptable evidence of the quality of the cement, if required by Council's Development Engineer. ***Proof of Quality***

4. If the Contractor 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 before the cement is used. ***Storage Time***

5. 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***

C271.13 WATER

1. Water shall be free from injurious amounts of materials harmful to concrete and to its reinforcement and neither salty or brackish. ***Quality***

2. Water that is not potable for human beings shall not be used in reinforced concrete. ***Potability***

C271.14 FINE AGGREGATE

1. 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 per cent) material finer than 2 micrometres, impurities and reactive materials. ***Quality***

2. Fine aggregates shall be evenly graded within the absolute limits shown 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

C271.15 COARSE AGGREGATE

Quality

1. Coarse aggregate shall consist of clean, hard, durable, crushed stone, crushed river gravel, screened river gravel or metallurgical furnace slag. It shall conform to the requirements of AS 2758.1 in respect of particle density, bulk density, water absorption (maximum 2.5 per cent), 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 Specification. If required, coarse aggregate shall be washed to satisfy these requirements.

Wear Test

2. The percentage of wear shall be determined as per AS 1141.23, and the loss of weight shall not exceed 30 per cent.

Additional Tests

3. When required by Council's Development Engineer, coarse aggregate shall be tested for conformance for any or all of the properties set out below:

(i) Crushing Value - AS 1141.21
The aggregate crushing value shall not exceed 25 per cent.

(ii) Soundness - AS 1141.24
The loss of mass when tested with sodium sulphate shall not exceed 12 per cent.

(iii) Particle Shape - AS 1141.14
The proportion of mis-shapen particles (2:1 ratio) shall not exceed 35 per cent.

Grading Requirements

4. Coarse aggregate shall be evenly graded within the absolute limits shown in Table C271.2.

Australian Standard Sieve (mm)	Proportion Passing (% of Mass)			Deviation Proposed Grading (% of Mass of Sample)
	40mm Nominal For Walls exceeding 150mm thickness	20mm Nominal For all other structures	Extrusion Concrete	
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

C271.16 ADMIXTURES

1. Chemical admixtures and their use shall comply with AS 1478. 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***

2. During the warm season, (October to March inclusive), a lignin or lignin-based (`ligpol') set-retarding admixture (Type Re or Type WR Re) approved by Council's Development Engineer shall be used to control slump within the limits stated in Clause C271.21. 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 for Type Re or Type WR Re shall be submitted to Council's Development Engineer, together with the proposed `dosage chart' in accordance with Clause C271.17. ***Retarder for Warm Season***

3. During the cool season, (April to September inclusive), only a lignin or lignin based set-retarding admixture containing not more than 6 per cent reducing sugars (Type WR Re complying with AS 1478) may be used in the mix. ***Retarder for Cool Season***

C271.17 TESTING OF MATERIALS

1. The Contractor shall submit to Council's Development Engineer a copy of a NATA Certified Laboratory Test Report on the quality and gradings of the aggregates proposed in the work. ***Contractor's Responsibility***

HANDLING AND TREATMENT OF CONCRETE

C271.18 MEASURING

1. 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, and,

   (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 Council's Development Engineer.

C271.19 MEASURING BY WEIGHT, ON-SITE MIXING

Mixing by Weight on Site

1. 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 Contractor of his obligation to provide concrete of the specified compressive strength.

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

Variation in Aggregate Moisture Content

2. The proportions set out in Table C271.3 make allowance for moisture contents of aggregates of 6 per cent for fine aggregates and 1 per cent for coarse aggregates. Where the moisture content of aggregates exceeds 8 per cent or 3 per cent respectively, the proportions of the mix shall be changed to compensate for the excess water in the aggregate.

C271.20 MEASURING BY VOLUME, ON-SITE MIXING

Mixing by Volume on Site

1. 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.

Volume Batching

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

Batch Measurement

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 by shovels or like methods will not be permitted. Batch proportions shall be so arranged such that each batch contains 1 bag of cement. One 40kg bag of cement shall be assumed to have a volume of 27.5 litres.

C271.21 CONSISTENCY

Consistency Requirements

1. 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 Council's Development Engineer, the Contractor shall determine the consistence of the concrete in accordance with AS 1012.3, Method 1. Except for extruded concrete, the nominated slump shall not exceed 80mm, plus the field tolerance of ±15mm.

Extruded Concrete Consistence

2. 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.

C271.22 MIXING AND DELIVERY

(a) General

Mechanical Mixing

(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.

Segregation of Concrete

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

(b) Machine Mixing at Site

Mixer Requirements

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

Mixer Capacity

(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.

Mixing Time

(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.

Total Mix Discharge

(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

Hand Mixing

(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.

Hand Mixing Conditions

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

Hand Mixing Procedure

(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 cubic metres each.

(d) Ready-Mixed Concrete

(i) The concrete shall be mixed and delivered in accordance with the requirements of AS 1379 relating to: - ***Mixing Standard and Discharge Times***

(1) Mixing and Delivery; and

(2) Use of Non-Agitating Equipment,

with the exception that in (1) the time taken from the introduction of water until the concrete is completely discharged shall be not more than 1.5 hours, and in (2) not more than 30 minutes.

(ii) The water used for flushing the chutes and for cleaning and any excess concrete shall be discharged in an area acceptable to Council's Development Engineer and in a manner in accordance with the requirements of the Protection of the Environment (Operations) Act 1997. The chutes shall be long enough to permit delivery to the whole of the area enclosed by the forms. ***Cleansing and Positioning of Chutes***

C271.23 PLACING AND COMPACTING CONCRETE

1. Without the approval of Council's Development Engineer, no concrete shall be placed during rain or while the air temperature is, or is likely to be within 24 hours, below 5°C or while the shade temperature exceeds 38°C. ***Air Temperature Requirements***

2. 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***

3. 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 metres, 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***

4. 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. ***Exposed Surfaces***

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

6. In the case of concrete placed by an extrusion machine, small quantities of cement-sand slurry comprising two parts of plasterer's sand and one part cement (by volume), together with sufficient water to bring the mixture 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***

C271.24 FINISHING OF UNFORMED SURFACES

(a) Surfaces other than Wearing Surfaces

1. 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 ***Finish for Unformed***

be taken to drain or otherwise remove promptly any water that comes to the surface. A capping of mortar will not be permitted. ***Surfaces***

2. 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

1. 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. 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 3-metre length. ***Finish for Wearing Surfaces***

2. 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

1. The finished levels of concrete structures not adjacent to road pavements shall not vary 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 3 metres long, subject to any necessary allowances on vertical and horizontal curves. ***Surface Tolerance***

C271.25 CURING AND PROTECTION

1. 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 for a minimum period of 3 days. During this time the work must be adequately protected from traffic and any other causes likely to damage the concrete. ***Curing Requirements***

C271.26 REMOVAL OF FORMS

1. All forms shall remain in place for minimum periods specified hereinafter. Council's Development Engineer may extend these periods 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

2. To permit the satisfactory finishing of barriers, forms shall be removed in not less than 12 hours or more than 48 hours after placing concrete, depending upon weather conditions. ***Barriers***

3. Care shall be taken in removing forms so that the concrete will not be cracked, ***Protection of***

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. ***Concrete***

4. No superimposed load shall be allowed on any part of a structure until the concrete has reached at least 70 per cent of the design strength. ***Superimposed Load***

5. 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***

C271.27 TREATMENT OF FORMED SURFACES

1. All concrete surfaces shall be true and even, free from stone pockets, depressions or projections beyond the surface. All arrises shall be sharp and true, and mouldings shall be evenly mitred or rounded. Care shall be exercised in removing forms to ensure this result. ***Quality of Surfaces***

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***

3. 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***

4. 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***

C271.28 JOINTS

1. Where horizontal construction joints are found to be necessary in walls, or cast-in-situ drainage structures (other than barriers and footpaths) the joints may be made at the base of walls and at other locations in the walls where approved by Council's Development Engineer. In order to provide for a bond between the new concrete and the concrete that 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***

2. 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. ***Vertical Expansion Joints***

3. 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 3 metres. ***Barrier Contraction***

4. In barriers, unless shown otherwise on the 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 preformed joint filler complying with RTA Specification 3204. ***Barrier Expansion***

5. In footpaths, median toppings and driveways, unless otherwise shown on the 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 preformed joint filler complying with RTA

Specification 3204.

6. 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 $2m^2$. The ratio of the longest side to the shortest side shall not exceed 1.6.

C271.29 STRENGTH OF CONCRETE

Strength Requirement

1. When tested in accordance with AS 1012.9, the concrete shall have a 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 C271.5 for the particular class of work.

Determination of Strength

2. The 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.

Moulding of Cylinders

3. In general, two pairs of test specimens shall be moulded for each 15 cubic metres 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.

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

Table C271.5 - Concrete Strength Requirements

Strength Age Factor

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

*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 - Concrete Age Conversion Factors

5. If the test specimens fail to achieve the specified strength, the Contractor may, with the approval of Council's Development Engineer, arrange for cores to be taken from the work. If the average strength of such cores complies with the specified requirements, the concrete will be accepted. ***Cores and Test Acceptance***

6. If cores taken fail to satisfy the strength requirements, the concrete shall be removed. ***Failure of Cores***

C271.30 SAMPLING CONCRETE

1. The Contractor shall provide equipment and facilities for the taking and storage of samples of any materials or concrete being used, or intended to be used in the work. ***Contractor's Responsibility***

2. Concrete test specimens shall be cylinders 300mm long and 150mm diameter, moulded, in accordance with AS 1012.8, from samples taken in accordance with AS 1012.1. ***Moulding of Test Cylinders***

STEEL REINFORCEMENT FOR CONCRETE

C271.31 MATERIAL

1. Steel reinforcement shall comply with the requirements of the appropriate following Australian Standards: - ***Standards***

(a) AS 1302 Steel Reinforcing Bars for Concrete.

(b) AS 1303 Steel Reinforcing Wire for Concrete.

(c) AS 1304 Welded Wire Reinforcing Fabric for Concrete.

2. The type and size of bars shall be as shown on the Drawings. ***Type and Size***

3. 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***

4. The Contractor shall supply evidence satisfactory to Council's Development Engineer that steel reinforcement complies with AS 1302, AS 1303 or AS 1304, as ***Documentary Evidence***

appropriate. Test certificates shall show the results of mechanical tests and chemical analysis.

5. 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. ***Further Sampling Contractor's Cost***

6. Plastic tips for wire chairs shall be capable of withstanding a load of 200kg mass on the chair for one hour at 23 ± 5°C without being pierced by the wire. The Contractor shall demonstrate that the proposed chairs conform to these requirements. ***Wire Chairs***

C271.32 BENDING

1. 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. ***Cutting and Bending***

C271.33 SPLICING

(a) General

1. All reinforcement shall be furnished in the lengths indicated on the Drawings. If splicing is required, this to be in accordance with the provisions of AS 1302. ***Plan Lengths***

(b) Lapped Splices

1. 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: - ***Lap Dimensions***

Plain bars, Grade 250	40 bar diameters
Deformed bars, Grade 400	35 bar diameters
Hard-drawn wire	50 bar diameters

2. 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***

C271.34 MARKING

1. 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 40mm 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. ***Marking Details***

C271.35 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***

C271.36 PLACING

Reinforcement Position

1. 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 0.5m 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 Drawings.

Tack Welding

2. Council's Development Engineer may approve the use of tack welding instead of wire ties on reinforcing wire. Tack welding of cold-worked and hard grade bars shall not be permitted.

Inspection Required

3. Council's Development Engineer shall approve the reinforcement in each section of the work before any concrete is deposited in the section and adequate time shall be allowed for inspections and any corrective work that may be required. Notice for inspection shall not be less than 48 hours.

Splices

4. Splices shall be staggered where practicable and when not shown on the drawings they shall be arranged as directed by Council's Development Engineer.

Lapped Splice

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

Bar Cover

6. 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:	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

C271.37 GENERAL

1. 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.

Adjacent to Walls

2. 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 Council's Development Engineer, or when the Contractor can demonstrate that 85 per cent of the design strength of the concrete has been achieved.

3. 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 from 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 95 per cent (standard compaction) as determined by AS 1289.5.4.1.

Selected Backfill

C271.38 TREATMENT AT WEEPHOLES

1. 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 per cent by mass shall pass the 9.5mm A.S. sieve.

2. The broken stone or river gravel 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

3. Alternatively the Contractor may provide a synthetic membrane of equivalent drainage characteristics. 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 Council's Development Engineer'.

Synthetic Membrane

SPRAYED CONCRETE

C271.39 GENERAL

1. 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

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

Depth

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

Colour

4. 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 75mm diameter cores taken from in-place sprayed concrete.

Strength

5. Cores shall be secured, accepted, cured, capped and tested in accordance with AS 1012.9 and AS 1012.14. The Contractor shall engage a NATA registered laboratory to carry out the sampling, curing and testing of the cores. Copies of test results shall be forwarded to Council's Development Engineer.

Test Cores

6. At least 14 days prior to applying any sprayed concrete the Contractor shall submit to Council's Development Engineer details of his proposed procedure, plant, materials and mix proportions. Materials shall comply with AS 3600.

Contractor's Responsibility

C271.40 SURFACE PREPARATION

1. Earth surfaces shall be graded, trimmed, compacted, and shall be dampened prior to applying the sprayed concrete. The Contractor shall take any precautions necessary to

Earth

prevent erosion when the sprayed concrete is applied.

2. 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***

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

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

C271.41 APPLICATION OF SPRAYED CONCRETE

1. 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 by air jet or other suitable means from the surface as work proceeds and disposed of. ***Procedure***

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

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

4. Construction joints shall be kept to a minimum. A joint shall be formed by placing or trimming the sprayed concrete to an angle of 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***

5. 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***

6. 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***

C271.42 CURING

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

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

LIMITS AND TOLERANCES

C271.43 SUMMARY OF LIMITS AND TOLERANCES

1. The tolerances applicable to the various clauses in this Specification are summarized in Table C271.7 below:

Item	Activity	Tolerances	Spec Clause
1.	**Subgrade**		
	(a) Relative Compaction	≥95% (standard compactive effort)	C271.03
2.	**Barriers, Footpaths etc.**		
	(a) Finished Subbase	To be trimmed and compacted so that the levels do not vary more than 12mm under a straight-edge 3 metres long.	C271.04
	(b) Relative Compaction of Subbase	≥98% (modified compactive effort) ≥100% (standard compactive effort)	C271.04
3.	**Formwork**		C271.11
	(a) 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**		
	(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.	C271.14
5.	**Coarse Aggregate**		
	(a) Percentage of wear	Loss of weight shall not exceed 30%	C271.15
	(b) Crushing Value	Crushing value shall not exceed 25%	C271.15
	(c) Soundness	The loss of mass when tested with sodium sulphate shall not exceed 12%	C271.15
	(d) Particle Shape	The proportion of misshapen particles (2:1 ratio) shall not exceed 35%	C271.15
	(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.	C271.15

Item	Activity	Tolerances	Spec Clause
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.	C271.19
7.	**Consistency**	In accordance with AS 1012.3, Method 1 the slump shall not exceed the nominated slump ±15mm.	C271.21
		In the case of concrete placed by extrusion machine, the slump will be between 10mm and 15mm.	C271.21
8.	**Ready-Mixed Concrete**		
	(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.	C271.22
		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 Council's Development Engineer if the air temperature within 24 hours is likely to be below 5°C or the shade temperature is likely to exceed 38°C.	C271.23
10.	**Finishing of Unformed Concrete Surfaces**		
	(a) Wearing Surface	To be finished true and uniform so that departure from designed grade shall not exceed 5mm in any 3 metre length.	C271.24
	(b) Finished Level	The finished levels of concrete structures not adjacent to road pavements shall not vary more than 25mm from the specified levels.	C271.24
		In the case of drainage pits and other structures adjacent to road pavements the finished concrete level shall not vary more than 10mm from the specified level and alignment.	C271.24

Table C271.7 - Summary of Limits and Tolerances