

CAPRICORN MUNICIPAL DEVELOPMENT GUIDELINES

MINOR CONCRETE WORKS

C271

CONSTRUCTION SPECIFICATION

TABLE OF CONTENTS

CLAUSE	CONTENTS	PAGE
GENERAL	.....	4
C271.01	SCOPE.....	4
C271.02	REFERENCE DOCUMENTS.....	4
EXCAVATION AND FOUNDATIONS	.....	5
C271.03	GENERAL.....	5
C271.04	NEW JERSEY TYPE BARRIERS, DRIVEWAYS AND FOOTPATHS.....	5
C271.05	RETAINING WALLS, HEADWALLS AND WINGWALLS.....	6
FORMWORK	.....	6
C271.06	GENERAL.....	6
C271.07	PROVISION FOR DRAINAGE.....	7
C271.08	CONSTRUCTION.....	7
C271.09	ERECTION.....	8
MATERIALS FOR CONCRETE	.....	8
C271.10	CEMENT.....	8
C271.11	WATER.....	8
C271.12	FINE AGGREGATE.....	9
C271.13	COARSE AGGREGATE.....	9
C271.14	ADMIXTURES.....	10
C271.15	TESTING OF MATERIALS.....	10
HANDLING AND TREATMENT OF CONCRETE	.....	11
C271.16	MEASURING.....	11
C271.17	MEASURING BY WEIGHT, ON-SITE MIXING.....	11
C271.18	MEASURING BY VOLUME, ON-SITE MIXING.....	12
C271.19	CONSISTENCY.....	12

C271.20	MIXING AND DELIVERY	12
C271.21	PLACING AND COMPACTING CONCRETE	14
C271.22	FINISHING OF UNFORMED SURFACES	14
C271.23	CURING AND PROTECTION.....	15
C271.24	REMOVAL OF FORMS.....	15
C271.25	TREATMENT OF FORMED SURFACES.....	16
C271.26	JOINTS.....	16
C271.27	STRENGTH OF CONCRETE	17
C271.28	SAMPLING CONCRETE	19
STEEL REINFORCEMENT FOR CONCRETE		19
C271.29	MATERIAL	19
C271.30	BENDING	20
C271.31	SPLICING	20
C271.32	STORAGE.....	20
C271.33	PLACING	20
BACKFILLING		21
C271.34	GENERAL	21
C271.35	TREATMENT AT WEEPHOLES.....	22
SPRAYED CONCRETE		22
C271.36	GENERAL	22
C271.37	SURFACE PREPARATION.....	23
C271.38	APPLICATION OF SPRAYED CONCRETE.....	23
C271.39	CURING	24
LIMITS AND TOLERANCES		24
C271.40	SUMMARY OF LIMITS AND TOLERANCES.....	24
ANNEXURE C271A		26
C271A	QUALITY CONTROL AND TESTING.....	26

Keeping the Capricorn Municipal Development Guidelines up-to-date

The Capricorn Municipal Development Guidelines are living documents which reflect progress of municipal works in the Capricorn Region. To maintain a high level of currency that reflects the current municipal environment, all guidelines are periodically reviewed with new editions published and the possibility of some editions to be removed. Between the publishing of these editions, amendments may be issued. It is important that readers assure themselves they are using current guideline, which should include any amendments which may have been published since the guideline was printed. A guideline will be deemed current at the date of development approval for construction works.

GENERAL

C271.01 SCOPE

C271.01.01 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 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.

C271.01.02 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.

C271.01.03 Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in Annexure C271A.

Quality

C271.02 REFERENCE DOCUMENTS

C271.02.01 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 1012.3.1 - 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 1289.5.1.1 - 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/NZS 4671 - Steel reinforcing materials
- 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.

EXCAVATION AND FOUNDATIONS

C271.03 GENERAL

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| C271.03.01 | 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).. | Foundations |
| C271.03.02 | All soft, yielding or other unsuitable material shall be replaced with sound material and the subgrade shall be compacted to provide a minimum of 97 per cent standard compaction as determined by AS 1289.5.4.1 for standard 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 |
| C271.03.03 | The Contractor shall supply all necessary sheeting and bracing to safely support the excavation in accordance with Statutory requirements. The excavation shall be kept free of water. | Shoring |

C271.04 NEW JERSEY TYPE BARRIERS, DRIVEWAYS AND FOOTPATHS

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| C271.04.01 | For New Jersey type barriers, driveways and footpaths a subbase of approved quality and of minimum 150mm compacted thickness, unless otherwise shown on the Drawings, shall be placed over the subgrade. The surface shall then be checked for uniformity, line and level, and all irregularities shall be made good. | Subbase |
| C271.04.02 | The subbase material shall be compacted to provide a minimum relative compaction as determined by AS 1289.5.4.1 of 97 per cent for standard compactive effort. | Compaction |
| C271.04.03 | The finished subbase shall not deviate more than 15mm under a straight edge 3 metres long, subject to any necessary allowance on vertical curves. | Subgrade and Subbase Tolerances |

C271.05 RETAINING WALLS, HEADWALLS AND WINGWALLS

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| C271.05.01 | 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. | <i>Rock Foundations</i> |
| C271.05.02 | 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. | <i>Earth Foundations</i> |
| C271.05.03 | 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. | <i>Pre-cast Concrete</i> |

FORMWORK**C271.06 GENERAL**

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| C271.06.01 | 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 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. | <i>Formwork Requirements</i> |
| C271.06.02 | Where concrete is placed in earth excavations, side forms shall be provided to prevent contact between concrete and the insitu earth. | <i>Side Forms</i> |
| C271.06.03 | 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. | <i>Placement of Concrete</i> |
| C271.06.04 | Formwork material used shall be sound and suitable for the purpose intended and surface finish specified. | <i>Material</i> |
| C271.06.05 | 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. | <i>Formwork Fittings</i> |

C271.06.06	Forms for edges of concrete shall be filleted and for re-entrant angles chamfered as shown on the Drawings	Edge Treatment
C271.06.07	Temporary openings shall be provided where necessary for cleaning out of formwork and inspection before concreting.	Cleaning and Inspection
C271.07	PROVISION FOR DRAINAGE	
C271.07.01	Where shown on the Drawings weepholes of 50mm diameter shall be provided in retaining walls and wingwalls.	Weep Holes
C271.08	CONSTRUCTION	
C271.08.01	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
C271.08.02	Timber for formwork shall be well seasoned, free from defects and, where in contact with fresh concrete, free from loose knots.	Timber Requirements
C271.08.03	Timber forms for exposed surfaces shall be constructed from plywood or particle board with hardwood or approved softwood studs and wale's. 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
C271.08.04	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 20mm minimum thickness. All form panels shall be placed in a neat, symmetrical pattern.	Formwork Panels for Exposed Surfaces
C271.08.05	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
C271.08.06	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

C271.09 ERECTION

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| C271.09.01 | 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. | <i>Formwork
Position
Tolerances</i> |
| C271.09.02 | Joints as erected shall be mortar tight. | <i>Mortar Tight</i> |
| C271.09.03 | 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. | <i>Coating of
Internal
Surfaces</i> |
| C271.09.04 | 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. | <i>Release Agent</i> |

MATERIALS FOR CONCRETE**C271.10 CEMENT**

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| C271.10.01 | Cement shall be Type GP Portland Cement complying with AS 3972. | |
| C271.10.02 | Documentary or other acceptable evidence of the quality of the cement shall be retained as part of the contractor Quality Records. | <i>Proof of
Quality</i> |
| C271.10.03 | 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. | <i>Storage Time</i> |
| C271.10.04 | All cement shall be transported in watertight containers, and shall be protected from moisture until used. Caked or lumpy cement shall not be used. | <i>Transport and
Storage</i> |

C271.11 WATER

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| C271.11.01 | Water shall be free from injurious amounts of materials harmful to concrete and to its reinforcement and neither salty nor brackish. | <i>Quality</i> |
| C271.11.02 | Water which is not potable for human beings shall not be used in reinforced concrete. | <i>Potability</i> |

C271.12 FINE AGGREGATE

C271.12.01 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**

C271.12.02 Fine aggregates shall be evenly graded within the absolute limits shown in Table C271.14.1, and shall not deviate from the proposed grading by more than the amounts in Table C271.14.1. **Grading Requirements**

Table C271.14.1 - Fine Aggregate Grading

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

C271.13 COARSE AGGREGATE

C271.13.01 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 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. **Quality**

C271.13.02 The percentage of wear shall be determined by AS 1141.23, and the loss of weight shall not exceed 30 per cent. **Wear Test**

C271.13.03 When required by the Superintendent, 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 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 miss-shapen particles (2:1 ratio) shall not exceed 35 per cent.

C271.13.04 Coarse aggregate shall be evenly graded within the absolute limits shown in Table C271.15.1 and shall not deviate from the grading of the samples submitted under Clause C271.17 by more than shown.

Table C271.15.1 - Coarse Aggregate Grading's

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

C271.14 ADMIXTURES

C271.14.01 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

C271.14.02 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 the Superintendent 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 the Superintendent, together with the proposed 'dosage chart' in accordance with Clause C271.17.

Retarder for Warm Season

C271.14.03 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

C271.15 TESTING OF MATERIALS

C271.15.01 A copy of a NATA Certified Laboratory Test Report on the quality and grading of the aggregates proposed to be used in the work shall be retained as part of the contractor's quality records.

Contractor's Responsibility

HANDLING AND TREATMENT OF CONCRETE

C271.16 MEASURING

C271.16.01 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 the Superintendent.

C271.17 MEASURING BY WEIGHT, ON-SITE MIXING

C271.17.01 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 C271.17.1 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 C271.17.1 shall not relieve the Contractor of his obligation to provide concrete of the specified compressive strength.

**Mixing by
Weight on Site**

Table C271.17.1 - Materials in Batch containing 1 bag (40Kg) Cement

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

C271.17.02 The proportions set out in Table C271.17.1 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.

**Variation in
Aggregate
Moisture
Content**

C271.18 MEASURING BY VOLUME, ON-SITE MIXING

C271.18.01 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**

C271.18.02 The nominal proportions given in Table C271.18.1 may be used as a guide for volume batching. **Volume Batching**

Table C271.18.1 - 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

C271.18.03 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 1 bag of cement. One 40kg bag of cement shall be assumed to have a volume of 27.5 litres. **Batch Measurement**

C271.19 CONSISTENCY

C271.19.01 A sufficient quantity of water shall be added to the mix so that the consistency of the concrete is such that it can be placed in the forms, compacted and worked into all corners without permitting the ingredients to segregate, or excess free water to collect on the surface. If required by the Superintendent, the Contractor shall determine the consistence of the concrete in accordance with AS 1012.3.1. Except for extruded concrete, the nominated slump shall not exceed 80mm, plus the field tolerance of ±15mm. **Consistency Requirements**

C271.19.02 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 Consistence**

C271.20 MIXING AND DELIVERY

C271.20.01 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. **Mechanical Mixing**

ii. Any concrete which exhibits signs of segregation shall not be used. **Segregation of Concrete**

C271.20.02 MACHINE MIXING AT SITE

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| 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 Requirements |
| 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. | Mixer Capacity |
| 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. | Mixing Time |
| iv. | The entire contents of a batch shall be discharged from the mixer before any materials are placed therein for the succeeding batch. | Total Mix Discharge |

C271.20.03 MIXING IN AN EMERGENCY

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

C271.20.04 READY-MIXED CONCRETE

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| i. | <p>The concrete shall be mixed and delivered in accordance with the requirements of AS 1379 relating to:-</p> <ol style="list-style-type: none"> 1. Mixing and Delivery; and 2. Use of Non-Agitating Equipment, <p>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.</p> | Mixing Standard and Discharge Times |
| ii. | All chutes shall be clean and free of coatings of hardened concrete. The chutes shall be long enough to permit delivery to the whole of the area enclosed by the forms. | Cleansing and Positioning of Chutes |

C271.21 PLACING AND COMPACTING CONCRETE

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| C271.21.01 | No concrete shall be placed in the work if the temperature of concrete is less than 10oC or greater than 35oC. If the ambient temperature is expected to exceed 35oC during placing and finishing, the Contractor shall take practical precautions to ensure the temperature of the concrete does not exceed the permitted maximum | <i>Air Temperature Requirements</i> |
| C271.21.02 | 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. | <i>Placement within Time Limit</i> |
| C271.21.03 | 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 a vibrator unit. Vibrators shall not be left in one position for more than 30 seconds, and shall not be permitted to rest on reinforcement. | <i>Placement in Forms, Vibrating</i> |
| C271.21.04 | 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. | <i>Exposed Surfaces</i> |
| C271.21.05 | Concrete shall not be moved after it has been in the forms for more than 10 minutes. | <i>Initial Set</i> |
| C271.21.06 | In the case of concrete placed by an extrusion machine, small quantities of cement-sand slurry, comprised of two parts of plasterer's sand and one part of cement (by volume), together with sufficient water to bring it to a semi-fluid condition, shall be placed in the special receptacle in the machine, if the machine is so equipped and shall be fed onto the surface of the concrete at a rate sufficient to produce a smooth and uniform finish. | <i>Slurry for Extruded Concrete</i> |

C271.22 FINISHING OF UNFORMED SURFACES

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| C271.22.01 | 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 be taken to drain or otherwise remove promptly any water which comes to the surface. A capping of mortar will not be permitted. | <i>Finish for Unformed Surfaces</i> |
| | 2. All future contact surfaces shall be left rough, with the coarse aggregate at the surface firmly embedded but not forced below the surface. | <i>Future Contact Surfaces</i> |

C271.22.02 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, or hand screeded where the distance between forms perpendicular to the direction of screed is no greater than 2 metres. 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**

C271.22.03 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**

C271.23 CURING AND PROTECTION

- C271.23.01 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 3 days. During this time the work must be adequately protected from traffic and any other causes likely to damage the concrete. **Curing Requirements**

C271.24 REMOVAL OF FORMS

- C271.24.01 All forms shall remain in place, after placement of concrete, for minimum periods specified hereinafter. These periods shall be extended 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

C271.24.02	To permit the satisfactory finishing of barriers, forms shall be removed in not less than 12 hours and no more than 48 hours after placing concrete, depending upon weather conditions.	<i>Barriers</i>
C271.24.03	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.	<i>Protection of Concrete</i>
C271.24.04	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.	<i>Superimposed Load</i>
C271.24.05	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.	<i>Removal of Hole Formers</i>
C271.25 TREATMENT OF FORMED SURFACES		
C271.25.01	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.	<i>Quality of Surfaces</i>
C271.25.02	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.	<i>Repair of Defects</i>
C271.25.03	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.	<i>Removal of the Wires</i>
C271.25.04	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.	<i>Coating with Bonding Agent</i>
C271.26 JOINTS		
C271.26.01	Where horizontal construction joints are found to be necessary in walls, or cast-in-situ drainage structures the joints may be made at the base of walls and at other locations in the walls where approved by the Superintendent. In order to provide for bond between the new concrete and the concrete which has already set, the surface on which the new concrete is to be placed shall be thoroughly cleaned of loose material, foreign matter and laitance. The surface shall be roughened or keyed and saturated with water. After any excess water has been removed, the surface shall be thinly coated with a neat cement grout.	<i>Horizontal Construction Joint</i>

C271.26.02	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.	<i>Vertical Expansion Joints</i>
C271.26.03	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.	<i>Barrier Contraction</i>
C271.26.04	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 a preformed jointing material of bituminous fibreboard.	<i>Barrier Expansion</i>
C271.26.05	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 a preformed jointing material of bituminous fibreboard.	
C271.26.06	All un-reinforced 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.	
C271.27	STRENGTH OF CONCRETE	
C271.27.01	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 C271.27.1 for the particular class of work.	<i>Strength Requirement</i>
C271.27.02	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.	<i>Determination of Strength</i>
C271.27.03	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.	<i>Moulding of Cylinders</i>

Table C271.27.1 - Concrete Strength Requirements

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	32	380	20	24	32
Reinforced concrete culverts, headwalls, base slabs, sign structure large footings, retaining walls	32	380	20	24	32
Extruded concrete	32	380	20	24	32

C271.27.04 The strengths specified at 28 days shall be increased by multiplying by factors as shown in Table C271.27.2 for tests at ages in excess of 28 days.

Strength Age Factor

Table C271.27.2 - Concrete Age Conversion Factors

*Age of test specimen in days of date of testing	Factor
28	1.00
35	1.02
42	1.04
49	1.06
56	1.08
70	1.10
84	1.12
112	1.14
140	1.16
168	1.18
196	1.20
224	1.22
308	1.24
365 and greater	1.25

*For intermediate ages the factor shall be determined on a pro-rata basis

C271.27.05 If the test specimens fail to achieve the specified strength, the Contractor may arrange for cores to be taken from the work. If the average strength of such cores complies with the specified requirements nominated in Table C271.27.1, the concrete will be accepted.

Cores and Test Acceptance

C271.27.06	If cores taken fail to satisfy the strength requirements, the concrete shall be removed.	<i>Failure of Cores</i>
C271.28	SAMPLING CONCRETE	
C271.28.01	Equipment and facilities shall be provided by the Contractor for the taking and storage of samples of any materials or concrete being used, or intended to be used in the work.	<i>Contractor's Responsibility</i>
C271.28.02	Concrete test specimens shall be cylinders 300mm long and 150mm diameter, moulded concurrently in accordance with AS 1012.8, from samples taken in accordance with AS 1012.1.	<i>Moulding of Test Cylinders</i>

STEEL REINFORCEMENT FOR CONCRETE

C271.29	MATERIAL	
C271.29.01	Steel reinforcement shall comply with the requirements of the appropriate following Australian Standards:- <ul style="list-style-type: none"> a) AS 1302 Steel Reinforcing Bars for Concrete. b) AS/NZS 4671 Steel Reinforcing Materials 	<i>Standards</i>
C271.29.02	The type and size of bars shall be as shown on the Drawings.	<i>Type and Size</i>
C271.29.03	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.	<i>Quality</i>
C271.29.04	The Contractor shall retain as part of the Quality Records evidence that steel reinforcement complies with AS 1302, AS 1303 or AS 1304, as appropriate. Test certificates shall show the results of mechanical tests and chemical analysis.	<i>Documentary Evidence</i>
C271.29.05	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.	<i>Further Sampling Contractor's Cost</i>
C271.29.06	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 Contractor shall demonstrate that the proposed chairs conform to these requirements.	<i>Bar Chairs</i>

C271.30 BENDING

C271.30.01 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

C271.31 SPLICING

C271.31.01 GENERAL

All reinforcement shall be furnished in the lengths indicated on the Drawings. If splicing is required, it shall be in accordance with the provisions of AS 1302.

Plan Lengths

C271.31.02 LAPPED SPLICES

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

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

Lap Dimensions

C271.31.03 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

C271.32 STORAGE

C271.32.01 Reinforcement shall be stored above the surface of the ground and shall be protected from damage and from deterioration by exposure.

Protection of Reinforcement

C271.33 PLACING

C271.33.01 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.

Reinforcement Position

C271.33.02 The Superintendent 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.

Tack Welding

C271.33.03 Splices shall be staggered where practicable.

Splices

- C271.33.04 Bars forming a lapped splice shall be securely wired together in at least two places, unless welded. **Lapped Splice**
- C271.33.05 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: **Bar Cover**
- a) Concrete normally in contact only with air
 - i. Slabs: 40 mm
 - ii. Other than slabs: 45 mm
 - b) Concrete in contact with earth or fresh water
 - i. Slabs of box culverts: 50mm
 - ii. Other than culverts: 50mm
 - c) Concrete in Aggressive Environments
 - i. All 70mm

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

BACKFILLING

C271.34 GENERAL

- C271.34.01 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.
- C271.34.02 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 or when the Contractor can demonstrate that 85 per cent of the design strength of the concrete has been achieved. **Adjacent to Walls**
- C271.34.03 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 97 per cent as determined by AS 1289.5.4.1 for standard compaction effort. **Selected Backfill**

C271.35 TREATMENT AT WEEPHOLES

- | | | |
|------------|--|--|
| C271.35.01 | 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: | <i>Size & Type of Backfill Material</i> |
| | 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 | |
| C271.35.02 | 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. | <i>Extent of Material</i> |
| C271.35.03 | Alternatively the Contractor may provide a synthetic membrane of equivalent drainage characteristics. It shall be stored and installed in accordance with Manufacturer's instructions. | <i>Synthetic Membrane</i> |

SPRAYED CONCRETE**C271.36 GENERAL**

- | | | |
|------------|--|--------------------------|
| C271.36.01 | 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. | <i>Definition</i> |
| C271.36.02 | The minimum depth of sprayed concrete to be applied shall be 75mm. | <i>Depth</i> |
| C271.36.03 | Sprayed concrete lining in open drains shall be coloured to match the adjoining rock colour. | <i>Colour</i> |
| C271.36.04 | 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. | <i>Strength</i> |
| C271.36.05 | Cores shall be secured, accepted, cured, capped and tested in accordance with AS 1012.14. Equipment and facilities shall be provided by the Contractor for the taking of cores from the work. The Contractor shall arrange for a laboratory with appropriate NATA registration for the curing and testing of the cores. Copies of test results shall be retained by the contractor as part of the Quality Records. | <i>Test Cores</i> |

C271.37 SURFACE PREPARATION

- C271.37.01 Earth surfaces shall be graded, trimmed and compacted and shall be dampened prior to applying the sprayed concrete. The Contractor shall take any precautions necessary to prevent erosion when the sprayed concrete is applied. **Earth**
- C271.37.02 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**
- C271.37.03 Corrugated steel pipes shall be cleaned of loose material, mud and any other foreign matter. **Steel Pipes**
- C271.37.04 The Contractor shall remove free water and prevent the flow of water which could adversely affect the quality of the sprayed concrete. **Water Flow**

C271.38 APPLICATION OF SPRAYED CONCRETE

- C271.38.01 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**
- C271.38.02 Spraying shall be discontinued if wind causes separation of the nozzle stream. **Wind Problem**
- C271.38.03 Concrete shall not be sprayed in air temperatures less than 5°C. **Air Temperature**
- C271.38.04 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**
- C271.38.05 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**
- C271.38.06 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**

C271.39 CURING

- C271.39.01 Curing shall commence within one hour of the application of sprayed concrete and may be by water or by colourless wax emulsion curing compound complying with AS 3799 and applied in accordance with manufacturer's specifications. **Commencement**
- C271.39.02 In water curing, the surface of the sprayed concrete shall be kept continuously wet for at least seven days. **Water Curing**

LIMITS AND TOLERANCES

C271.40 SUMMARY OF LIMITS AND TOLERANCES

C271.40.01 The limits and tolerances applicable to the various clauses in this Specification are summarised in Table C271.40.1 below:

Table C271.40.1 - Summary of Limits and Tolerances

Item	Activity	Limits/Tolerances	Spec Clause
1.	Subgrade		
	(a) Relative Compaction	≥97% (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 15mm under a straight-edge 3 metres long.	C271.04
	(b) Relative Compaction of Subbase	≥95% (standard compactive effort) ≥97% (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 C271.14.1.	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 miss-shapen 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 C271.15.1.	C271.15
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 ± 15 mm.	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	No concrete shall be placed in the work if the temperature of concrete is less than 10°C or greater than 35°C. If the ambient temperature is expected to exceed 35°C during placing and finishing, the Contractor shall take practical precautions to ensure the temperature of the concrete does not exceed the permitted maximum.	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

ANNEXURE C271A

C271A QUALITY CONTROL AND TESTING

ACTIVITY	KEY QUALITY VERIFICATION REQUIREMENTS	MAXIMUM LOT SIZE	MINIMUM TEST FREQUENCY	TEST METHOD
MANDATORY TESTING				
Ready-Mixed Concrete Supply	Material Quality - Suppliers documentary evidence and certification	1 contract	1 per mix type	AS1012.3 Method 1 AS1012.1, AS1012.8, AS1012.9
	Consistency - Slump	15m ³	1 per load	
	Compressive Strength (7 and 28 day)	15m ³	2 pairs per 15m ³	
Concrete Placement (in accordance with required surface finish standard to AS 3600)	Finished Levels dimensions (in accordance with drawings) tolerances in accordance with AS3600	15m ³	1 cross section per 15m	Survey and 3m Straight Edge
Sprayed Concrete	Test Panels and Cores	1 contract	3 test panels and 4 cores per mix design	AS1012.4, AS1012.9 AS1012.14
	Compressive Strength Cores	15m ³	2 per 15m ³	AS1012.4, AS1012.9 AS1012.14
	Curing Material Quality - Supplier's documentary evidence and certification	1 contract	1 per production batch	
AUDIT TESTING – IF ORDERED BY COUNCIL				
Subgrade	Compaction	1000 lin m or 1000m ²	1 per 200 lin m or 200m ²	AS1289.5.4.1
Gravel Subbase Construction	Compaction	1 day's placement	1 per 100 lin m or 100m ²	AS1289.5.4.1
	Subbase Geometry	1 day's placement	1 per 25 lin m	3m Straight Edge
Steel Supply	Material Quality - Suppliers documentary evidence and certification	1 delivery	1 per production batch	
Backfilling	Material Quality			
	- Maximum particle size	1 contract/ material type	1 per 200m ³ or lot	Q103
	- Plasticity Index	1 contract/ material type	1 per 200m ³ or lot	AS1289.3.3.1
	Compaction	1 day's work or max 200m ²	1 per 200m ² or lot	AS1289.5.4.1