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Technical Specification

Transport and Main Roads Specifications
MRTS40 Concrete Base in Pavements
Jointed Unreinforced, Jointed Reinforced, Continuously Reinforced and Steel Fibre Reinforced Pavements

October 2010

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1 Introduction

This Technical Specification applies to the construction of road pavements using concrete base for jointed unreinforced, jointed reinforced, continuously reinforced and steel fibre reinforced pavements. It does not include jointed unreinforced dowelled base.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

2 Definition of terms

The terms and symbols used in this Technical Specification shall be as defined in the references listed below, with possible conflict of definition being resolved by prioritising them in order of the listing:

a) as in Table 2-A and Table 2-B below

b) MRTS01 *Introduction to Technical Specifications*, and

c) AS 1348-2002 Glossary of Terms – Roads and Traffic Engineering.

Table 2-A – Definition of terms

Term	Definition
Agitator	An item of plant or equipment which maintains the plastic concrete in the mixed state.
AS Size	Sieve size conforming to AS 1152 Specification for Test Sieves.
Average Strength (f_{cm})	The arithmetic mean of the compressive strengths influenced by two or more specimen cylinders taken from the same sample.
Basecourse	A course or courses primarily intended to directly support the traffic loads within the pavement structure and concrete shoulders.
Batch	One load or charge of a mixing plant or transit mixer.
Batching	The process of combining the concrete ingredients in fixed proportions by weight or by volume, including charging and mixing.
Cementitious Materials	Portland cement with possible combinations of fly ash and/or slag in accordance with this Technical Specification.
Central Concrete Mixer	A central mixer which is permanently located adjacent to the manufacturer's batching equipment.
Class of Concrete Work	Concrete that complies with a particular set of requirements as detailed herein e.g. base concrete, slab anchor concrete, non-integral shoulder concrete.
Completion of Batching	For stationary batch mixers, this shall be the time when the batch is discharged into the delivery truck. For mobile mixers, it shall be the time when mixing and slump adjustment ceases at the batching plant, or 10 minutes after the commencement of mixing, whichever occurs first.
Concrete	A thoroughly mixed combination of cementitious materials, aggregates and water, with or without the addition of chemical admixtures or other materials, all of which separately and when combined conform to the relevant requirements of this Technical Specification.

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Term	Definition
Concrete Base	A base consisting of concrete which has been designed and constructed in accordance with this Technical Specification.
Concrete Mixers	Mixers conforming to Clause 2.4 of AS 1379 and using the batching process.
Continuously Reinforced Concrete (CRC) Base	A concrete base without contraction joints and reinforced with continuous longitudinal deformed steel in accordance with the Drawings.
Course	One or more layers of the same material within a pavement structure.
Delivery Time	The elapsed time measured from the completion of batching to the arrival at site within 100 m of the point of placement.
Dowels	Smooth steel bars which provide load transfer across joints.
Drawings	The drawings prepared for the works, to be used in accordance with the Contract, including all variations provided for by the Contract.
Formed Joint	All joints except for induced joints. This includes slip-formed and fixed-formed joints and edges.
Forming Time	The elapsed time measured from the Completion of Batching to the incorporation of the concrete into the works, including compaction and final forming, but excluding hand finishing and texturing (where applicable).
Free Edge	This term is used in the context of limiting all restraint against an edge and also the movement of joints which intersect that edge or joint. A free edge is provided by an isolation joint or by an outer edge. Untied butt joints and dowelled expansion joints do not constitute free edges.
Haul Time	The elapsed time measured between the completion of batching and the completion of discharge of the mix.
Integral Shoulder	A concrete shoulder which is made up of the same concrete and is the same thickness as the base pavement, is cast integrally with the base pavement (see *Austroads Pavement Design Guide*, Clause 8.3.5) and is a minimum of 0.6 m wide unless shown otherwise on the Drawings.
Job Mix(es)	The proposed job mix(es) which conforms to all the specified requirements.
Jointed Reinforced Concrete (JRC) Base	A concrete base incorporating mesh reinforcement in all slabs and dowels at transverse joints.
Jointed Unreinforced or Plain Concrete Base	A concrete base which contains no reinforcement other than tie bars across longitudinal joints and with transverse contraction joints, without dowels, induced at the specified intervals. There can be reinforcing mesh in specified slabs.
Layer	The portion of a pavement course placed and completed as an entity.
Lean Mix Concrete Sub-base	A sub-base consisting of lean mix concrete which has been designed and constructed in accordance with MRTS39 *Lean Mix Concrete Sub-base for Pavements*.
Load	A single truck load of concrete comprising one or more batches.
Lot	As defined in Clause 15.2.2 of this Technical Specification.
Lower Subgrade	The layer beneath the controlled subgrade.
Mechanical Paver	Pavers required to be used for the construction of base as defined in Clause 9.2.2. Pavers referred to as slip-form pavers which comply with Clause 9.2.2 may be used.

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Term	Definition
Mesh	Wire fabric conforming to AS/NZS 4671.
Mixing Time	Applicable to batch mixers only; the mixing time for each batch shall be measured from the time all the ingredients are in the mixing drum until the time mixing at the specified rate, or after specified revolutions, ceases.
Mobile Concrete Mixer	A mixer where mixing is carried out entirely in a truck-mounted drum mixer which is integral with, or can be connected to, a prime mover.
Nominated Job Mix	The job mix(es) accepted for use on the works and nominated for use for a specified period.
Non-integral Shoulder	A concrete shoulder which is made up of the same concrete and is the same thickness as the base pavement, which is formed, debonded and nominally tied to the base pavement and is a minimum of 1.4 m wide.
Non-structural Shoulder	A shoulder (concrete or otherwise) which is not considered to reduce stresses in the structural pavement sufficient to decrease the base thickness. It is de-bonded from the concrete base (except for nominal tie bars in the case of a concrete non-integral shoulder).
Pavement	The portion of the road, including shoulders, placed above the subgrade, which supports and forms a running surface for vehicular traffic.
Preliminary Mix(es)	The concrete mix(es) used to establish the relationship between flexural and compressive strength.
Production Concrete	A nominated job mix which is being mixed, delivered and placed in the works.
Proposed Job Mix(es)	The mix(es) which the contractor has submitted for use in the works.
Relief Edge	An edge which relieves contraction stresses in joints and/or sections aligned parallel to that edge.
Retempering	The addition of water after the completion of batching.
Sample	A portion of material drawn from a lot, in accordance with any relevant Standard, test method or AS requirements, for the purpose of testing.
Shoulder	The portion of the pavement contiguous to and flush with the structural pavement.
Slag Aggregate	Air-cooled iron blast-furnace slag aggregate.
Slag Cement	Ground, granulated iron blast-furnace slag cementitious material.
Specimen Beam	A single concrete beam made from a sample for the purpose of flexural strength testing.
Specimen Cylinder	A single concrete cylinder, 100 mm diameter x 200 mm length or 150 mm diameter x 300 mm length in accordance with AS 1012.8, made from a sample for the purpose of testing.
Standard Deviation (s)	A statistical measure of the variation from the mean of the samples.
Steel Fibre Reinforced Concrete (SFRC) Base	A concrete base which incorporates steel fibre reinforcement. The steel fibres are distributed with random orientation throughout the concrete. SFRC is treated similarly to JRC.
Structural Pavement	The concrete running lanes within the geometric edge line, any structural concrete shoulder and any integral widening outside the geometric edge line.

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Term	Definition
Structural Shoulder	A non-integral shoulder which is also fully tied (in accordance with the *Austroads Pavement Design Guide*), keyed (corrugated) and has a minimum width of 3 m, or is an integral shoulder.
Sub-base (Course)	A portion of the pavement immediately beneath the base.
Subgrade	The prepared formation beneath the working platform or, where there is no working platform, beneath the lowest pavement layer where such a layer is in accordance with a Technical Specification for pavements.
Substrate	The layer immediately beneath the lean mix sub-base.
Surface Evenness	The roughness of the pavement surface in counts/km as measured by Austroads Roughness Meter.
Testing Station	The agreed location for the taking of samples as specified herein.
Trafficked Pavement	That part of the pavement, bounded by longitudinal joints, which lies either totally or in part within the trafficked carriageway as defined by lane lines.
Trafficked Slab	A slab transversely bounded by longitudinal joints or edges or a longitudinal joint and an edge and which lies either totally or in part within the trafficked carriageway as defined by lane lines. For other than continuously reinforced pavements, a slab is bounded longitudinally by the planned transverse joints.
Transition Lot	As defined in Clause 15.2.3
Transition Point	The point at which vibration on a paving machine is turned off or ceases effective compaction. (See Clause 15.2.3.)
Trial Mix(es)	This mix(es) proposed for use in the works
Verge	That portion of the road adjacent to the shoulder.
Wearing (Running) Course	The pavement course which is in direct contact with the vehicular traffic.
Wet Curing	Curing at ambient temperature when the concrete surface is, in effect, being covered with water or placed in a fog room/chamber with a relative humidity exceeding 98%.
Yielded Cubic Metre of Concrete	The exact constituents (including all components and their masses) required to make up a cubic metre of concrete for each job mix, based on a determination of mass per unit volume in accordance with AS 1012.5, using internal vibration.

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Table 2-B – Definition of symbols

Symbol	Definition
f_c	Compressive strength
f_{cm}	Average compressive strength from two cylinders
f_f	Flexural strength
$f\rho_f$	Specified 28-day flexural strength
f_{c7}	7-day compressive strength
$f\rho_c$	The 28-day specified compressive strength required for the particular concrete and the particular project (Clause 5.4.1)
$f\rho_{cf}$	The 28-day compressive strength required to achieve the 28-day specified flexural strength
r_7	The ratio of 28-day compressive strength to 7-day compressive strength
R_f	The ratio of 28-day compressive strength to 28-day flexural strength

Symbol	Definition
V_f	Volume of steel fibre
L	Length of steel fibre
D_f	Diameter of steel fibre
l/d_f	Aspect ratio of steel fibre
K_f	Bond coefficient of steel fibre
F_f	Fibre factor
f_{td}	The concrete tensile strength (MPa)
f_{sy}	The characteristic yield strength of the longitudinal reinforcing steel
P	Proportion of the gross cross-sectional area of the concrete base which is to be reinforcing steel
D_b	Diameter of longitudinal reinforcing bars
W	Maximum allowable crack width
s_c	Standard deviation of 28-day concrete compressive strength
s_7	Standard deviation of 7-day concrete compressive strength

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3 Referenced documents

3.1 Standards

Table 3.1 lists documents referenced in this Technical Specification.

Table 3.1 – Referenced documents

Reference	Title
Q105	Plastic Limit and Plasticity Index
Q110A	Dry density/moisture relationship – standard compaction
Q188	Determination of the Quartz Content of Sand (Petrological Assessment)
Q201A	Flakiness Index (General)
Q205A	Determination of the Ten Percent Fines Value (Dry)
Q205B	Determination of the Ten Percent Fines Value (Wet)
Q205C	Wet/Dry Strength Variation
Q208B	Degradation Factor (Coarse Aggregate)
Q215	Crushed Particles
Q458	Alkali-Silica Reactivity
Q460A	Compressive Strength and Recovery of Preformed Joint Filler
Q460B	Extrusion of Preformed Joint Filler
Q460C	Expansion of Preformed Self-Expanding Joint Filler
Q460D	Accelerated Weathering of Preformed Joint Filler
Q460E	Resistance to Heat Degradation of Closed-Cell Foamed Joint Filler
Q460F	Resistance to Disintegration of Preformed Cork Joint Filler
Q461	Durability of Sealant

Reference	Title
Q462	Resistance of Vulcanised Rubber to the Absorption of Oil
Q463A	High Temperature Recovery of Preformed Polychloroprene Elastomeric Joint Seals for Bridge Structures
Q463B	Low Temperature Recovery of Preformed Polychloroprene Elastomeric Joint Seals
Q470	Coefficient of Thermal Expansion of Concrete
Q471	Making, Curing and Testing Moulded Concrete Specimens with Field Simulated Curing.
Q472	Making and Curing Concrete Compressive, Indirect Tensile and Flexural Test Specimens
Q473	Density of Hardened Concrete (Water Displacement)
Q475	Tie Bar Pull-Out Test
Q630	Qualitative Analysis of Materials (Infra-Red Spectrophotometry)
Q705	Texture Depth of Road Surfacings (Sand Patch)
Q708	Road Roughness – Surface Evenness
AS 1012.1	Methods of Testing Concrete – Sampling of Fresh Concrete
AS 1012.3.1	Methods of Testing Concrete – Methods for the Determination of Properties Related to the Consistency of Concrete – Slump Test
AS 1012.3.3	Methods of Testing Concrete – Methods for the Determination of Properties Related to the Consistency of Concrete – Vebe Test
AS 1012.4.2	Methods of Testing Concrete –Determination of Air Content of Freshly Mixed Concrete – Measuring Reduction in Air Pressure in Chamber above Concrete
AS 1012.5	Methods of Testing Concrete –Determination of Mass Per Unit Volume of Freshly Mixed Concrete
AS 1012.6	Methods of Testing Concrete – Method for the Determination of Bleeding of Concrete
AS 1012.8.1	Methods of Testing Concrete – Method for Making and Curing Concrete – Compression and Indirect Tensile Test Specimens
AS 1012.8.2	Methods of Testing Concrete – Method for Making and Curing Concrete – Flexure Test Specimens
AS 1012.9	Methods of Testing Concrete – Determination of the Compressive Strength of Concrete Specimens
AS 1012.10	Methods of Testing Concrete – Determination of Indirect Tensile Strength of Concrete Cylinders ('Brazil' or Splitting Test)
AS 1012.11	Methods of Testing Concrete – Determination of the Modulus of Rupture
AS 1012.12.2	Methods of Testing Concrete – Determination of Mass Per Unit Volume of Hardened Concrete – Water Displacement Method
AS 1012.13	Methods of Testing Concrete – Determination of the Drying Shrinkage of Concrete for Samples Prepared in the Field or in the Laboratory
AS 1012.14	Methods of Testing Concrete – Method for Securing and Testing Cores from Hardened Concrete for Compressive Strength
AS 1012.20	Methods of Testing Concrete – Determination of Chloride and Sulfate in Hardened Concrete and Concrete Aggregates
AS 1141.0	Methods for Sampling and Testing Aggregates – List of Methods

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Reference	Title
AS 1141.1	Methods for Sampling and Testing Aggregates – Definitions
AS 1141.2	Methods for Sampling and Testing Aggregates – Basic Testing Equipment
AS 1141.3.1	Methods for Sampling and Testing Aggregates – Sampling – Aggregates
AS 1141.4	Methods for Sampling and Testing Aggregates – Bulk Density of Aggregate
AS 1141.5	Methods for Sampling and Testing Aggregates – Particle Density and Water Absorption of Fine Aggregate
AS 1141.6.1	Methods for Sampling and Testing Aggregates – Particle Density and Water Absorption of Coarse Aggregate – Pycnometer Method
AS 1141.6.2	Methods for Sampling and Testing Aggregates – Particle Density and Water Absorption of Coarse Aggregate – Weigh-in-Water Method
AS 1141.11	Methods for Sampling and Testing Aggregates – Particle Size Distribution by Sieving
AS 1141.12	Methods for Sampling and Testing Aggregates – Materials Finer than 75 µm in Aggregates (by Washing)
AS 1141.13	Methods for Sampling and Testing Aggregates – Material Finer than 2 µm
AS 1141.14	Methods for Sampling and Testing Aggregates – Particle Shape, by Proportional Calliper
AS 1141.15	Methods for Sampling and Testing Aggregates – Flakiness Index
AS 1141.31	Methods for Sampling and Testing Aggregates – Light Particles
AS 1141.32	Methods for Sampling and Testing Aggregates – Weak Particles (including Clay Lumps, Soft and Friable Particles) in Coarse Aggregates
AS 1141.34	Methods for Sampling and Testing Aggregates – Organic Impurities other than Sugar
AS 1141.35	Methods for Sampling and Testing Aggregates – Sugar
AS 1141.37	Methods for Sampling and Testing Aggregates – Iron Unsoundness
AS 1152	Specification for Test Sieves
AS 1289.0	Methods of Testing Soils for Engineering Purposes – General Requirements and List of Methods
AS 1289.4.2.1	Methods of Testing Soils for Engineering Purposes – Soil Chemical Tests – Determination of the Sulphate Content of a Natural Soil and the Sulphate Content of the Ground Water – Normal Method
AS 1348	Glossary of Terms – Roads and Traffic Engineering
AS 1379	Specification and Supply of Concrete
AS 1478.1	Chemical Admixtures for Concrete, mortar and grout – Admixtures for Concrete
AS/NZS 1554.3	Structural Steel Welding – Welding of Reinforcing Steel
AS 1726	Geotechnical Site Investigations
AS 2350.2	Methods of Testing Portland and Blended Cements – Chemical Composition of Portland Cement
AS 2439.1	Perforated Plastics Drainage and Effluent Pipe and Fittings – Perforated Drainage Pipe and Associated Fittings
AS 2706	Numerical Values – Rounding and Interpretation of Limiting Values
AS 2758.1	Aggregates and Rock for Engineering Purposes – Concrete Aggregates

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Reference	Title
AS 3582.1	Supplementary Cementitious Materials for Use with Portland and Blended Cement- Fly Ash
AS 3582.2	Supplementary Cementitious Materials for Use with Portland Cement – Slag – Ground Granulated Iron Blast Furnace
AS 3799	Liquid membrane-forming curing compounds for concrete
AS 3972	Portland and Blended Cements
AS/NZS 4671	Steel Reinforcing Materials
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
DR 99507	Method for Sampling and Testing Aggregates – Method 65 : Alkali Aggregate Reaction – Petrographic Analysis
C 151-93a	Test Method for Autoclave Expansion of Portland Cement
C 793-91	Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants
C 794-93	Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
C 1018-94b	Test Method for Flexural Toughness and First-Crack Strength of Fibre-Reinforced Concrete (Using Beam with Third-Point Loading)
C 1040-93	Test Methods for Density of Unhardened and Hardened Concrete in Place by Nuclear Methods
D 792-91	Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D 2240-95	Test Method for Rubber Property – Durometer Hardness
D 2628-91	Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
D 2835-89 (1993)	Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
MIL-S-8802	Sealing Compound, Temperature Resistant, Integral Fuel Tanks and Fuel Cell Cavities, High Adhesion

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3.2 Interpretation of limiting values

Unless otherwise stated, limiting values and the rounding of test values shall be interpreted in accordance with MRTS01 *Introduction to Technical Specifications*.

4 Quality system requirements

4.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points and Witness Points applicable to this Specification are summarised in Table 4.1.

Table 4.1 – Hold Points and Witness Points

Clause	Hold Point	Witness Point
5.1.1	1. Source and conformance of cement	
5.1.2	2. Source and conformance of flyash	
5.1.7.1	3. Compatibility of multiple admixtures	Admixtures in concrete production

Clause	Hold Point	Witness Point
5.1.7.2		Air content of freshly mixed concrete
5.1.7.3		Criteria to change admixture type
5.1.8.1	4. Compliance with source material requirements for aggregates	
5.1.8.2	5. Material source assessment	
5.4.2		Vebe value for each job mix
5.5.2.3	6. Proposed job mix report, certifying conformance	
5.5.2.4	7. Proposed job mix acceptance	
5.5.3	8. Determination of r_7	
5.5.4	9. Variations to job mix	
5.6.4.1	10. Mixer uniformity testing	
8.4.2	11. Placed reinforcing mesh	
8.4.3	12. Odd-shaped slabs	
8.4.4	13. Placed reinforcement in CRC base	
8.4.5		Placed steel mesh in odd-shaped and mismatched CRC base
9.2.2		Mechanical paver
9.3.1	14. Intention to pave base and trial	
9.3.3.2	15. Surface height of sub-base	
Table 9.7.2		Trafficking concrete base
Table 9.7.2		Trafficking concrete base
Table 9.7.2		Trafficking concrete base
Table 9.7.2		Trafficking concrete base
Table 9.7.2		Trafficking concrete base
9.8	16. Paving trial	
10.2.4	17. Sealant details	
13.1.1	18. Base removal procedures	
14.3.1		Edge drain trench
14.5		Work-as-executed drawings of edge drains
15.4	19. Certification of silicon sealant	

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4.2 Conformance requirements

The manufacture and placement of concrete and all constituent materials shall be administered on the basis of lots which shall be clearly identified and recorded (see MRTS01 *Introduction to Technical Specifications* and MRTS50 *Specific Quality System Requirements*).

Test certificates shall be obtained and held on site for materials tested at the point of manufacture (such as steel, admixtures and curing compounds).

Conformance testing on all other material, including aggregate and mixed concrete, shall be carried out on lots at the batching site or taken from the placed concrete, as relevant.

All quality assurance records (including test results) shall be maintained on a computer system which shall also include the capacity to summarise, graph and carry out statistical calculations on the data.

In addition to the tests specified in this technical standard, charts shall be maintained for at least those elements given in Table 4.2 below.

Table 4.2 – Minimum charting requirements

Item	Requirement	Referenced Clause
Combined Aggregate	percent passing 0.075 mm sieve	6
Concrete Supply	mean 7-day compressive strength standard deviation of 28-day compressive strength	7
Concrete Placement	reference density relative compaction	13

The charts shall include the following:

a) the actual results with the maximum tolerances

b) a five-point running mean with limits set at 0.7 the maximum tolerances, and

c) a five-point running range (highest from the lowest).

Lot sizes and testing requirements are specified in Clause 15.

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5 Concrete

5.1 Materials for concrete

5.1.1 Cement

All cement shall be of Australian manufacture and shall conform to Type SL in AS 3972, Portland and Blended Cements. Type GB cement in accordance with AS 3972 may be supplied provided that it is blended for use in the works and the subsequent cementitious blend is sampled at the site and tested for compliance with the requirements of a Type SL in AS 3972.

The Contractor shall obtain and submit documentary evidence from the cement supplier regarding the source and conformance to AS 3972 of all cement used in the base concrete. **Hold Point 1**

5.1.2 Fly ash

Fly ash may be used in base concrete subject to the following conditions:

a) The Contractor shall nominate an intention to use fly ash (either separately or as blended cement) in the base, and in all cases state the proportions when submitting details of the mix design

b) Fly ash shall conform to AS 3582.1 ‘fine grade’, and

c) In addition to the requirements of AS 3582.1, the fly ash shall have a percent passing the AS 0.045 mm sieve of not more than 95%.

Where fly ash and an air entraining agent is used in a mix, the Contractor shall demonstrate, in writing, to the Administrator that the amount of air entrained can be controlled within specified limits and that

the compressive strength is satisfactory. This proof shall include the limits on fineness and loss on ignition necessary to achieve the specified level of air entrainment with the proposed level of fly ash. These limits shall be included in and form part of the requirements for the concrete.

The Contractor shall also assure himself that the requirements of this sub-Clause are achievable before submitting the tender.

The Contractor shall obtain from the fly ash supplier and shall include in the quality assurance record documentary evidence regarding the source and conformance to AS 3582.1 of all fly ash used in the concrete. **Hold Point 2**

5.1.3 Slag

Ground granulated iron blast-furnace slag may be used in concrete, subject to the following conditions:

a) The Contractor shall nominate an intention to use slag (either separately or as blended cement) and state the proportions when submitting details of the mix design, and

b) Slag shall conform to AS 3582.2.

The Contractor shall obtain from the slag supplier and shall include in the quality assurance records documentary evidence regarding the source and conformance to AS 3582.2 of all slag used in the concrete.

5.1.4 Fly ash and slag in combination

Fly ash and slag in combination may be used in concrete, provided that the Contractor nominates an intention to use both fly ash and slag in combination with Portland cement, and states the proportions when submitting details of the mix design.

5.1.5 Silica fume

Silica fume shall not be used in any concrete either as an addition, in isolation or as a component of any material such as Portland cement as defined in AS 3972, Clause 4.2.

5.1.6 Water

Water used in the production of concrete shall be free from materials harmful to concrete and reinforcement, and be neither salty nor brackish.

The water shall conform to AS 1379, Table 4, ‘Limits for Impurities in Mixing Water’, except for the following:

a) maximum 500 parts per million of chloride ion determined by AS 1478.1 Appendix C, and

b) maximum 400 parts per million of sulphate ion determined by AS 1289.4.2.1.

5.1.7 Chemical admixtures

5.1.7.1 General

Chemical admixtures shall comply with AS 1478.1 and shall be used in accordance with AS 1379. Admixtures shall not contain calcium chloride, calcium formate, triethanolamine or any other accelerator.

Admixtures or combinations of admixtures shall be used in accordance with Clauses 5.1.7.2 and 5.1.7.3.

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The total alkali contribution (measured as Na_2O equivalent) of all admixtures used in a mix shall not exceed 0.20 kg/m^3.

The Contractor shall ensure and certify that admixtures used in concrete production are the same as those for which Certificates of Compliance have been obtained. **Witness Point**

Where combinations of two or more admixtures are proposed in a mix, their compatibility shall be certified in writing by the manufacturers. **Hold Point 3**

5.1.7.2 Air entrainment

Other than for SFRC, an air entraining agent shall be used in base concrete mixes to achieve an air content of 4.5% ± 1.5%, when tested in accordance with AS 1012.4.2 with compaction by internal vibration.

The Contractor shall provide an air content gauging device at the site so that the air content of the freshly mixed concrete may be accurately determined in accordance with AS 1012.4.2. **Witness Point**

5.1.7.3 Water-reducing retarding admixtures

During the warm season (typically September to May inclusive, unless agreed to otherwise with the Administrator) a lignin or lignin-based ('ligpol') set-retarding admixture (Type Re or WRRe) shall be used, in accordance with the manufacturer's instructions. The dosage shall be varied to account for air temperature and haul time in accordance with the manufacturer's recommendations.

During the cooler season (typically June to August inclusive, unless the Administrator agrees to otherwise) only a lignin containing not more than 6% reducing sugars (Type WR complying with AS 1478) may be used in the mix.

If the Contractor proposes to vary the admixture between the warm and cool seasons, such variation shall constitute a permitted variation to the nominated mix in terms of Clause 5.5.2.5.

The Contractor shall provide in the Quality Plan details of the criteria (such as temperature) which may be used to initiate changes in admixture type with season. **Witness Point**

High range water reducers, Type HRWRRe, may also be used.

5.1.8 Aggregates

5.1.8.1 General

Compliance with the Technical Specification for source material requirements for aggregates shall be demonstrated at the time of submission of the trial mix. (See Clause 5.5.2.2.) **Hold Point 4**

The Contractor shall nominate the grading of the aggregate which shall be subject to the limitations of grading envelopes given in this Technical Specification.

5.1.8.2 Aggregate source assessment

The Contractor shall provide a material source assessment of the proposed material components to be used as concrete aggregate, which shall include an investigation of geological site characteristics and source material properties.

The source material shall be classified into one of the source material groups defined in Table 5.1.8.2 and the material source assessment shall show that material meeting the source material requirements of this Technical Specification can be produced. Where aggregate components are to be supplied from more than one source, a material source assessment of each source shall be provided.

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Due to the variable nature of most material sources, the assessment shall indicate the presence of materials with properties superior to the source material standards specified in this Technical Specification to allow for such variability, and hence to ensure that the requirements for the concrete aggregate in the stockpile(s) and/or other nominated storage points are satisfied.

The material source assessment shall be forwarded to the Administrator with the proposed mix information detailed in Clause 5.5.3. **Hold Point 5**

Table 5.1.8.2 – Terms for assessing material source for aggregates

Term	Definition
Material Group	A category selected on the basis of material classification, geological processes and source material properties.
Material Source	A quarry or pit from which concrete aggregate is won by blasting, ripping or other excavation means. The aggregate shall have to be processed by crushing and/or screening before use.
Acid Igneous Rock	As defined in AS 1726. Includes Rhyolite, Dacite, Tuffs (of same composition), Granite, Adamellite and Granodiorite.
Basic Igneous Rock	As defined in AS 1726. Includes Basalt, Dolerite and Gabbro.
Intermediate Igneous Rock	As defined in AS 1726. Includes Trachyte, Trachyandesite, Andesite, Tuffs (of same composition), Syenite and Diorite.
Metamorphic Rock	As defined in AS 1726. Includes Hornsfels, Quartzite, Metagreywacke, Greenstone, Slate and Amphibolite.
Natural Gravel	Naturally occurring colluvial or alluvial gravels.
Sedimentary and Duricrust Rocks	As defined in AS 1726. Includes Limestones, Dolomite, Mudstone, Arenite, Chert and Silcrete.

SUPERSEDED

5.1.8.3 Coarse aggregates

Coarse aggregates shall consist of clean, cuboidal, durable, natural gravel; crushed stone; or combinations thereof. The material shall be greater than AS sieve size 4.75 mm and shall conform to AS 2758.1, including assessment for alkali-reactive materials.

Slag aggregate shall not be used.

Coarse aggregate shall conform to the requirements of Table 5.1.8.3-A, Table 5.1.8.3-B and Clause 5.1.8.5.

If the Contractor proposes to blend two or more coarse aggregates, coarse aggregate from each source shall comply with all the requirements of this Technical Specification except grading. The combined grading of aggregate shall comply with all the requirements of Clause 5.3.3.

When submitting nominated mix details, the Contractor shall provide grading figures to indicate the average grading of the coarse aggregate, which shall be known as the ‘nominated coarse aggregate grading’. (See Clause 5.3.3.)

Table 5.1.8.3-A – Requirements for coarse aggregates: 10 percent fines, wet/dry variation; degradation factor

Source Material	Requirements		
	Ten Percent Fines Value (Wet)[1] (Minimum kN)	Wet/Dry Strength Variation[1,2] (Maximum %)	Degradation Factor (Coarse Aggregate) (Minimum mm)
Acid Igneous	110	40	40
Intermediate Igneous	120	35	45
Basic Igneous	130	30	50
Metamorphic	120	35	45
Sedimentary, Duricrust, Natural Gravel	110	40	-

Notes:

1. The 10% fines value (wet) and wet/dry strength variation tests shall be carried out in accordance with Test Methods Q205B and Q205C respectively on, where possible, the size fraction, AS 13.2 mm – AS 9.5 mm. Where there is insufficient material for this size fraction, the next lowest fraction where there are sufficient materials shall be used.
2. For greenstone source material only (metamorphic group), if the greenstone does not comply with the maximum wet/dry strength variation limits, it may be deemed to comply if its 10% fines value (wet) is 160 kN or greater.

Table 5.1.8.3-B – Requirements for coarse aggregate: other properties

Property	Test Method	Requirement
Bulk Density of Aggregate	AS 1141.4	min. 1200 kg/m^3
Particle Density and Water Absorption of Coarse Aggregate	AS 1141.6.1 or 1141.6.2	max. 2.5%
Materials Finer than 75 µm in Aggregates (by Washing)	AS 1141.12	max. 2.0%
Material Finer than 2 µm	AS 1141.13	max. 1.0%
Particle Shape, by Proportional Calliper (3:1 ratio) (2:1 ratio)	AS 1141.14	 max. 10% max. 35%
Flakiness Index (General)	AS 1141.15	max. of 25%
Light Particles	AS 1141.31	max. 1.0%
Weak Particles (including Clay Lumps, Soft and Friable Particles) in Coarse Aggregates	AS 1141.32	max. 0.3%
Crushed Particles	Q215	min. 80%
Alkali-Silica Reactivity	Q458	as per Clause 5.1.8.5

SUPERSEDED

5.1.8.4 Fine aggregate

Fine aggregate shall consist of natural sand or manufactured sand containing not less than 50% natural sands. Particles shall be clean, hard and durable. Fine aggregate shall conform to AS 2758.1, including assessment for alkali-reactive materials. Fine aggregate shall conform to the requirements of

Table 5.1.8.4. For manufactured sands, the source rock shall comply with the requirements of Clauses 5.1.8.2 and 5.1.8.3.

At least 40% by mass of the total aggregate in the concrete mix shall be quartz sand. Quartz sand is aggregate having a nominal size of less than 4.75 mm and shall contain at least 70% quartz by mass.

If the Contractor proposes to blend two or more fine aggregates, the fine aggregate from each source shall comply with all the requirements of this Technical Specification except grading. The combined grading of aggregate shall comply with all the requirements of Clauses 5.3.1 and 5.3.2.

When submitting nominated mix details, the Contractor shall provide grading figures to indicate the average grading of the fine aggregate, which shall be known as the nominated fine aggregate grading. (See Clause 5.3.2).

Table 5.1.8.4 – Requirements for fine aggregate

Property	Test Method	Requirement
Bulk Density of Aggregate	AS 1141.4	min. 1200 kg/m^3
Particle Density and Water Absorption of Fine Aggregate	AS 1141.5	max. 2.5%
Material Finer than 75 µm in Aggregate (by Washing)	AS 1141.12	max. 5.0%
Material Finer than 2 µm	AS 1141.13	max. 1.0%
Organic Impurities other than Sugar	AS 1141.34	colour to be no darker than the standard colour of the reference solution
Sugar Content	AS 1141.35	less than 1 part in 10,000
Petrographic Examination of Slag Aggregate	AS 1141.15	max. 1 in 12 (slag aggregate)
Alkali-Silica Reactivity	Q458	as per Clause 5.1.8.5
Quartz Content of Fine Aggregate	Q188	min. 70%
Plasticity Index	Q105	max. 2%

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5.1.8.5 Alkali reactive materials

In addition to the requirements of Section 10 of AS 2758.1, all nominated concrete mixes shall meet the requirements of the 'innocuous' classification of Test Method Q458. Concrete mixes containing a minimum 20% of an approved fly ash by mass of total cementitious material shall be deemed to comply with this additional requirement.

5.1.9 Steel fibres

The ultimate strength of the steel fibre shall not be less than 750 MPa. The hardness of steel fibre shall not be less than 85 HRB (Hardness Rockwell B Scale).

The type and size of steel fibres shall be such as to yield a Fibre Factor (F_f) of at least 30, as determined in the following relationship:

F_f = $V_f \times l/d_f \times K_f$

where:

V_f = fibre content (% volume of the mix)

l/d_f = aspect ratio of the fibre

K_f = bond coefficient of the fibre without enlarged ends

For fibres with enlarged ends, the value of K_f shall be as given by the manufacturer. If a value is not given, a value of 0.75 shall be assumed for the bond coefficient, unless evidence is provided to support a higher value.

A steel density of 7850 kg/m^3 shall be assumed unless specified otherwise by the manufacturer.

The minimum fibre content shall be 75 kg/m^3 of concrete and the maximum content shall be 100 kg/m^3, unless otherwise specified.

In the case of thin (10 mm maximum aggregate size) bonded concrete overlays, the minimum fibre content shall be 100 kg/m^3.

5.2 Supply and storage of materials

5.2.1 Cementitious materials

Cementitious material shall be transported and stored so as to prevent any contamination and to minimise the adverse effect of moisture and high humidity during transportation and storage. Caked or lumpy cementitious material is nonconforming and shall be removed and replaced. The cost of replacing rejected cementitious material shall be borne by the Contractor.

Where delivery of cementitious material is in bags, they shall be marked with the manufacturer's name, the brand name (if appropriate), the name of the producing works, the material type, the standard to which it was made, and the date of manufacture or date code. Bagged material shall be delivered in the original sealed and branded bags. If bagged material is to be stored in bulk containers, it shall be charged through a 6 mm mesh screen which is welded or bolted to, and covers the entire feed area of, the container's charging hopper.

Cementitious material shall be stored above ground level in dry, weatherproof sheds and be protected from dampness which may be acquired from contact with floors or walls. Bags shall be stacked so as to allow counting, inspection, and identification of each consignment.

Cementitious material shall be used in order of receipt and as soon as possible. The Contractor shall demonstrate a system to ensure freshness. Material more than two months old shall not be used. Material containing lumps is nonconforming and shall be removed and replaced.

5.2.2 Aggregates

Aggregates shall be stored in stockpiles. The stockpiles shall be located in clean areas which are paved

a) with at least an AMCO prime and a bitumen seal with a 14 mm cover aggregate, designed in accordance with the Austroads Design of Sprayed Seals, and

b) over a granular pavement complying with MRTS05 *Unbound Pavements*,

and which are

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a) sufficiently sound to accommodate all loadings

b) adequately drained to prevent ponding

c) not liable to flooding, and

d) maintained to the original standard while in use for the works.

A stockpile shall be a homogeneous portion of material of each component used to make up each of the coarse and fine aggregates to be used in the works. There shall be a separate stockpile for each component. The various sizes and types of aggregates shall be separated by solid dividing walls of a height and strength sufficient to allow segregation of a specific aggregate size, and prevent mixing with other aggregate sizes or deleterious materials.

Alternatively, the specific aggregate sizes shall be stored at a sufficient distance apart to prevent intermixing.

An aggregate lot shall consist of a discrete stockpile solely for use on these works. These materials shall not be used for any other works. The stockpile shall be formed by either of the following methods:

a) a stockpile for each lot, or

b) a continuous, rectangular in plan view, shaped stockpile where material is added at one end and withdrawn at the other end, with each lot being identified by pegged locations within the stockpile.

Nonconforming stockpile lots shall be removed from the stockpile prior to the addition of further portions.

Where plant is required to operate on stockpiles, washing and decontamination procedures shall be employed before permitting access to the stockpile. Contaminated material is nonconforming and shall be removed and replaced.

Stockpiles of fine aggregate shall be capable of draining freely. Wet/fine aggregate shall not be used until it has drained sufficiently to ensure proper control of the water/cementitious material ratio.

To provide adequate control of the concrete mix, the Contractor shall monitor moisture content of the aggregate at least three times per day, immediately after rain, and after any other changes have occurred to the stockpile.

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5.2.3 Chemical admixtures

The Contractor shall supply for each consignment of chemical admixture a record stating the manufacturer's name, type and quantity of admixture delivered, and date manufactured, together with the manufacturer's test certificate showing that the consignment has been tested and analysed, and conforms in all respects to the relevant Australian Standard (AS 1478) or Technical Specification. Admixtures shall be stored in waterproof conditions and used in order of receipt. The Contractor shall comply with all of the manufacturer’s requirements. Any admixture that does not comply with the specified requirements immediately prior to use is nonconforming and shall be removed from the site and replaced.

5.2.4 Steel fibres

Steel fibres shall be stored under waterproof conditions and supported clear of the ground. They shall be protected from damage and from deterioration due to exposure.

5.3 Aggregate grading

5.3.1 Combined grading

Notwithstanding any requirements in Clause 5.3.2 and 5.3.3, the grading of the combined aggregate shall at all times be within the limits shown in Table 5.3.1. The grading of the combined aggregates shall be determined on sample(s) of the combined aggregate that is to be used in the works in accordance with the following:

a) AS 1141.11, and

b) Within the AS 1141.11 test method procedure, the sample of material is washed prior to sieving in accordance with Section 5.6 of AS 1141.11 and the dust washed from the sample accounted for in the results of the sieve analysis.

The specified grading distributions are based on materials of equal bulk densities in a saturated surface-dry condition. Where bulk densities are unequal, the specified combined particle size distribution shall be adjusted accordingly.

The Contractor shall nominate target coarse and fine aggregate grading that, at the extremes of all the tolerances and their combinations, shall always ensure that the combined grading is wholly within the limits of Table 5.3.1.

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Table 5.3.1 – Combined total aggregate grading for concrete base

AS Sieve	% Passing Sieve Size by Mass of Sample
19.0 mm	95 – 100
13.2 mm	75 – 90
9.50 mm	55 – 75
4.75 mm	36 – 48 (for non-SFRC) 36 – 50 (for SFRC)
2.36 mm	30 – 42
1.18 mm	22 – 34
600 micrometre	16 – 27
300 micrometre	5 – 12
150 micrometre	0 – 3
75 micrometre	0 – 2

5.3.2 Fine aggregate grading

The grading of the fine aggregate used in the concrete base, determined in accordance with AS 1141.11, shall not deviate from the nominated fine aggregate grading (as defined in Clause 5.1.8.4) by more than that shown in Table 5.3.2.

Table 5.3.2 – Maximum deviation from nominated fine aggregate grading

AS Sieve	Maximum Deviation (% passing sieve size by mass of sample)
4.75 mm	3
2.36 mm	10

AS Sieve	Maximum Deviation (% passing sieve size by mass of sample)
1.18 mm	10
600 micrometre	10
300 micrometre	5
150 micrometre	2

5.3.3 Coarse aggregate grading

The grading of the coarse aggregate used in concrete base, determined in accordance with AS 1141.11, shall not deviate from the nominated coarse aggregate grading (as defined in Clause 5.1.8.3) by more than that shown in Table 5.3.3:

Table 5.3.3 – maximum deviation from nominated coarse aggregate grading

AS Sieve	Maximum Deviation (% passing by mass of sample)
19.0 mm	2
13.2 mm	5
9.5 mm	5

5.4 Concrete standards

5.4.1 Compressive strength

5.4.1.1 Specified compressive strength

The minimum characteristic compressive strength for base concrete shall be 40 MPa.

5.4.1.2 Specified flexural strength

The minimum characteristic flexural strength for base concrete shall be:

a) 4.8 MPa for jointed unreinforced, jointed reinforced and continuously reinforced pavements, and

b) 5.5 MPa for steel fibre reinforced pavements.

If fly ash and slag combinations less than those tabulated in Table 5.4.1.2 are used, the specified 28-day flexural strength shall be increased by 10%.

Where fly ash and/or slag combinations equal to or exceeding the values in Table 5.4.1.2 is used, no increase to the specified 28-day flexural strength is required.

Table 5.4.1.2 – Percentages of cementitious material required to obviate the need for an increase in flexural strength

Cementitious Material	Minimum Percentage of Total Cementitious material
Fly ash	15%
Fly ash and ground granulated iron blast-furnace slag	30%

5.4.1.3 Determination of compressive strength

The procedure shall be as follows:

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a) The Contractor shall develop a preliminary mix (see Clause 5.5.2.1) with a flexural strength of 5.5 MPa

b) Using the preliminary mix design, sufficient concrete shall be manufactured to make at least ten flexural strength beams and the same number of compressive strength cylinders

c) The following shall be determined

   i. 28-day flexural strength. The flexural strength shall be tested in accordance with AS 1012.11, on specimens that have been made and cured in accordance with Test Method Q472;

   ii. 28-day compressive strength. The compressive strengths shall be tested in accordance with AS 1012.9, with compaction by internal vibration, using specimens of 100 mm nominal diameter which have been made and cured in accordance with Test Method Q472, and

   iii. Density of the beam and cylinder specimens

d) All results from all samples manufactured, not only the minimum specified, shall be used in the analysis. All results, at least ten, shall be averaged to give average flexural strength (f_f) and average compressive strength (f_c), and

e) The 28-day compressive strength ($f\rho_{cf}$) shall be the average compressive strength required to achieve the average flexural strength.

The size of the flexural beam specimens shall be:

a) For non-SFRC mixes, and for SFRC mixes with fibre lengths less than or equal to 30 mm, the beams shall be standard 100 mm x 100 mm x 350 mm specimens

b) For SFRC mixes with fibre lengths greater than 30 mm and less than or equal to 50 mm, the beams shall be 150 mm x 150 mm x 450 mm, and

c) For SFRC mixes with fibre lengths exceeding 50 mm, the beam dimensions shall conform to ASTM C1018-94b.

SUPERSEDED

5.4.1.4 Determination of tensile strength

The indirect tensile strength shall be determined for each trial mix, based on a minimum of three specimens tested at age 28 days. Specimens shall be 150 mm nominal diameter cylinders moulded in accordance with AS 1012.8 and tested in accordance with AS 1012.10. The results shall be reported to the Administrator.

5.4.2 Consistence

The Contractor shall nominate a slump value for each job concrete mix within the range specified below which shall allow the production of a dense, non-segregated mix with bleeding limited so as to prevent bleed water flowing over the slab edge under the conditions of placement.

For mechanically placed concrete the nominated slump shall be between 25 mm and 45 mm. For hand-placed concrete the nominated slump shall be between 55 mm and 75 mm. For SFRC, the above ranges shall be reduced to 20 – 40 mm and 45 – 65 mm respectively.

If more than 70% of the coarse aggregate used in the concrete mix is coarse slag or light-weight aggregate, the above ranges shall be reduced to 10 – 30 mm and 40 – 60 mm respectively.

For each job mix, the Vebe value shall be determined and reported in accordance with AS 1012.3.3. The Vebe value for mechanically placed concrete shall not exceed 2.5 seconds. **Witness Point**

5.4.3 Drying shrinkage

For each job mix, the drying shrinkage, determined in accordance with AS 1012.13, shall not exceed 500 microstrains after 21 days air drying (i.e. 28 days concrete age).

For the production concrete, the drying shrinkage of field-moulded specimens shall not exceed 600 microstrains after 21 days air drying. If the concrete exceeds 600 microstrains, the Contractor shall immediately modify the mix and resubmit a conforming job mix.

5.4.4 Air content

Except for SFRC, the air content of the fresh concrete, determined in accordance with AS 1012.4.2 with compaction by internal vibration, shall be 4.5 ± 1.5%.

5.4.5 Bleeding

For each nominated concrete mix, the ratio of bleed to mixing water, determined in accordance with AS 1012.6 with compaction by internal vibration, shall not exceed 3%.

5.4.6 Chemical content

The sulphate content of concrete as placed, expressed as the percentage by mass of acid-soluble SO_3 to cement, shall not be greater than 5%.

The mass of acid-soluble chloride ion per unit volume of concrete as placed shall not exceed 0.8 kg/m^3.

Sulphate and chloride ion contents shall be determined by either of the following methods:

a) Testing of concrete constituents in accordance with:

   i. Chloride content – AS 1012.20 for aggregate and AS 1478.1 Appendix C for water and admixtures dissolved in water, then calculating the total content and percentage, and

   ii. Sulphate content – AS 1289.4.2.1 for water and admixture dissolved in water; AS 1012.20 for aggregates; AS 2350.2 for cementitious material, calculating the total content and percentage.

   (Testing of individual constituents (except for admixtures) shall have been undertaken 6 months prior to the date of closing of tenders. For admixtures, the soluble salt contents may be taken as the values certified in writing by the manufacturer. The tested water shall be from the source proposed to be used in the works.), and

b) Testing of hardened concrete in accordance with AS 1012.20. The concrete shall be produced using water only from the source proposed to be used in the works.

5.4.7 Relative compaction of concrete

The relative compaction shall be not less than 98%.

Lots which do not comply with the above are deemed to be nonconforming.

5.4.8 Cementitious content and component requirements

The cementitious content and component requirements shall be in accordance with Table 5.4.8.

SUPERSEDED

Table 5.4.8 – Cementitious content and component requirements

Component	Requirement
Portland Cement	min. 60%[1]
Fly Ash	max. 25%[1] (min. 20% when used to replace the need for conformance to Q458)[2]
Slag	max. 35%
Total Cementitious[3]	min. 300 kg/m^3 for non-SFRC min. 350 kg/m^3 for SFRC

Notes:

1. Percentage of Portland cement, fly ash and slag expressed as a percentage of the actual total cementitious material used in the concrete used in the works.
2. In lieu of conformance to the requirements of Q458, a minimum of 20% fly ash shall be used in concrete base.
3. Per yielded cubic metre of concrete.

5.5 Concrete mixes

5.5.1 General

The Contractor shall be responsible for the design and production of all concrete used in the works. The supply of concrete by a subcontractor or the use of premixed concrete shall in no way lessen or remove this responsibility.

The testing required under this Clause shall have been carried out within the twelve-month period prior to the date of submission of the proposed job mix to the Administrator. The Administrator may permit a reduced trial if sufficient production mix results are available (but no trial mix results) from within the past 12 months.

For each concrete mix, all phases of any particular test shall be carried out by a single laboratory with appropriate registration issued by the National Association of Testing Authorities (NATA). All constituent test reports shall also be NATA endorsed.

5.5.2 Hierarchy of concrete mixes

For all mixes, test specimens shall be homogenous and moulded from the same batch. For the purposes of this Technical Specification the development of the concrete mix(es) to be used in the works involves the following phases.

5.5.2.1 Preliminary mix

A preliminary mix shall be designed close to and within ± 0.5 MPa of the specified flexural strength. The test results are used to develop a relationship between the flexural strength and the compressive strength for the constituent materials to be used for the works. The preliminary mix can be a different mix from the trial mix and the proposed job mix, or be the same mix if the Contractor achieves all the requirements with only one or two sets of mixes.

5.5.2.2 Trial mix

Trial mixes are concrete mixes which are used to develop a concrete mix(es) which meets all the requirements for the class of concrete for this Technical Specification. The trial mix(es) can be different from or the same as the preliminary mix and/or the proposed job mix.

SUPERSEDED

5.5.2.3 Proposed job mix

A proposed job mix is a trial concrete mix which satisfies all the requirements of this Technical Specification and which is submitted by the Contractor to the Administrator.

A separate report for each proposed job mix, certifying conformance to the requirements of the Technical Specification and providing details required under Clause 5.5.3 below, shall be submitted by the Contractor not less five working days prior to the commencement of paving. **Hold Point 6**

5.5.2.4 Job mix

If the proposed job mixes submitted meet all the requirements of this Technical Specification, they shall be deemed to be the job mix(es) for the works, and the Administrator shall release the **Hold Point 7**.

The job mix(es) for a particular class of concrete works shall be used on that class of concrete in the works only if:

a) all the constituent materials comply with these Technical Specifications and are the same as the materials used in the original proposed job mix design, and

b) the specified requirements for the concrete, particularly strength and consistency, are achieved in the works.

5.5.2.5 Nominated job mix

This is the job mix nominated by the Contractor for use on a particular class of concrete works for a specific period.

Before commencing production of each base concrete mix the Contractor shall submit to the Administrator the nominated job mix, identifiable by its reference number, to be used on a particular class of concrete work. This statement, signed by the Contractor, shall also state that the nominated job mix(es) and its constituents meet the requirements of this Technical Specification.

A nominated job mix shall not be changed without one day's notice to the Administrator and without an alternative job mix being nominated and immediately available.

For any class of concrete work there shall be only one nominated job mix at any specific time.

SUPERSEDED

5.5.3 Submission of proposed job concrete mixes

Submission of a proposed job mix by the Contractor shall include the following details incorporating, where necessary, provision of NATA-endorsed test results for all tests (except for Vebe) in this Technical Specification and a copy of the Contractor's verification checklist:

a) class of concrete work – (structural pavement, slab anchors, non-integral shoulders, CRC, etc.)

b) the name of concrete subcontractor or supplier, where applicable, and the proposed methods and degree of quality control. Where the contractor, subcontractor or supplier produces concrete of requisite classes on a regular basis, information is required regarding mean strength and standard deviation for recent output of each class of concrete to be supplied

c) material constituents including: cement type, brand and source, fly ash source, water source

d) admixture including source, type, name and dosage recommended by the manufacturer

e) details of aggregates including source, geological type, moisture condition on which the mix design is based (i.e. oven dry, saturated surface-dry or nominated moisture content)

f) all material test results including Test Method Q458 where applicable (see Clause 5.1.8.5)

g) contents by mass of yielded m^3 of all materials comprising the mix, including aggregates, water, admixtures, cementitious materials (Portland cement and/or fly ash and/or slag), nominated slump, nominated grading and water/cementitious ratio

h) the proposed sequence of addition of ingredients. (For admixtures, details of pre-dilution shall be provided, consistent with the requirements of Clause 5.1.7.) Trial mixing shall comply strictly with these proposals, and

i) for a proposed job mix batch at the nominated slump with a tolerance of ± 10 mm the mix details and test results are to be provided for:

   i. cement, fly ash and total cementitious content per yielded cubic metre of concrete

   ii. nominated grading of aggregates

   iii. compressive strength at age seven days

   iv. compressive strength at age 28 days

   v. flexural strength at age seven days

   vi. flexural strength at age 28 days

   vii. indirect tensile strength at age 28 days (on 150 mm cylinders)

   viii. Vebe reading at nominated slump (± 10 mm) for machine paving

   ix. drying shrinkage after 21 days air drying

   x. air content

   xi. bleeding, and

   xii. chemical content in terms of Clause 5.4.6.

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The required testing shall have been carried out within the twelve-month period prior to the date of submission to the Administrator for assessment.

For each proposed job mix, the 7-day and 28-day compressive strengths shall each be determined on sufficient standard compressive strength cylinders to provide five results of each which are within 2.0 MPa of the median value. The five results shall be averaged to give the average 7-day compressive strength and the average 28-day compressive strength.

The ratio of the 28-day compressive strength to the 7-day compressive strength shall be calculated by dividing the average 28-day compressive strength by the average 7-day compressive strength, both as determined above. The result shall be termed r_7. **Hold Point 8**

5.5.4 Variations to the job mix

Within the limits specified below, the Contractor may vary the quantities of the constituents in any job mix to maintain the standard and 'paveability' of the concrete, without resubmitting a new nominated mix in accordance with Clause 5.5.2.5, as follows:

a) The total cementitious material may be varied by + 20 kg/m^3 or, provided that the 7-day and 28-day compressive strength results are sufficiently high to indicate that the specified strength can still be achieved, by – 10 kg/m^3. Both of these are subject to conformance to the requirements of Clause 5.4.8

b) 5% by mass of each constituent, except admixtures and water, or

c) Admixture dosages in accordance with Clause 5.1.7.

Prior to commencement of production with the varied quantities, the Contractor shall notify the Administrator of any variations to a job mix. **Hold Point 9**

5.6 Production and transport of concrete

5.6.1 General

The Contractor's production and transport of concrete shall be such as to:

a) prevent segregation and/or loss of materials

b) supply a homogenous product, and

c) result in concrete workability, at the time of incorporation into the works, which is compatible with the capacity of the placing equipment to achieve the specified compaction and surface finish with the minimum of manual finishing.

For mechanical paving, the mixing, agitation and transport equipment shall have an operational capacity which allows continuous paving at the Contractor's target paving speed. In no case shall the capacity be less than that required to maintain a continuous paving speed of 1 m per minute, with adequate allowance for mixer efficiency and control testing.

Details of the proposed methods of handling, storing and batching materials for concrete, and details of proposed mixers and methods of agitation, mixing and transport shall be submitted as part of the Quality Plan. Included in this Plan shall be the proposed sequence of addition of ingredients to the mixer.

5.6.2 Handling, storage and batching of materials

Handling, storing and batching of materials for concrete shall comply with AS 1379 as amended by this Technical Specification.

Cementitious materials shall be weighed in an individual hopper.

Aggregates that have become intermixed or contaminated with foreign matter shall not be used in the works.

Water and admixtures may be batched by weight or by volume. Volumetric batching of water shall employ the use of a measuring device calibrated in 1 litre increments. Measuring devices or dispensers for admixtures shall be calibrated to AS 1379.

The permissible tolerance for weight batching of steel fibres shall be + 10% and - 0%.

5.6.3 Mixers and agitation equipment

Concrete shall be mixed in a batch mixer having a capacity suitable for the type and extent of work being undertaken. Under no circumstances shall the rated capacity of the mixer be exceeded.

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Mixers and agitation methods shall comply with AS 1379 Sections 3 and 4, varied in accordance with Clause 5.6.4. The minimum or recommended mixing time so determined shall therefore be adopted as the minimum mixing time for that mix.

5.6.4 Mixing

5.6.4.1 Mixer uniformity testing – general

Mixing shall comply with AS 1379, Sections 3 and 4 and Appendix A, together with the requirements in Clause 5.6.4.

A mixer uniformity test shall be carried out for each type of concrete mixer to be used in the works. Alternatively, the Contractor may nominate to carry out a mixer uniformity test for the base concrete only and use the same mixing time for all other concrete mixes.

For the purpose of conducting the mixer uniformity test, the mixer shall be charged in accordance with the manufacturer's instructions and to the maximum volume (or throughput) that is proposed to be used for the works. The volume (or throughput) at test shall thereafter not be exceeded unless a further uniformity test is conducted.

Concrete from the mixer uniformity test shall not be incorporated into the works.

Mixer uniformity testing shall constitute a **Hold Point 10**.

5.6.4.2 Uniformity testing of central concrete mixers

Where concrete is to be produced and mixed by a central batch mixer, mixer uniformity tests shall be conducted before paving is commenced with that mix, and thereafter upon production of each 30,000 m^3 of concrete from that mixer, or as otherwise required in accordance with AS 1379 Clause 2.4.2. Mixes of all types (including sub-base, base, gutter and kerbs) and to all clients shall be included in the above volumetric total.

Tests shall be carried out on each base mix to be placed in the works. Alternatively, tests may be carried out on the base mix of lowest target slump to be placed in the works, and the minimum mixing time so determined shall thereafter be adopted for all base mixes.

Tests shall be conducted on three consecutive batches (of the same mix) which conform to all of the requirements of this Technical Specification.

The Contractor shall report mixing speed and mixing time.

The whole of a single batch shall be discharged and sampled by one of the following procedures:

a) By discharge into a moving vehicle whose tray length is not less than 8 m. Sampling shall be from the truck prior to tipping. Samples shall be obtained using a shovel or scoop, but the top 100 mm of concrete shall be excluded.

b) By discharge into a transport vehicle typical of that to be used in the works, and then spread evenly over a length of between 6 and 10 m of ground which is either sealed or pre-dampened to prevent absorption of water from the mix. The samples shall be taken from the deposited concrete in accordance with AS 1012.1.

c) In each case, the batch shall be sampled at three points approximately 15%, 50% and 85% along the discharged or deposited length of the mix. A sample of approximately 50 litres shall be taken from each point. Samples shall be individual and not composites. (See AS 1012.1 Clause 2).

SUPERSEDED

The mixer shall be deemed to have passed the uniformity test if the difference between the highest value and the lowest values for the corresponding properties of the three samples does not exceed the limiting values given in AS 1379 Table A1 for any of the three batches. Additionally, no slump value shall lie outside the specified range.

5.6.4.3 Uniformity testing of mobile concrete mixers

Where concrete is to be mixed by mobile batch mixers, each mixer shall have been tested for uniformity within the past 24 months in accordance with AS 1379 and each mixer shall display identification plates or equivalent certification in accordance with AS 1379 Clause 2.4.1.4.

Further tests shall be carried out upon evidence of inadequate mixing, as required under AS 1379 Clause 3.2.2.3.

Additional to the requirements contained therein, the date of the latest test shall be shown.

Truck mounted agitators shall mix concrete at full mixing speed for three minutes on site, before commencing discharge into the works.

5.6.5 Charging the mixer and mixing

The Contractor shall stipulate the method of charging the mixer in the Quality Plan for the works. Where steel fibre reinforcement or any other mix additive is used, the method of charging the mixer shall be consistent with the recommendations of the supplier.

The first batch of materials charged into a clean mixer shall contain sufficient excess cement, water and sand to allow ‘coating’ of the inside of the drum without diminishing the normal mortar content of the mix.

Prior to their introduction to other materials, admixtures shall be thoroughly mixed and pre-diluted before being injected into the supply line for adding water to the concrete. Incorporation shall be by a method that ensures that no adverse interaction occurs. The pre-dilution and mixing shall comply with the instructions of the admixture manufacturer.

Mixing shall continue until the materials are thoroughly blended and the minimum mixing time is met after all the materials have entered the mixer.

The entire batch of concrete shall be discharged from the mixer before any further charging of the mixer takes place.

If the mixing operation ceases for a period of time exceeding 45 minutes, the mixer shall be thoroughly cleaned out before subsequent batches are mixed.

5.6.6 Retempering

Concrete that is delivered by other than mobile batch mixer shall not have water or any other ingredient added to the mixed batch.

Concrete that is delivered by mobile batch mixer may be retempered strictly in accordance with the following conditions which shall replace the relevant corresponding Clauses of AS 1379.

Only the Contractor who is mixing the concrete may retemper a batch prior to the completion of discharge of the batch, and only if the relevant following conditions are satisfied.

SUPERSEDED

a) Immediately after retempering, the mixing mechanism shall be operated at mixing speed for such additional time as may be necessary to re-establish uniformity of the mix but not less than 90 seconds.

b) The fact that a batch has been retempered and the quantity of water so added (accurate to one litre) shall be recorded on the identification certificate for that batch. If water is added after the commencement of discharge the remaining quantity of concrete at that time shall also be recorded.

c) Immediately after sub-clause (a) above has been satisfied, the slump shall be determined and the requirements of Clause 6.1.4 'Consistence' shall apply.

d) If a maximum water-to-cement ratio has been specified, the quantity of water added shall be such that the specified ratio is not exceeded.

e) The quantity of water added shall not cause the concrete to exceed the specified requirements for properties such as compressive strength, flexural strength and consistency.

f) Depending on the concrete temperature, retempering shall be permitted only within the times given in Table 5.6.6, measured from the completion of batching to when retempering is to occur.

Retempering shall take place only in the presence of the Contractor's representative previously nominated to the Administrator for this purpose, and only at either the batch plant, the testing station, or the point of placement.

Cylinders shall be made from the retempered mix in accordance with Clause 6.1.5 to determine the compressive strength. Such cylinders shall be additional to the cylinders required under Clause 6.1.5, unless that particular delivery load had been chosen to represent the lot.

Table 5.6.6 – Retempering times

Concrete Temperature[1]	Maximum Time between Batching and Retempering
≤ 15ºC:	40 minutes
> 15°C – ≤ 25°C:	30 minutes
> 25°C:	20 minutes

Note 1: Concrete temperature shall be measured at the commencement of discharge of a batch at intervals not exceeding 60 minutes throughout the paving operation. The latest value shall apply.

5.6.7 Mixing time limits

For mobile concrete mixers the minimum mixing time shall be the minimum mixing time determined in Clause 5.6.4.3.

For central concrete mixers, the minimum mixing time shall be the greater of the values determined from Table 5.6.7 below.

Table 5.6.7 – Mixing time limits

Concrete Batch Size	Minimum Mixing Time
All batches	The minimum mixing time determined in accordance with Clause 5.6.4.2.
For batches of 1.0 m^3 capacity or less	60 seconds

SUPERSEDED

Concrete Batch Size	Minimum Mixing Time
For batches exceeding 1.0 m^3	60 seconds, plus 6 seconds for each cubic metre or fraction thereof in excess of 1.0 m^3.
For twin shaft mixers	60 seconds after fully charging provided mixer uniformity requirements are met

Where, by reason of delay, it is necessary to hold a batch in the mixer, mixing may be continued for a maximum of 10 minutes except for split drum mixers where the maximum shall be 5 minutes. For longer delays, the batch may be held in the mixer and turned over at regular intervals, subject to the time limits on the forming time.

5.6.8 Maximum forming time

The Contractor shall nominate a 'maximum forming time' for each nominated mix, which shall not exceed 90 minutes for agitator-delivered concrete and 60 minutes for tipper-delivered concrete, taking into account:

a) the prevailing weather conditions and concrete temperature

b) the requirements of Clause 9.3.8, and

c) the capacity of the equipment and methods in current use to place, compact and finish the mix to the specified standard with a minimum of manual finishing.

The procedure to determine the maximum forming time shall be included in the Quality Plan.

During paving, the Contractor shall monitor and record the forming time and shall report to the Administrator the actual forming times.

Batches with a forming time above the nominated maximum forming times shall be retested for consistency in accordance with Clause 6.1.4. Batches shall be treated as follows:

a) Batches that do not conform to the requirements for consistency shall be rejected and removed from the site.

b) Batches that conform to the requirements for consistency shall be conforming only if, after sampling, curing and testing in accordance with Clause 6.1.5 and Clause 9.3.6, the compressive strength and compaction of cores from those specific batches conform. This testing shall be additional to routine random sampling unless those batches had been chosen in the random selection process.

5.6.9 Transport and delivery

A manufacturer's Certificate in the form of a delivery docket in accordance with AS 1379 shall be supplied for each batch or load and shall be retained by the Contractor. The certificates shall be pre-numbered and issued sequentially in accordance with the order of batching. The certificates shall record the time of 'completion of batching' as defined in Table 3.2-A. Any subsequent addition of water shall be in accordance with Clause 5.6.6. Such Certificates shall be available to the Administrator on request.

The production and delivery of ready-mixed concrete shall be in accordance with the requirements of AS 1379, except as otherwise specified.

SUPERSEDED

Freshly mixed concrete that is to be machine placed may be transported in tipper trucks, truck mixers or agitators. Truck mixers shall be used only as agitators. Concrete that is to be hand placed shall only be delivered using agitator vehicles.

The size of the batch in an agitator vehicle shall not exceed the manufacturer's rated capacity nor shall it exceed 80% of the gross volume of the drum of the mixer.

The mixed material shall be transported and delivered so that segregation and/or loss of the constituent materials do not occur. The deliveries shall be timed so as to ensure an essentially continuous placing operation.

The number of delivery vehicles provided shall be sufficient to ensure a constant supply of concrete to enable the paving plant to proceed continuously. When paving with a mechanical paver, sufficient transport capacity shall be provided to enable continuous paving at the Contractor's target paving speed. In no case shall the capacity be less than that required to maintain a continuous paving speed of one metre per minute.

6 Conformance testing of concrete production and supply

6.1 Sampling and testing procedures

6.1.1 General

The concrete shall be checked for conformance to the specified requirements prior to, during and after the construction operation, as relevant. Conformance checking shall be carried out in accordance with any maximum lot sizes, minimum testing frequencies and minimum test numbers as given in MRTS40.

The Contractor shall arrange for a laboratory with appropriate NATA registration to conduct all sampling and testing of concrete and aggregates during production and supply as required herein.

6.1.2 Aggregates

All aggregates shall be sampled in accordance with AS 1141.3.1 during concrete production.

Samples for conformance testing shall be randomly sampled from the stockpile lot at the batch plant and tested for conformance to the aggregate standards in Clause 5.1.8 and the aggregate gradings in Clause 5.3.

6.1.3 Air content

Air content measurement shall be carried out on all air-entrained concrete prior to placement. Testing shall be carried out in accordance with AS 1012.4.2. Concurrently, the mass per unit volume of the freshly mixed concrete shall be determined in accordance with AS 1012.5.

Testing shall be carried out on production days at the following frequency:

a) one per load until three conforming results are obtained; and thereafter

b) one per 50 m^3 until four consecutive conforming results are obtained; and thereafter

c) one per 200 m^3 for the remainder of the day.

Testing under (b) and (c) shall be on batches of concrete from which cylinders are moulded for 28-day compressive strength under Clause 6.1.5.

If for any sample the measured air content is not within the limits specified (see Clause 5.4.4), one repeat test shall be made immediately from another portion of the same sample.

SUPERSEDED

If the value obtained from the repeat test falls within the specified limits, the concrete represented by the sample shall be deemed to conform to the specified limits.

If the value obtained from the report test falls outside the specified limits, the concrete represented by the sample is nonconforming.

If the value obtained from the repeat test falls outside the specified limits, the testing frequency shall revert to that specified in Sub-Clause (a) above.

Concrete with an air content less than 3% or higher than 6% is nonconforming and shall not be used in the base but may be used elsewhere in the works, subject to the concrete complying with the requirements for the particular application.

6.1.4 Consistence

The consistence and workability of the concrete shall be such that it can be handled and transported without segregation and can be placed, worked and compacted into all corners, angles and around all reinforcement so that homogeneous concrete is the outcome.

At all times between the end of mixing and the incorporation of concrete in the works, the slump shall be within ± 10 mm of the Contractor's nominated slump for the mix for mechanically placed concrete, and within ± 15 mm thereof for hand-placed concrete.

The consistence of the concrete shall be checked by means of the slump test in accordance with AS 1012.3.1. Sampling shall be as follows:

a) Tipper truck delivery: the test sample shall be a composite of three portions, taken from different locations using a shovel or scoop, obtained prior to discharge. The top 100 mm shall be excluded, and

b) Agitator delivery: the test sample shall be an individual sample (i.e. not composite) obtained in accordance with AS 1012.1.

The consistence shall be tested within the time limits specified in Table 6.1.4-A below as measured from the completion of batching and as appropriate for the temperature of concrete.

Table 6.1.4-A – Consistence time limits

Temperature	Maximum Time
≤ 15ºC	40 minutes
> 15ºC to ≤ 25ºC	30 minutes
> 25ºC	20 minutes

Concrete temperature shall be measured at the commencement of discharge of the first batch and when taking each consistence test sample. Intervals between the measurement of concrete temperature shall not exceed 60 minutes throughout the paving operation. The latest value shall apply.

Slump testing shall be carried out as given in Table 6.1.4-B, except that all truck loads shall be slump tested for hand placed concrete.

SUPERSEDED

Table 6.1.4-B – Consistence (slump) testing requirements

Event	Activity
a) Commencement of slump testing on each class of work	Test every load prior to discharge until 8 consecutive conforming loads are tested. Calculate the standard deviation (SD) of test results from these 8 loads.
b) If SD > 8.0 mm:	Continue slumping every load until test results from any 8 consecutive loads have an SD < 8.0 mm.
c) If SD ≤ 8.0 mm:	Go to process slump testing (d)
d) Process slump testing	Process slump testing involves slump testing every fourth load until a nonconforming slump is measured.
e) Nonconformance slump	Following a nonconformance, all loads thereafter shall be slump tested (prior to discharge) until the SD of test results from 6 consecutive loads is less than or equal to 8 mm. When this occurs, slump testing may revert to process slump testing of each fourth load as per (d).

Additional consistence testing shall also be conducted as required in accordance with Clause 5.6.6.

If, for any sample, the measured slump is not within the specified limits, one repeat test shall be made immediately from another portion of the same sample. If the value obtained from the repeat test falls within the specified limits, the concrete represented by the sample shall be deemed to comply with the appropriate specified value; otherwise it shall be deemed nonconforming.

Concrete which is nonconforming in relation to consistence shall not be used as concrete base but may be used elsewhere in the works, subject to the concrete complying with the requirements for the particular application.

All slump test results shall be recorded, whether conforming or otherwise.

6.1.5 Compressive strength

6.1.5.1 Sampling

For concrete delivery by tipper truck, samples shall be taken at random during the paving operation in accordance with AS 1012.1. For delivery by agitator, sampling shall be undertaken at the point of discharge.

For each lot of base, excluding transition lots, not less than 10 samples and for each transition lot, one sample per 50 cubic metres with a minimum of two shall be moulded for the determination of the compressive strength at both seven days and 28 days. All cylinders of a sample shall be moulded from the same sample of concrete.

All cylinders shall be cast in purpose-made steel moulds and compacted by internal vibration in accordance with Test Method Q472 which includes use of conforming electrical vibrators, and each pair identified as a matched set or pair at age seven days and 28 days respectively. Each cylinder shall be identified with the load and/or lot as appropriate and a written record made of the location of each load within the pavement.

6.1.5.2 Curing of specimen cylinders

Cylinders shall be covered with reflective covers for the period of 18 hours immediately after casting. Specimens shall be handled with care, transported without bumping or vibration to the NATA registered laboratory, and placed under standard curing conditions within 36 hours, in accordance with AS 1012.8.

SUPERSEDED

Where cylinders are temporarily stored on site, they shall be stored in lime-saturated water at a temperature of 27 ± 2ºC.

6.1.5.3 Inspection and capping of specimen cylinders

Inspection of concrete cylinders shall be in accordance with AS 1012.9, Clause 4. Capping of concrete cylinders shall be in accordance with AS 1012.9 Clause 6.

Attention is drawn to:

a) AS 1012.9, Clause 4.1 and the notes in that Clause, and

b) Clause 7.1 of this Technical Specification. The Contractor has the choice of capping within the specified requirements except that when the arithmetic average strength of five consecutive samples is less than:

$\underline{f\rho}_c + 0.9s_7$;

r_7

then sulphur capping shall be used until the arithmetic average strength of five consecutive samples is greater than the above.

6.1.5.4 Testing of specimen cylinders

The compressive strength of concrete represented by a pair of cylinders moulded from one sample shall be:

a) Where the two results do not differ by more than 0.10 f_{cm}, the average compressive strength of the two cylinders (f_{cm})

b) Where the two results differ by more than 0.10 f_{cm}, and the mean of the difference between the pairs of results for ten consecutive pairs up to and including the one in question > 5% of the mean strength value for all 20 cylinders, the higher compressive strength of the two specimens, and

c) Where the two results differ by more than 0.10 f_{cm}, and the mean of the difference between the pairs of results for ten consecutive pairs up to and including the one in question is ≤ 5% of the mean strength value for all 20 cylinders, the average compressive strength of all the cylinders from that sample.

Where any test result is excluded by the above criteria, the Contractor shall check that the manufacture, storage and testing of the cylinders is being correctly carried out. The suspect cylinders shall be retained in the laboratory for at least 14 days to permit further examination.

6.1.5.5 Adjustment of test strength for age of specimen

Should any specimen which has been continuously cured in accordance with AS 1012.8, be tested more than 28 days after moulding, the equivalent 28-day compressive strength shall be the test compressive strength, divided by the factor applying to the particular mix as determined from adequate records for that mix type. Where this information is not available, the factors in Table 6.1.5.5 shall be used. For intermediate ages the factor shall be determined by linear interpolation.

SUPERSEDED

Table 6.1.5.5 – Age factors

Age of Concrete (Days)	Cylinders		Cores	
	Fly Ash Content (%)			
	< 10%	10 – 25%	< 10%	10 – 25%
28	1.00	1.00	0.90	0.90
35	1.02	1.03	0.93	0.94
42	1.04	1.06	0.96	0.98
49	1.06	1.09	0.98	1.01
56	1.08	1.12	1.00	1.04
70	1.10	1.15	1.02	1.07
84	1.12	1.18	1.03	1.09
112	1.14	1.21	1.06	1.12
140	1.16	1.24	1.07	1.14
168	1.18	1.27	1.08	1.16
186	1.20	1.30	1.09	1.18
224	1.22	1.33	1.09	1.19
308	1.24	1.36	1.10	1.20
Greater than 365	1.25	1.38	1.10	1.21

6.2 Concrete strength conformance

Concrete shall be assessed for conformance to strength requirements on a statistical basis, using the results of 28-day compressive strength testing as set out below.

A lot shall be deemed to conform to the requirements of this Technical Specification in terms of compressive strength as per Table 6.2.

Table 6.2 – Compressive strength requirements

Sample	Requirement
The strength of each sample tested is:	
- for all base types	not less than $f_{\rho c}$; and,
Or, where any one or more samples fails to meet (a) above and no result is less than 0.9 $f_{\rho c}$:	
- for all base types	the average of all samples of the lot shall not be less than $f_{\rho c}$ + 1.35 s_c where: s_c = the standard deviation of the sample compressive strengths determined during the last 30 days; or if test results for less than 30 pairs of cylinders are available for the last 30 days, s_c shall be 3.0 MPa;

Lots which do not comply with the above are deemed to be nonconforming.

7 Monitoring testing

7.1 Monitoring compressive strength results

7.1.1 7-Day strengths

The 7-day compressive test results shall be used to perform the earliest possible check of the concrete mix as follows.

SUPERSEDED

The mean strength of any five consecutive test results shall not be less than

$$\underline{f\rho_c} + 0.9s_7$$

$$r_7$$

where

s_7 = standard deviation of 7-day compressive results determined from all the 7-day results available from the last 30 days. Where test results for less than 30 pairs of cylinders for the last 30 days cannot be made available, s_7 shall be 3.0 MPa.

Should the mean strength not meet the above criterion or s_7 exceeds 3.0 MPa, the Contractor shall furnish a report to the Administrator and, if necessary, modify the mix and/or improve the method of production of the concrete to ensure that the specified 28-day strength (see Clause 5.4.1) is achieved.

7.1.2 28-day strengths

The standard deviation of any 30 consecutive 28-day compressive strength results shall not be more than 4.0 MPa.

Should standard deviation not comply, the Contractor shall furnish a report to the Administrator and, if necessary, modify the mix and/or improve the method of production of the concrete to ensure the required uniformity of 28-day strength is achieved.

7.2 Updating r_7

The ratio (r_7) between the measured 28-day compressive strength (f_c) and 7-day compressive strength (f_{c7}), shall be continuously updated as 7-day and 28-day strengths become available.

7.3 Monitoring flexural strength

A set of six flexural strength beams shall be taken and moulded at the frequency given in MRTS40. All specimens within a set shall be moulded from the same sample of concrete. The 7-day and 28-day flexural strengths shall be measured and reported.

7.4 Charting

In addition to the tests specified in this Technical Specification, charts shall be maintained for at least the tests results specified in MRTS40.

SUPERSEDED

8 Placing of steel reinforcement in base

8.1 Materials

Steel reinforcement shall comply with AS/NZS 4671. The type and size shall be as shown on the Drawings or as stipulated herein.

Steel reinforcement placed in the works shall be free from loose or thick rust, grease, tar, paint, oil, mud, mill-scale, mortar or any other coating, but shall not be brought to a smooth, polished condition. Its surface condition shall be such as not to impair its bond to the concrete or its performance in the member.

Where galvanised bars are specified, the bars shall be hot-dipped to provide a minimum thickness of 100 micrometres of 98.5% pure zinc metal. Should any doubt arise as to the quality of the applied coating, tests shall be required and these shall be carried out in accordance with AS/NZS 4680.

For each heat batch from which the reinforcement is provided the Contractor shall obtain a Certificate of Compliance from a laboratory with appropriate NATA registration, stating that all steel reinforcement complies with AS/NZS 4671. All relevant test results shall accompany the Certificate.

Reinforcement shall be readily identifiable as to grade and origin.

8.2 Bending

Reinforcement shall be formed to the dimensions and shapes shown on the Drawings. Reinforcement shall not be bent or straightened in a manner that will damage the material. Bars with kinks or bends not shown on the Drawings shall not be used. Heating of reinforcement for the purposes of bending shall not be permitted. Where the radius of a bend or hook is not stated on the Drawings, it shall be made around a pin having a diameter of not less than four times the diameter of the bar bent.

8.3 Storage

Reinforcement, unless promptly incorporated into the concrete, shall be supported clear of the ground and protected from damage and from deterioration due to exposure.

8.4 Placing

8.4.1 General

Reinforcing bars and wire mesh fabric shall be accurately placed to the dimensions and details shown in the Drawings, or for CRC as directed by the Administrator.

Reinforcement shall be:

a) Secured in place by wiring the bars and/or fabric together with annealed steel wire having a diameter of not less than 1.2 mm. Tack welding may be used instead of wire ties on reinforcing bars. The support shall not be of a design that is likely to impede compaction of the enveloping concrete, and

b) Supported in position using either concrete chairs, plastic chairs or plastic-tipped wire chairs in accordance with the following:

   i. The use of wire chairs without plastic tips, or of timber or pieces of aggregate to support reinforcement shall not be permitted

   ii. The arrangement and spacing of chairs shall be such that the reinforcement shall be supported in the specified position with no more than 2 mm permanent deflection or displacement of the reinforcement during placing and compaction of the concrete. The chairs shall also have sufficient bearing area at their base to prevent overturning or embedment

   iii. The mass of reinforcing steel supported by any one chair shall not exceed 10 kg. Chairs shall be capable of supporting a 200 kg mass without permanent distortion in excess of 2 mm. The distance from the supporting surface on which the chair rests to exposed steel of the chair shall be not less than 50 mm, and

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

SUPERSEDED

8.4.2 Reinforcing mesh

Steel reinforcement mesh shall be placed within 75 ± 15 mm of the finished top surface of the base slab unless otherwise shown on the Drawings.

Reinforcement mesh shall be clear of all joints and edges by 70 ± 20 mm unless otherwise shown on the Drawings. **Hold Point 11**

8.4.3 Reinforcing mesh in odd-shaped and mismatched jointed unreinforced base slabs

A slab is a portion of concrete base bounded by joints and/or free edges. A trafficked slab shall be considered to be odd-shaped if the length, including free edges, of the longer side is greater than 1.25 times the length of the shorter side or if the joint pattern produces an angle of less than 85° between two adjacent sides. An untrafficked slab shall be considered to be odd-shaped if the length of the longer side is greater than 3 times that of the shorter side, or if the joint pattern, including free edges, produces an angle of less than 80° between two adjacent sides.

Slab dimensions shall be measured normal and parallel to the longitudinal joints. Where these dimensions are variable within a slab, the worst case shall be adopted for the purpose of determining the dimensional ratio. Slabs containing block-outs for drainage structures shall be considered as odd-shaped.

Where any tied joint meets a slab and is not continued across that slab, that slab shall be considered a mismatched slab and the related joint deemed a mismatched joint. Untied joints shall not be allowed to form mismatched joints/slabs, except at isolation joints.

Unless otherwise shown on the Drawings, odd-shaped and mismatched slabs shall be reinforced with F82 reinforcing mesh except that:

a) transverse construction joints may mismatch without reinforcement in the adjoining slab, and

b) odd-shaped slabs formed by a transverse construction joint need not be reinforced unless specifically shown in the Drawings.

Odd-shaped slabs shall not be permitted except as shown in the Drawings. **Hold Point 12**

8.4.4 Steel bars for CRC base

The minimum proportion of longitudinal steel, or steel ratio, shall be 0.67%.

When flexural strengths are available from trial mixes, the proportion of reinforcing steel specified in the design must be checked using Equation 9.9 in the Austroads *Guide to the Structural Design of Road Pavements*. If the actual strength of the concrete is higher than specified, the proportion of steel reinforcement must be increased accordingly.

Equation 9.10 in the Austroads Guide is not to be used to adjust the proportion of reinforcing steel.

Longitudinal steel shall be placed on top of transverse steel. Longitudinal steel shall have a minimum top cover of 80 mm with a tolerance of + 20 mm and - 0 mm unless otherwise shown on the Drawings. The transverse steel shall have a minimum bottom cover of D/2 - 10 mm, where D is the nominal thickness of the base concrete. The minimum cover of any bar to the nearest concrete surface shall be 50 mm unless shown on the Drawings or indicated otherwise herein. **Hold Point 13**

SUPERSEDED

8.4.5 Reinforcing mesh in odd-shaped and mismatched CRC base

For continuously reinforced concrete base, an area of base shall be considered to be odd-shaped if any of the following conditions exist:

a) the angle formed by any two joints and/or edges is less than 80°

b) the width of a section of CRC (bounded by adjacent longitudinal joints, either formed or induced) reduces at a rate greater than 1 in 6, or

c) the continuity of the pavement is disrupted by a structure such as a drainage pit.

Slab dimensions shall be measured normal and parallel to the longitudinal joints. Where these dimensions are variable within a slab, the worst case shall be adopted for the purpose of determining the dimensional ratio. Slabs containing blockouts for drainage structures shall be considered as odd-shaped.

Where any tied joint meets a slab and is not continued across that slab, that slab shall be considered a mismatched slab and the related joint deemed a mismatched joint. Untied joints shall not be allowed to form mismatched joints/slabs, except at isolation joints.

Unless otherwise shown on the Drawings, odd-shaped and mismatched slabs shall be reinforced with F82 reinforcing fabric except that:

a) transverse construction joints may mismatch without reinforcement in the adjoining slab, and

b) odd-shaped slabs formed by a transverse construction joint need not be reinforced unless specifically shown in the Drawings.

Odd-shaped areas shall not be permitted except as shown in the Drawings.

The placement of steel mesh shall constitute a **Witness Point**.

8.5 Splicing

Splicing of bars shall be permitted only as per the Technical Specification.

The length of lapped splices not shown on the Drawings shall be as per Table 8.5.

Table 8.5 – Splice lengths

Steel Grade	Length of Splice as a Multiple of the Bar Diameter (mm)
Grade 400Y	35 times the bar diameter
Grade 230S	25 times the bar diameter
Plain bars and hard drawn wire	45 times the bar diameter

Splices in reinforcing fabric shall be measured as the overlap between the outermost wire in each sheet of fabric transverse to the direction of splice. This overlap shall not be less than the pitch of the transverse wires plus 25 mm.

The ends of bars forming a lapped splice shall be welded or securely wired together in at least two places.

In welded splices, bars may be welded by an electrical method only. Welding shall comply with AS 1554.3. The welded splice shall meet requirements of tensile and bend tests specified for the parent metal.

SUPERSEDED

Splicing of longitudinal reinforcement in continuously reinforced concrete pavement shall be staggered or skewed across the width of the pavement. No more than one third of the bars shall have splices at the same transverse location of the pavement.

8.6 Tie bars

Tie bars for longitudinal joints shall not be inserted through the finished top surface (i.e. after the float pan) of the concrete base. Tie bars shall be placed ahead of paving by a suitable bar inserter into the edge of the joint or by an automatic tie bar inserter on the mechanical paver. The method of insertion shall be such that tie bars develop an anchorage strength of at least 85% of the yield strength of the bar. Details of the proposed method of tie bar insertion shall be submitted to the Administrator.

Bar insertion shall not disturb the concrete surface.

Unless otherwise specified in the Drawings, all parts of any tie bar shall lie within ± 25 mm vertically and within ± 75 mm horizontally of its design position.

In longitudinal joints, tie bars shall not be placed closer than 300 mm to a transverse untied joint (such as contraction and isolation joints) nor closer than 150 mm to a transverse tied joint.

At induced longitudinal joints (such as longitudinal sawn joints), tie bars shall be located to provide a clearance of 30 mm between the tie bar and the bottom of the inducer (such as a saw-cut or ribbon).

In transverse joints, tie bars shall not be closer than 100 mm to any longitudinal joint or slab edge. For continuously reinforced concrete, tie bars shall be placed below the longitudinal steel but shall have a minimum bottom cover of D/2 - 20 mm.

8.7 Dowels

Dowels shall be installed ahead of paving, using an approved dowel support system.

Dowels shall be located as shown on the Drawings. Where the alignment is not shown, dowels shall be parallel to the line between the centroid of each slab. For this purpose a slab also comprises the total dimensions of discrete slabs which are tied to each other.

Dowels shall be sawn and not cropped. Dowels shall be straight and free of irregularities that could hinder their movement, in accordance with this Technical Specification. They shall be free of burrs or protrusions outside the normal diameter. Dowels shall be galvanised and shall be de-bonded to ensure free movement of the concrete base slab with temperature variations

Unless otherwise shown on the Drawings, dowels shall be placed at mid-depth (with a tolerance of ± 20 mm), parallel to the base surface and normal to the line of the joint with tolerances as follows:

a) Tolerances prior to construction as measured on the dowel cradles:
    i. all dowels within a joint shall be within ± 3 mm per 300 mm length of dowel
    ii. two-thirds of the bars shall be within ± 2 mm per 300 mm length of dowel, and
    iii. no dowel shall differ in alignment from an adjoining dowel by more than 3 mm per 300 mm length in either the horizontal or vertical plane.

b) Tolerances in the finished slab
    i. twice the tolerances for alignment given in (a), and
    ii. all dowels shall be equally positioned about the intended line of the joint within a tolerance of ± 25 mm.

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When the concrete is placed, no steel other than the dowels or dowel support structure shall cross the line of the joint.

One end of each dowel on the same side of each joint shall be coated for a distance of 250 mm with two coats of bitumen emulsion (or one coat of bitumen) and sanded to ensure free movement of the concrete base slab with temperature variations. At expansion joints, the coated end shall have a preformed cap to provide a minimum of 30 mm clearance for movement.

9 Paving concrete in base

9.1 Materials

9.1.1 Curing compounds

The base shall be cured by the application of sprayed curing compound after texturing. The compound shall be applied immediately after the surface is free of bleed water so as to form a continuous and unbroken film.

The Contractor shall supply for each consignment of curing compound a copy of the delivery docket stating the manufacturer's name and the type and quantity delivered, together with the certificates as specified in Clause 9.1.1.2.

Batches of curing compound shall be used in order of receipt and shall be stored in waterproof conditions. The Contractor shall comply with any special requirements of the manufacturer of the product. Any curing compound that does not conform to the requirements of the Technical Specification immediately before use is nonconforming and shall be removed and replaced.

9.1.1.1 Types of curing compounds

Curing compounds shall be as per Table 9.1.1.1-A.

Table 9.1.1.1-A – Application of curing compound

Pavement layer	Curing Compound
No Asphalt Overlaying Layer	a) hydrocarbon C5 based resin compound complying with AS 3799 Class B Type 1-D, or b) water-born hydrocarbon C5 based resin complying with AS 3799 Class Z Type 1-D
Overlying Asphalt Layer	Bitumen and hydrocarbon C5 based resin emulsified in water and complying with AS 3799, Type 3, Class Z and also the requirements in Table 9.1.1.1-B. In warm weather conditions with base concrete where the bitumen impedes early sawcutting and/or raises concrete temperatures above specified limits, deletion may be approved by the Administrator

Table 9.1.1.1-B – Requirements for curing compound

Component	Proportion in the Total Mixture
Hydrocarbon resin, C5	minimum 10% maximum 30%
Bitumen emulsion	minimum 30% maximum 60%
Surfactants	maximum 10%
Solvent	maximum 10%

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9.1.1.2 Requirements for curing compounds

For each curing compound proposed for use in the works, the Contractor shall provide to the Administrator a report, supported by test certificates from a laboratory with appropriate NATA registration, to certify that the proposed curing compound has been tested in accordance with AS 3799 and that it complies with the Technical Specification. The sample for acceptance testing which is covered by the Contractor's report shall hereafter be referred to as the 'reference sample'. The testing shall be carried out not more than one month prior to the commencement of the concrete paving.

The test certificates shall report the results for the following properties, with testing in accordance with AS 3799:

a) non-volatile content

b) efficiency index

c) density

d) drying time, and

e) reference for the infrared spectrum as determined in accordance with Test Method Q630.

9.1.1.3 Conformance of compounds

All testing shall be undertaken by a laboratory with appropriate NATA registration.

a) Initial delivery

   A random sample shall be taken from the first delivery to the project and tested in accordance with, and shall comply with, the requirements of AS 3799 for the following properties:

   i. non-volatile content

   ii. density

   iii. drying time, and

   iv. infrared spectrum as determined in accordance with Test Method Q630.

   On the basis of these results, the Contractor shall provide written certification (accompanied by the test results) that the delivered batch has the same formulation as that of the reference sample, and

b) Subsequent deliveries

   For all subsequent deliveries, the Contractor shall provide written certification that each delivered batch has the same formulation as that of the initial delivery. The certification shall be made in accordance with AS 3799, on the basis of the manufacturer's Certificate of Analysis, for uniformity of the following properties:

   i. non-volatile content

   ii. density, and

   iii. viscosity.

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9.1.2 Wax emulsion used for debonding

Unless a bituminous protection layer has been placed as part of the sub-base construction, a wax emulsion de-bonding treatment shall be applied to the top surface of the sub-base. This treatment shall be additional to the curing treatment applied to the sub-base as specified in MRTS39 *Lean Mix Concrete Sub-base for Pavements*. The wax de-bonding compound shall be wax emulsion de-bonding compound complying with MRTS42 *Supply of Wax Emulsion for Curing Compound for Concrete* and applied at a rate not less than the spray rate nominated in MRTS42 *Supply of Wax Emulsion for Curing Compound for Concrete*.

9.2 Mechanical paving equipment

9.2.1 Pre-spreading device for CRC and JRC

A separate device (hopper spreader) shall be used ahead of the mechanical paver in CRC and JRC base construction to transport and spread concrete uniformly over the full width being paved. The spreading device shall not disturb the reinforcement or its supports. It shall be capable of transporting and spreading concrete at a rate sufficient for the continuous operation of the paver and in such a manner that the concrete is not segregated or otherwise adversely affected.

Concrete shall be discharged without segregation into the hopper spreader which is to be equipped with the means of controlling its rate of deposition on the sub-base. The concrete shall be spread without segregation and to a uniform uncompacted density over the whole area of the slab. The deposited concrete shall be struck off to the necessary level by the underside of the hopper as it traverses the slab. The machine shall be capable of being rapidly adjusted for changes in average and differential surcharge necessitated by changes in slab thickness or crossfall.

9.2.2 Mechanical paver

The mechanical paver shall be a self-propelled machine with a gross operating mass of not less than four tonnes per metre of paved width. It shall be capable of paving at a speed of one metre per minute or less as required to enable the continuous operation of the paver and obtain the required degree of compaction. It shall include the following features:

a) an automatic control system with a sensing device to control line and level to the specified tolerances;

b) a means of regulating the flow of mix to the vibrators without segregation of the components;

c) internal vibrators capable of compacting the full depth of the concrete;

d) an adjustable extrusion screed and/or conforming plate to form the surface profile and produce the required finish on all surfaces; and

e) the capability of paving to the widths and depths shown on the Drawings.

The paver shall be regularly inspected and serviced to ensure that it is maintained at all times in full operating condition, consistent with the manufacturer's specifications. Key items such as vibrators and sensors shall be monitored throughout all paving lots. **Witness Point**

9.3 Placing operations

9.3.1 General

Mechanical paving shall be used except where this is impracticable. Impracticable areas may include tapers and other areas approved by the Administrator. The areas which are not constructed using a

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mechanical paver may be hand-placed within fixed forms which include the requirements of Clause 9.3.5. Concrete pumps shall not be used for mechanically placed concrete.

The Contractor shall place and finish concrete so as to:

a) limit segregation or loss of materials

b) limit premature stiffening

c) produce a uniform, dense, homogenous product between planned cracks, joints and edges

d) expel entrapped air and closely surround all reinforcement and embedments, and

e) provide the specified thickness and surface finish.

Details of the equipment and methods to be used for spreading, placing and finishing the concrete base, together with proposed paving widths and any areas to be hand-placed shall be submitted as part of the Quality Plan.

For each of the proposed mechanical paving configurations, the following parameters shall be nominated:

a) maximum paving speed (i.e. instantaneous, not average)

b) target (optimum) paving speed

c) vibrator spacing, frequency and amplitude, and ranges thereof

d) gross operating mass per linear metre of paving width, and

e) installation of guide-wire tracking location system.

Paving must be carried in a continuous manner at a paving speed not exceeding 1.5 m/minute. A process which causes paver stops is not allowed. If stops occur, a construction joint must be made and the process changed to avoid this occurrence.

The Contractor shall have an operating procedure to indicate the malfunction of each individual vibrator and shall provide details of same.

For hand-paving, the following parameters shall be nominated:

a) the size and number of vibrators

b) the spacing and duration of vibrator insertions.

For transition lots, the following parameters shall be nominated:

a) the proposed technique for paving (for both mechanical and hand paving to fixed forms) at transverse construction joints (including both the start and finish of paving runs)

b) for the actual mechanical pavers to be used, the distance between the transverse construction joint and the point of effective slipform vibration (at both the start and finish of paving runs)

c) the size and number of manual vibrators

d) the spacing and duration of vibrator insertions

e) the method of side-forming to prevent edge slump, and

f) proposals to ensure suitable workability (for hand placement) of the mix within the transition lot.

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The Contractor shall give the Administrator seven days written notice of his intention to commence construction of the base on any section of works (including placement of the trial concrete section). **Hold Point 14**

A trial length of concrete shall be constructed in accordance with Clause 9.8, seven days prior to commencement of paving.

The Contractor shall maintain records showing the location of each batch/load of concrete in the finished work. The system shall be sufficiently accurate to enable subsequent identification of specific batches/loads for examination and/or testing. Details shall be submitted as part of the Quality Plan.

9.3.2 Temperature and rain

The Contractor shall measure and record concrete and air temperature in the shade at the point of placement. The air temperature shall be taken adjacent to the point of concrete placement but remote from artificial influences such as the paver.

No concrete shall be placed in the works:

a) if the temperature of the concrete is less than 10°C or exceeds 30°C

b) during rain or when rain is likely to fall during placement

c) if the ambient air temperature at the site of placement is less than 5°C and falling, or greater than 35°C during placement, or

d) Where an air temperature greater than 30°C is forecast, monitoring at actual temperatures at the site, at maximum 30 minute intervals, shall be undertaken and batching of concrete must cease when the air temperature reaches 30°C.

Attention shall be paid to placing the concrete at a time of day when the ambient temperature is lower than the maximum, and to providing early curing for hot weather concreting operations.

If the ambient air temperature measured at the point of placement is likely to exceed 35°C during placing and finishing operations, the Contractor shall take practical precautions, included in the Quality Plan, to ensure that the temperature of the concrete does not exceed the permitted maximum so that the concrete can be placed and finished without defects, otherwise it shall be rejected. Typical precautions include –

a) At the mixer

   i. shading or irrigating aggregate stockpiles

   ii. painting water tanks white

   iii. insulating or burying delivery lines, and

   iv. chilling the water.

b) At the site

   i. cooling the formwork by dampening with water sprays

   ii. applying curing compound as early as possible

   iii. erecting wind breaks, and

   iv. minimising the time for placing and finishing.

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9.3.3 Underlying surface conditions for placement of concrete

9.3.3.1 General

The sub-base surface on which concrete base is to be placed shall be clean and free of loose or foreign matter. Spalled areas shall be cleaned out and filled with a low-shrink rapid-hardening cement mortar or plaster to provide a smooth surface flush with the sub-base surface. The mix used shall be stable and shall adhere to the sub-base concrete. The surface of the repaired spall shall be sprayed with curing compound in accordance with MRTS39 *Lean Mix Concrete Sub-base for Pavements*. The curing compound may be applied by hand-held lance.

9.3.3.2 Surface height of lean mix sub-base

The level at the top of the sub-base shall be determined in accordance with MRTS39 *Lean Mix Concrete Sub-base for Pavements*.

The Contractor shall submit to the Administrator a schedule of the measured surface heights of the top of the lean mix concrete sub-base, including the thickness of bitumen debonding agent already placed.

If there are heights outside the specified values and if these nonconformances in the sub-base result in the Contractor being unable to achieve the specified requirements for the base, including design specified height and thickness, the Contractor shall, within one working day, advise the Administrator of corrective actions. These shall not compromise other requirements for the works. **Hold Point 15**

9.3.3.3 Wax emulsion de-bonding treatment

Where the concrete base is a jointed reinforced concrete base, including those slabs where steel mesh is included in odd-shaped slabs, mismatched slabs and other slabs where reinforcement is included for a particular reason in what is basically a jointed unreinforced design, a bituminous seal protection layer shall be applied to the wax emulsion cured surface of the sub-base.

For other pavement types, such as continuously reinforced, jointed reinforced and steel fibre reinforced, if specified in MRTS39 *Lean Mix Concrete Sub-base for Pavements*, a bituminous seal protection course shall be applied to a fully intact wax emulsion cured surface of the sub-base. If the wax curing compound has been trafficked or damaged, an additional application shall be applied before the bituminous seal.

If a bituminous seal is not specified, then a wax emulsion de-bonding shall be applied.

Wax emulsion, including application and testing, shall comply with all requirements of Clause 9.1.2. The emulsion shall be applied at the application rate specified for the particular agent. It shall be applied prior to the placement of base reinforcing steel.

The wax emulsion de-bonding treatment shall be applied between 48 and 24 hours prior to placement of base to the top surface of the sub-base at a rate which is sufficient to de-bond the base from the sub-base at not less than the rate nominated in MRTS42 *Supply of Wax Emulsion Curing Compound for Concrete*. This treatment shall be additional to the curing treatments applied to the sub-base as specified in MRTS39 *Lean Mix Concrete Sub-base for Pavements*.

The application of the de-bonding treatment to the sub-base surface shall not occur until:

a) the achievement of a sub-base strength of 4.0 MPa, and

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b) the submission of sub-base level schedules and the completion of any disposition for nonconformance (MRTS39 *Lean Mix Concrete Sub-base for Pavements*).

Before applying the surface de-bonding treatment, the surface shall be cleaned of all loose, foreign and deleterious material.

Spalled areas (with the exception of full-depth cracks) greater than 10 mm deep and 15 mm wide shall be filled in with a low-shrink rapid-hardening cement mortar or a mixture of aggregate and bitumen to provide a surface flush with the sub-base surface. The mix used shall be stable and shall adhere to the sub-base concrete.

Full-depth cracks which have spalled more than 10 mm deep and 15 mm wide shall be filled with a suitable flexible sealant or a mixture of sand and bitumen to provide a surface flush with the sub-base surface.

Where no de-bonding treatment is required, the above spall treatment shall be applied at least 24 hours prior to placement of the base.

9.3.4 Mechanical paving

The supporting surface for the tracks of the paver, curing machine and any other equipment in the paving and curing train shall be brought to a smooth and firm condition (such that there is less than 2 mm deflection under the paver tracks) by the Contractor prior to paving and shall be maintained in such condition by the Contractor.

Paving within travel lanes shall precede paving within adjacent shoulder lanes. Paving with CRC shall precede paving in any adjoining pavement.

For CRC and JRC base, concrete shall be spread uniformly over the full width being paved, ahead of the mechanical paver. (See Clause 9.2.1) The mechanical paver shall compact, screed and finish the freshly placed concrete in such a manner that a minimum of finishing by hand shall be required.

For plain jointed base concrete, the mechanical paver shall spread, compact, screed and finish the freshly placed concrete in such a manner that a minimum of finishing by hand shall be required.

At locations where the paver is unable to fully compact and finish the concrete (such as, but not confined to, transverse construction joints), supplementary manual vibration shall be used. The number of working internal vibrators used shall be not less than one for each 10 cubic metres of concrete placed per hour. The number of standby vibrators shall be not less than one quarter of the number in use, with a minimum of one.

A homogeneous surface with uniform finish shall be provided. It shall then be finely textured longitudinally, using a hessian drag (or equivalent) behind the paver. The length of the surface drag shall be adjusted for prevailing weather and mix design to achieve the specified texture depth, unless approved otherwise by the Administrator. The drag shall be replaced when worn or rendered ineffective for producing a uniform consistent texture. Texturing shall not cause rounding of paved edges.

Longitudinal texturing on base where transverse tyned texturing is not specified shall be as given in Table 9.3.4.

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Table 9.3.4 – Texture Depth

Test Method	Texture Depth
TRL Mini Texture Meter	0.40 ± 0.05 mm
Test Method Q705 – Sand Patch	0.55 ± 0.05 mm

The choice of test method for texture depth shall be at the Contractor's discretion and testing is exempt from the requirement for NATA registration.

The average depth of longitudinal texturing shall be tested at a frequency of one test per 2000 m^2 of base and the depth of texturing shall be adjusted accordingly.

The slab edge produced by the paver shall maintain its shape and shall not sag or tear. If excessive bleed water flow occurs, such as flowing over the slab edge, the Contractor shall cease paving until the consistence of the mix is adjusted to prevent such flow, or until the mix is redesigned.

The Contractor shall coordinate the delivery, spreading and paving activities of the paver, including location and delay time, to maintain the continuous and uniform progress of the paver.

Where an interruption to paving occurs, which is likely to result in a non-homogeneous concrete mass, the Contractor shall form a transverse construction joint in accordance with Clause 10.1. The Contractor shall record details of any interruptions to the progress of the paver, including the reasons thereof, location, and duration.

Should subsequent testing at the location of an interruption indicate the presence of non-homogeneous concrete, such concrete shall be removed and replaced in accordance with Clause 13.

Where an interruption to placing occurs which is likely to result in a non-monolithic concrete mass, the Contractor shall form a transverse construction joint in accordance with Clause 10.1.

Should subsequent testing at the location of an interruption indicate the presence of non-monolithic concrete, such concrete shall be removed and replaced in accordance with Clause 13.

9.3.5 Hand placing

The Contractor shall program hand-placing and mechanical paving operations to ensure that the riding quality of the finished pavement is not impaired.

Forms shall be designed and constructed so that they can be removed without damaging the concrete and shall be true to line and grade, and braced in a substantial and unyielding manner. Forms shall be mortar tight and de-bonded to ensure non-adhesion of concrete to the forms. They shall be set to tolerances equivalent to those specified for the finished base surface.

Concrete shall be deposited and spread uniformly in the forms without segregation. The concrete shall be compacted by immersion vibrators and by at least two passes of a hand-guided vibratory screed traversing the full width of the slab on each pass. A suitable head of concrete shall be maintained in front of the screed over its whole length to ensure the uniform transmission of vibration into the slab.

A dense and homogeneous surface with uniform finish shall be provided. It shall then be textured using hessian (or equivalent) dragged longitudinally along the surface of the concrete, without delay, following the finishing operations. The length of the surface drag shall be adjusted for prevailing weather and mix design to achieve the specified texture depth, unless approved otherwise by the Administrator. The drag shall be replaced when worn or rendered ineffective for producing a uniform consistent texture. Texturing shall not cause rounding of paved edges.

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Longitudinal texturing on base where transverse tyned texturing is not specified shall be as given in Table 9.3.4.

The choice of test method to measure texture depth shall be at the Contractor's discretion and testing is exempt from the requirement for the NATA registration.

On base where tyned texturing is not specified, the average depth of longitudinal texturing shall be tested at a frequency of one test per 2000 m^2 of base and the depth of texturing shall be adjusted accordingly.

Where an interruption to placing occurs which is likely to result in a non-monolithic concrete mass, the Contractor shall form a transverse construction joint in accordance with Clause 10.1.

Should subsequent testing at the location of an interruption indicate the presence of non-monolithic concrete, such concrete shall be removed and replaced in accordance with Clause 13.

9.3.6 Compaction of concrete

Relative compaction of concrete in the base shall be determined and assessed in accordance with Clause 12.2.

A lot shall be deemed to conform with the requirements of this Technical Specification in terms of relative compaction as follows:

a) for lots where less than five cores have been sampled, the relative compaction of each core shall be greater than or equal to 98.0%, and

b) for lots where five or more cores have been sampled, the characteristic relative compaction shall be greater than or equal to 98.0%.

Lots that do not comply with the above are deemed to be nonconforming.

9.3.7 Finishing operations

All unformed surfaces shall be finished true to line and level within the tolerances specified in Clause 9.4.

All finishing operations shall be completed prior to the application of any curing. The finishing operation shall be such as to provide a non-voided homogeneous surface, free from visible surface cracking. Where possible, the concrete surface shall be reworked to eliminate any plastic shrinkage cracking.

Where a bituminous or asphalt wearing surface is to be applied, the surface of the hand-placed concrete shall be finished with a wood float or a hessian drag.

9.3.8 Prevention of moisture loss

The Contractor's Quality Plan shall identify which meteorological or other data shall be collected, how such data shall be used and what measures shall be taken to restrict the evaporation of water from the concrete surface and to prevent the incidence of plastic shrinkage cracking.

Figure 9.3.8 is provided as a guide for assessing the rate of evaporation.

Where necessary, the Contractor shall use, in accordance with the manufacturer's instructions, an evaporation retarder to restrict the evaporation of water. Details of the proposed evaporation retarder shall be submitted to the Administrator at least one week before concrete work commences.

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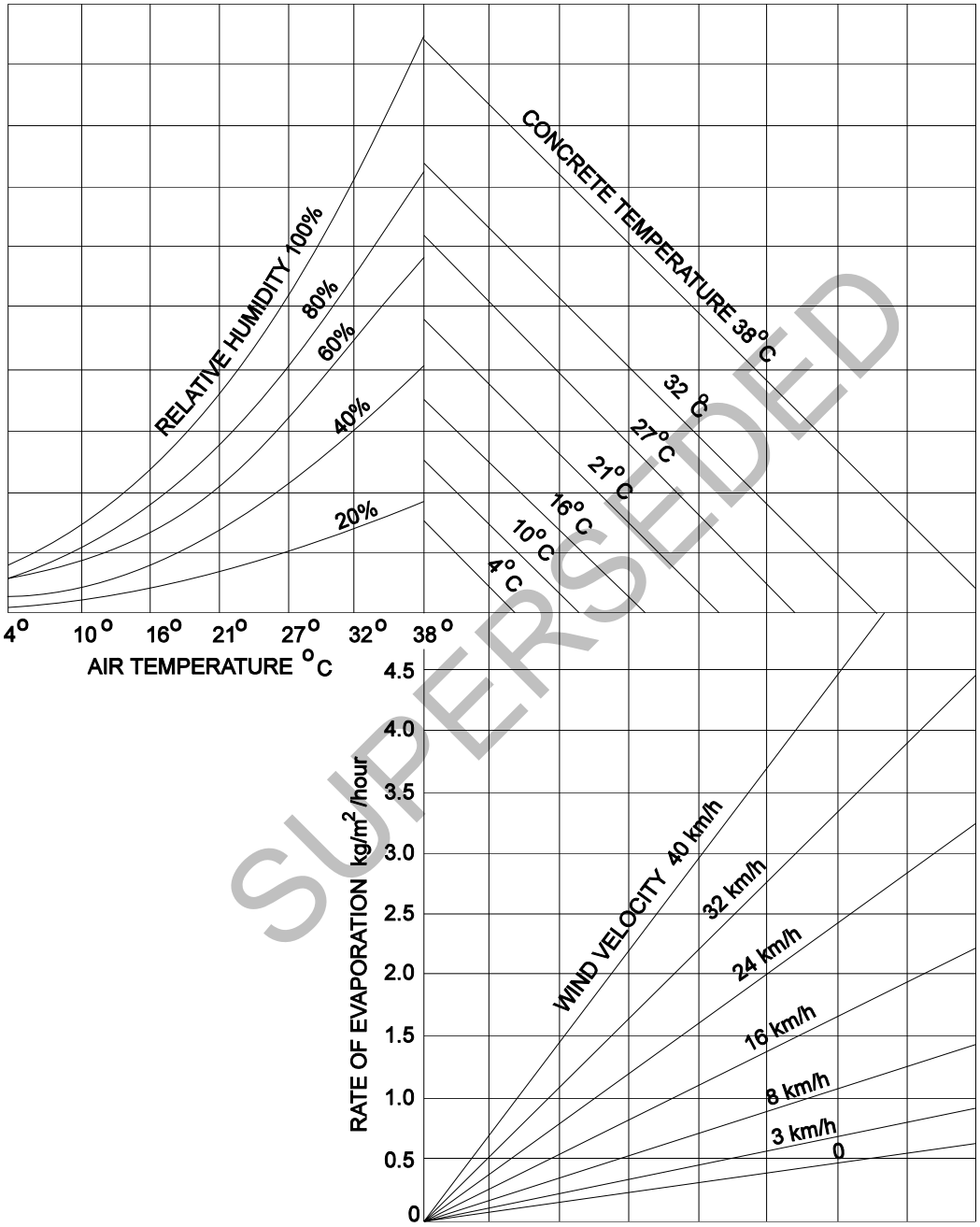
Should the Contractor elect to use an evaporation retarder to restrict the evaporation of water, application shall be by fine uniform spray. Evaporation retarder shall not be used as a finishing agent.

The Contractor shall regularly inspect the plastic concrete to monitor the effectiveness of his procedures and modify the procedures where necessary to prevent the formation of plastic shrinkage cracking.

Figure 9.3.8 – Evaporation from concrete freshly placed on site



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Source of figure: Gebler, S. 1984, 'Predict evaporation rate and reduce plastic shrinkage crack', Concrete International: Design and Construction, vol.5, no.4 pp. 19-22.

Figure 9.3.8 shows the combined effects of air temperature, humidity, concrete temperature, and wind velocity on the rate of evaporation of water from freshly placed and unprotected concrete. For

example, for an air temperature at 27°C, relative humidity at 40%, concrete temperature at 27°C and a wind velocity of 26 km/h the rate of evaporation would be 1.6 kg/m^2/hour.

To determine the evaporation rate from the graph:

- Enter the graph at the air temperature (in this case 27°C)
- Move vertically to intersect the curve for relative humidity encountered – here 40%
- From this point move horizontally to the respective line for concrete temperature – here 27°C and
- Move vertically down to the respective wind velocity curve – in this case interpolating for 26 km per hour –and then horizontally to the left to intersect the scale for the rate of evaporation.

9.4 Geometric standards

9.4.1 Horizontal alignment tolerances

For the purpose of this Clause, an outer edge is classified as one against which material other than base concrete (e.g. granular backfill, kerb concrete, no-fines concrete) is to be placed.

The outer edges of the base shall be perpendicular to the sub-base surface and shall not deviate from the position shown on the Drawings at any point by more than 25 mm and not depart from the vertical by more than ± 5º.

Where an edge is to form a longitudinal joint line, the allowable horizontal alignment shall comply with Clause 10.2.

The edge shall be continuous over its full length without steps or offsets in any axis. The line shall not deviate from a 3 m straight-edge placed along the joint by more than 20 mm after due allowances for any planned curvature.

Outer edges shall be corrugated as specified in the Drawings to cater for possible future widening of the pavement.

Tie bars shall not be provided unless specifically required in the Drawings

9.4.2 Surface heights

The height at any point on the top surface of the base shall be within ± 10 mm of the specified height.

9.4.3 Three metre straight-edge tolerance

The top surface of the base shall be tested under a 3 m straight-edge laid in any direction. Where the straight-edge is placed on convex sections, the cantilever length shall not exceed 0.75 m.

Deviations under the straight-edge shall not exceed 5 mm except for areas within 10 m of superelevation transitions where deviations shall not exceed 3 mm.

9.4.4 Thickness

For each lot, the average thickness of the lot as defined in Clause 12.6 shall not be less than the specified thickness given in MRTS40.

Lots which do not comply with the base thickness requirements are deemed to be nonconforming.

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9.4.5 Surface evenness

The surface evenness shall be determined in accordance with Test Method Q708 and shall conform to the limits given in Table 9.4.5.

Lots which do not comply with the surface evenness requirements are deemed to be nonconforming.

Table 9.4.5 – Surface evenness values

Nominated Pavement Section		Maximum Austroads Road Roughness (Counts/ Kilometre)
Through carriageways	Trafficked pavement	40
	Shoulders [1]	55
Ramps [1]	Within gore areas [2]	55
	Beyond gore areas [2] posted speed ≥ 80 km/h posted speed < 80 km/h	 50 55
Minor roads [1]	Posted speed ≥ 80 km/h	50
	Posted speed < 80 km/h	55
Other areas	[3]	60

Notes:

1. Shoulders on ramps and minor roads shall not be separately assessed.
2. Unless otherwise specified, the gore kerb nose (between the ramp and the through carriageway) shall constitute the limit of the gore area.
3. Project-specific areas specified by the Administrator.

9.4.6 Inspection

The Contractor shall survey the alignment, surface heights, surface profile and evenness for conformance with the above requirements within 15 days of paving or as otherwise approved by the Administrator. If nonconformance is detected, the Contractor shall immediately implement Corrective Action in accordance with Quality System Requirements.

9.4.7 Rectification

Individual locations identified as nonconforming in terms of finished surface profile shall be rectified to achieve conformance and provide a surface consistent with the adjacent conforming concrete by methods approved by the Administrator.

9.5 Transverse texturing of surface

The surface of the concrete base shall be transversely textured unless a sprayed bituminous or asphaltic concrete surfacing is proposed.

As soon as possible after placing, and after application of the longitudinal surface dragged finish, the surface of the freshly placed concrete shall be transversely textured by means of a mechanical device for grooving plastic concrete. The texturing equipment shall utilise rectangular-shaped tynes of flat spring steel, approximately 0.6 mm thick. The width of the tynes shall be 3 mm. The tynes shall be spaced in a random pattern. The spacing shall be neither less than 10 mm nor more than 21 mm, with a mean spacing between 13 mm and 14 mm.

A typical random spacing pattern is shown in Table 9.5-A below.

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Table 9.5-A – Random tyne spacing pattern

10	14	16	11	10	13	15	16	11	10	21	13	10

The width of the texturing brushes or combs shall be at least 750 mm. Provision shall be made for downward adjustment to compensate for wear. The tynes shall be of minimum 200 mm length to allow drawing across the concrete surface at a flat angle and thus allow texturing as soon as possible after paving.

For paving widths exceeding 4.5 m, the texturing shall be carried out using a machine spanning the concrete slab and guided for direction by the rails in the case of side-form construction, or by the paver guide wires in the case of mechanical paving construction.

Tynes shall be drawn across the surface in the one direction only and away from any constraint provided by looping the tyne around a supporting hold bar.

The process shall produce a uniform finish. The average texture depth shall be measured by one of the methods given in Table 9.5-B, and the limits shall be as given in Table 9.5-B.

Table 9.5-B – Measurement of texture depth

Nominated pavement section	**Average Texture Depth (mm)**	
	TRL Mini Texture Meter	**Sand Patch QDMR Q705**
Transitions between straights and curves	0.55 ±0.05	0.85 ±0.15
Other areas	0.45 ±0.05	0.65 ±0.15

The choice of test method shall be at the Contractor's discretion and testing is exempt from the requirement for NATA registration.

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9.6 Curing by application of liquid membrane-forming compound

9.6.1 General

Curing shall be implemented to prevent water loss from the concrete and subsequent deficiencies such as plastic shrinkage cracking. Curing shall include at least the requirements in this Technical Specification.

9.6.2 Method of application

Curing shall be by the use of liquid membrane-forming curing compounds which comply with the requirements of Clause 9.1.1.

Equipment and materials for curing operations shall be kept on site at all times during concrete paving.

The curing of unformed (exposed) surfaces of concrete shall commence as soon as the relevant finishing or texturing operations are completed and, in the case of water-based emulsions, within 15 minutes of the surface being free of bleed water, so as to form a continuous and unbroken film.

The compound shall be applied in two applications. The first application shall be immediately after texturing and the second application shall be 10 to 30 minutes later or otherwise in accordance with the manufacturer's recommendation. On fixed-formed surfaces, the first application shall be within half an hour of removal of the formwork and the second shall be 15 to 45 minutes later.

The curing compound shall be applied as a fine spray and by the following means:

a) For paving widths < 2.5 m –
   by hand lance with either single or multiple nozzles

b) For paving widths ≥ 2.5 m –
by spray bar fitted with multiple nozzles spaced to give a uniform cover for the final paving width in a single pass, and

c) For paving widths ≥ 4.5 m –
by mechanical sprayer fitted with a spray bar with multiple nozzles spaced to give a uniform cover for the final paving width in a single pass.

For areas where mechanical means of application are not used, the compound shall be sprayed by hand lance and the rate shall be increased by 25%. Included in this category are the faces of formed joints and sections of slip-formed edges that were supported by temporary forms at the time of initial spraying.

If the mechanical sprayer becomes unavailable, concrete paving by mechanical means shall cease, and shall not recommence until the mechanical sprayer becomes fully operable again.

All sprayers shall incorporate a device for continuous agitation and mixing of the compound in its container during spraying. After shutting off the spray nozzles there shall be no dripping of the curing compound on the concrete surface. Any areas where concentration of curing compound has occurred shall be rectified to bring the coverage to the specified state as soon as possible.

Spray bars and lances shall be fitted with protective hoods to minimise the drift of curing compounds to workers and roadside areas.

9.6.3 Rate of application

The curing compound shall be applied in two applications and each application shall be not less than the rate necessary to allow for absorption, run off, variation in the application and other losses, and shall leave a residual film which represents an application rate not less than that stated on the Certificate of Conformance for the application rate used in the Moisture Retention Performance test in Clause 3.1.2 of AS 3799.

For the sides of formed slabs and for small areas where mechanical means of distribution cannot be used, the compound shall be sprayed at a rate 25% higher than that used on the top surface of the concrete.

Any element of a lot on which the application does not conform to the requirements of this Technical Specification shall be resprayed within six hours at an application rate not less than twice the deficiency in the original application.

9.6.4 Integrity of membrane

The curing membrane shall be maintained in a continuous and unbroken film for seven days after placing the concrete. Any damage to the curing membrane shall be made good by hand spraying of the affected areas.

Additionally, at the commencement of each paving run (and notwithstanding that film damage may not be readily apparent), any adjoining hardened concrete of age less than seven days shall be resprayed with a single application for a minimum distance of 7 m in the area trafficked by staff during placement at the construction joint.

The cost of making good such damaged curing membrane shall be borne by the Contractor.

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9.6.5 Concrete base edges

Additional protection sufficient to prevent cracking shall be provided for the edges of the concrete base. This shall include at least an additional treatment of curing agent to the vertical edge as soon as possible and/or, where necessary, the covering of the vertical edge and at least 500 mm of the horizontal edge section of the slab with a suitable fabric to prevent the loss of water.

9.7 Protection of work

9.7.1 Weather protection

The Contractor shall undertake continuous surface temperature monitoring during the first 24 hours after placement. The temperature shall be monitored at not fewer than two locations within each day's paving, using purpose-made surface thermometers and in such a way as to reflect the true surface temperature.

The Contractor shall ensure that the temperature of the concrete does not fall below 5°C during the first 24 hours after placing. Failure to maintain the temperature of the concrete at or above 5°C shall constitute a nonconformance under the Contract.

Regardless of temperature levels, concrete base placed over anchors shall be thermally protected for a minimum of 24 hours after placement by covering with impermeable sheeting. The covering shall include vertical edges and not less than one-half of any adjoining base slab which was cast at the same time. The covers shall be thoroughly weighted around all edges to prevent air flow under them.

Details of procedures and equipment proposed for use for the protection of recently placed sections in the event of low air temperatures shall be submitted as part of the Quality Plan.

The Contractor shall protect the work from rain damage. Detailed proposals for procedures and equipment to be used for such protection shall be submitted as part of the Quality Plan.

The equipment for protection of work shall be kept on site and be capable of being fully operational at short notice. Personnel experienced in the operation of such equipment shall be available at short notice.

9.7.2 Trafficking of concrete base

Trafficking of the concrete base shall be strictly controlled according to the in-situ base strength which shall be assessed on the basis of concrete cylinders which have been moulded, cured and tested in accordance with Test Method Q471.

Alternatively, in-situ strength may be assessed from cores taken for the purposes of Clause 12.2, subject to the following conditions –

a) The cores shall be wet-conditioned, prepared and tested in accordance with AS 1012.14 except that the total duration of wet-conditioning (including that required for compaction testing) shall be not less than 24 hours nor more than 36 hours and shall conclude immediately prior to strength testing, and

b) Except for the period of wet-conditioning, the cores shall not be exposed to temperatures in excess of ambient air temperature.

The Contractor shall not take additional cores for this purpose without the prior approval of the Administrator.

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In-situ strength assessment shall be made at a frequency selected by the Contractor to suit the construction program for the works. Upon determination of the in-situ strength of any lot, all concrete placed prior to that lot using the same concrete mix may be assumed to have achieved an equivalent strength.

When the in-situ strength of any lot has been determined, it can be assumed that all conforming concrete lots of the same concrete mix placed prior to that lot shall have at least that strength unless there are additional tests to indicate a higher strength.

Trafficking of concrete base shall be restricted according to Table 9.7.2.

Table 9.7.2 – Concrete base trafficking restrictions

Actual compressive strength and joint condition	**Restrictions**
< 20 MPa	Access shall be limited to essential equipment such as concrete saws and coring machines provided that they have a maximum gross weight of 2.0 t and provided that no damage or marking is done to the surface, verge or joints of the concrete. No vehicle shall be permitted within 2 m of any concrete pavement edge which is not abutting and supported by a shoulder, ramp or another placed concrete lane. **Witness Point**
≥ 20 MPa < 25 MPa and all joints permanently sealed	Access shall be limited to wheeled vehicles essential for the direct construction of the concrete pavement with the following maximum loads: a) Single axle 5.0 t b) Tandem axle (four tyres) 6.0 t c) Tandem axle more than four tyres 8.0 t d) Triaxial axle 9.0 t, and e) More than triaxial 10.0 t. No vehicle shall be permitted within 2 m of any concrete pavement edge which is not abutting and supported by a shoulder, ramp or another placed concrete lane. **Witness Point**
≥ 25 MPa < 30 MPa and all joints permanently sealed	Access shall be limited to wheeled vehicles complying with the Queensland Mass Limits for Heavy Vehicles. Access to the following shall not be permitted: all traffic not directly associated with the works; all traffic and vehicles associated with the works which are not carrying concrete, materials or equipment required for work on the supply and placement of concrete base; All traffic with axle loads greater than those in the "≥ 20 MPa < 25 MPa" stated above shall enter and exit the pavements from the ends and at pre-designed and approved longitudinal edges. **Witness Point**
≥ 30 MPa but < the 28-day strength and all joints permanently sealed	Access shall be limited to wheeled vehicles complying with the Queensland Mass Limits for Heavy Vehicles and excluding all traffic not directly associated with the works. **Witness Point**
≥ the 28-day specified strength and all joints permanently sealed	Access shall be limited to wheeled vehicles complying with the Queensland Mass Limits for Heavy Vehicles. **Witness Point**

Tracked vehicles shall not be permitted on concrete base unless –

a) the actual concrete strength exceeds 25 MPa

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b) the applied pressure of the tracks is less than 15 t per m^2 over the track area in direct contact with the surface; and

c) the use of a tracked vehicle is essential for the construction of the concrete pavement.

Tracked vehicles shall have rubber tracks; otherwise they are to be run on rubber matting laid on the concrete surface.

Granular verge material shall not be compacted against the edge of concrete base have been permanently sealed until the base has achieved an in-situ strength of at least 25 MPa and all joints, including vertical sides of joints.

No material, including edge drain filler, verge material, top soil, mulch, etc, shall be placed on the concrete base.

Rigid blades, such as grader blades and front end loaders, shall not be allowed to impact on joints.

Notwithstanding the above, and in the interests of minimising damage to the curing compound, trafficking by all forms (including foot traffic) shall be limited to that which is essential for the efficient operation of the project until the achievement of an in-situ strength of 25 MPa. Furthermore, any damage caused to any part of the work by the Contractor's operations shall be rectified to produce a dense, homogeneous concrete base with the specified surface finish and texture, and with the specified surface curing and/or de-bonding agent.

9.8 Trial lengths

The Contractor shall demonstrate the materials, plant, equipment and methods of construction that are proposed for concrete paving by first constructing a trial length of base, at least 50 m but not more than 100 m long for mechanised construction; and at least 15 m but not more than 50 m long and at least 20 cubic metres of concrete for hand placement. The trial length shall be constructed at a rate similar to that which is proposed in the main works. If the trial is conducted at a paving width of less than 70% of the maximum width proposed to be placed by that method in subsequent runs, the Administrator shall have the right to call for a new trial section prior to the commencement of production paving at the maximum width.

From each of six different batches of concrete, a pair of cylinders shall be cast and tested for 7-day compressive strength and a pair for 28-day compressive strength. All specimens shall be tested in accordance with Clause 6. The 7-day result shall be used to monitor the strength assessed in accordance with Clause 7.1.1.

From each of three different batches, a set of three flexure beams shall be cast and tested for 7-day strength and a set for 28-day strength. Sampling shall be from batches which have been selected for testing compressive strength.

At least four cores shall be taken from each trial, including one from each transition lot, in accordance with Clause 12.2.5 to test conformance for compaction. The cores shall be extracted from randomly selected locations from any part of the trial length.

If the relative compaction of any core of the trial section is less than 98.0%, then notwithstanding the conformance requirements in Clause 12.2.5, the trial section shall be removed and a new trial section constructed.

Where the Contractor or supplier proposes to use both fly ash and an air entraining agent in a job mix, the supplier shall provide the Administrator with proof that the amount of air entrained can be

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controlled within specified limits and that the compressive strength is satisfactory. This proof shall include the limits on fineness and loss on ignition necessary to achieve the specified level of air entrainment with the proposed level of fly ash. This proof shall be provided at least 10 working days before concrete work on the trial length of the works commences.

At least one longitudinal joint of each type proposed in the main works shall be constructed and assessed in the trial length. Also, one transverse construction (end-of-day) joint shall be demonstrated in each trial length.

Additionally, for plain base, at least two transverse contraction joints as proposed in the main works shall be constructed and assessed in the trial length.

For reinforced base, where the Contractor proposes to use double row steel reinforcement, in the trial length the Contractor shall demonstrate that the specified compaction standard can be consistently achieved.

Compliance for position of steel reinforcement (where applicable) and for the position and alignment of tie bars shall be checked by drilling additional cores from the slab, unless they can be determined from cores taken for density assessment.

On base where tyned texturing is specified, the Contractor shall construct, during the trial concrete base, trial panels of longitudinal texturing only, for subsequent testing and reference throughout the work. A minimum of two panels shall be constructed, each of not less than 1 m^2. Between-panel texture depth shall be varied in the trial, but within-panel texture depth variation shall be minimised.

Finally, the surface of the trial length shall be checked for conformance to alignment, surface heights, thickness and surface profile in accordance with Clause 12.

The trial length shall be completed at least 10 working days before concrete pavement work commences. Completion of the trial concrete base and submission of all test results (except for all compressive strength and flexural strength tests) shall constitute a **Hold Point 16**.

In the event of other nonconformance in the trial section, the Administrator may require a new trial section which shall be treated as the first.

The Administrator shall have the right to call for a new trial section at any stage of work under the Contract when changes by the Contractor in the equipment, materials, mix, plant or rate of paving are deemed by the Administrator to be significant and warrant such procedure, or when concrete base does not comply with the Technical Specification.

The acceptance of a trial section for incorporation into the works shall be conditional on its conformance with the Specification.

9.9 Concrete cracking

9.9.1 Unplanned cracking in jointed reinforced base

For the purpose of this Clause, a slab is a section of base bounded by joints and/or edges specified in the plans and Technical Specifications for the works. Unplanned concrete cracks are defined as follows:

a) Plastic shrinkage cracks are discrete cracks through the mortar of length less than 500 mm and of depth less than 50% of the slab thickness, which do not intersect a longitudinal edge or formed joint (i.e. other than induced joints), and

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b) All other cracks, except those in specially reinforced slabs such as terminal, anchor and reinforced odd-shaped slabs, are deemed to be structural cracks.

Notwithstanding all other requirements in the documents, including the Technical Specifications for concrete sub-base and base, the Contractor is responsible for unplanned cracking as follows:

a) Plastic shrinkage cracking, and

b) All slabs containing type (b) cracks are nonconforming and shall be removed and replaced in accordance with Clause 13.

A Corrective Action statement shall be issued prior to any of the above activities.

9.9.2 Cracking in jointed reinforced base

For the purpose of this Clause, a slab is a section of base bounded by joints and/or edges specified in the plans and Technical Specifications for the works. Concrete cracks are defined as follows:

a) Plastic shrinkage cracks are discrete cracks through the mortar of lengths less than 500 mm and of initial depth less than 50% of the slab thickness, which do not intersect a longitudinal edge or formed joint (i.e. other than induced joints)

b) Flexural cracks are cracks which can occur within the central part of the slab at a distance of more than L/5 from joints, where L is the slab dimension between joints. They shall typically run continuous between joints and/or edges and shall extend for the full depth of the base, and

c) All other cracks, except those in specially reinforced slabs such as terminal, anchor and reinforced odd-shaped slabs, are deemed to be structural cracks.

Slabs which contain only type (a) cracks with a cumulative length not exceeding 1.0 m and/or type (b) cracks shall be accepted as conforming. These cracks shall be filled with a suitable low-viscosity penetrating epoxy resin within seven days of casting the concrete.

All slabs containing type (c) cracks and/or type (a) cracks with a cumulative length exceeding 1.0 m are nonconforming and shall be removed and replaced in accordance with Clause 13.

9.9.3 Cracking in CRC base

Planned cracks in continuously reinforced concrete base are discrete full depth transverse cracks over the full width of a paving run, typically between 0.5 – 1.5 m. The limits for cracks shall be as follows:

a) Longitudinal induced cracks (referred to as longitudinal joints) are deemed to be ‘planned’. These joints shall be treated in accordance with this Technical Specification and/or as detailed in the Drawings, and

b) Plastic shrinkage cracks are discrete cracks of length less than 500 mm and of initial depth less than 50% of the base thickness, which do not intersect a longitudinal edge or formed joint (i.e. excluding induced joints).

Where plastic shrinkage cracks are such that the cumulative length in any area of base is less than 1.0 m, these cracks shall be filled with a suitable low-viscosity penetrating epoxy resin within seven days of casting the concrete.

Any cracking beyond that specified above shall render that concrete nonconforming and shall be removed and replaced in accordance with Clause 13. Where non-conforming cracking occurs, these

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non-conformances shall be formally reported within seven days accompanied by a scaled crack map of all cracks in the lot where the non-conforming cracking is located.

10 Concrete pavement joints

10.1 Transverse construction joints

Transverse construction joints shall be provided at discontinuities in the placement of concrete determined by the Contractor's paving operations. These joints shall be constructed at 90° ± 5° to the longitudinal joint. They shall not be closer than 1.5 m to a transverse joint.

The line of the joint shall not deviate by more than 20 mm from a 3 m straight-edge placed along the joint. The joint shall be continuous over the paving width and shall not have steps or offsets in any axis.

Tie bars shall be provided at the joint as detailed on the Drawings. Insertion of tie bars shall comply with Clause 8.6. Unless otherwise specified in the Drawings, all parts of any tie bar shall lie within ± 25 mm vertically of its design position and within ± 75 mm horizontally.

Other than for CRC base where continuous longitudinal steel is already provided through the joint, 12 mm deformed steel bars (Y12), each 1 m long and centrally located in the slab at 300 mm centres but not closer than 150 mm to any longitudinal joint or free edge, shall be provided.

CRC transverse construction joints shall have an additional longitudinal bar of the same size as the main longitudinal steel, 10 m long, tied under every third bar on the fresh concrete side. Where the end of the additional bar coincides with a lap, the additional bar is to be extended beyond the lap.

Where such reinforcement is inserted by drilling and fixing in hardened concrete, the length of bar inserted shall be not less than 0.25 m. A suitable polyester or epoxy mortar shall be used and the setting system shall develop an anchorage strength of at least 85% of the yield strength of the bar.

Where the joint is formed in hardened concrete by sawcutting, the face of the joint (excluding the upper and lower 50 ± 5 mm) shall be scabbled to expose the coarse aggregate. The roughened surface and projecting reinforcement shall be cleaned and all excess water and loose material shall be removed.

Alternatively, the above-mentioned shall be formed with a transverse construction joint. The corrugated surface and projecting reinforcement shall be washed clean and all excess water and loose material shall be removed.

The face of all construction joints shall be constructed without bond. The first-placed joint face shall be dense and fully compacted. It shall be free of honeycombing and re-entrant angles. The first-placed face of the joint shall be treated in accordance with Clause 10.5. These provisions also apply to CRC against which other concrete pavement formats, such as jointed unreinforced concrete, are to be placed.

Steel tie bars shall not be sprayed with any contaminant or compound such as bitumen, de-bonding agent, oil, rust-preventative paint, etc.

The Contractor shall develop a written procedure as part of his Quality Plan for the construction of transverse construction joints for the works. It shall include the provision of a stop-end (‘header-board’) levelled to the surface profile.

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The Contractor shall inspect each joint within 24 hours of its construction. If non-conformance is detected in relation to joint alignment and edge ravelling, or the edge is damaged, the joint shall be reinstated or repaired. The repair material shall not be placed integrally with the adjoining concrete.

10.2 Longitudinal joints

10.2.1 General

Longitudinal joints shall be provided at the locations and to the details shown on the Drawings. Induced joints shall be induced by sawcut to a depth of one-third the thickness of the base slab (unless detailed otherwise in the Drawings).

All joints in SFRC shall be formed.

Longitudinal joints shall be continuous over their full length without steps in any axis. The line of all longitudinal tied joints shall not deviate from the designed position at any point by more than 25 mm. The line shall also not deviate from a 3 m straight-edge by more than 20 mm, having made due allowance for any planned curvature.

At formed corrugated joints, the face within 50 ± 5 mm of the top arris shall be square to the finished top surface of the base with a tolerance of ± 5º, and the face within 50 ± 5 mm of the bottom arris shall be square to the finished bottom surface of the base with a tolerance of ± 10º.

In the case of butt joints (non-corrugated), the joint shall be constructed square to the finished top surface of the base with a tolerance of ± 5º.

The face of all formed longitudinal joints shall be constructed without intimate microtexture bond.[1] The first-placed joint face shall be dense and fully compacted. It shall be free of honeycombing and re-entrant angles. The first-placed face of the joint shall be treated in accordance with Clause 10.5. This provision applies also to joints between new and existing concrete pavements.

Reinforcing steel shall be provided across tied joints, as and where detailed in the Drawings.

At induced joints, tie bars shall be accurately located to maintain a clearance of 30 mm between the tie bar and the bottom of the sawcut. Tie bars shall not be placed closer than 150 mm to a transverse tied joint nor closer than 500 mm to a transverse untied joint (such as contraction and isolation joints).Unless otherwise specified in the Drawings, all parts of any tie bar shall lie within ± 25 mm vertically of its design position and within ± 75 mm horizontally.

Insertion of tie bars shall comply with Clause 8.6.

10.2.2 Sawn-induced joints

Where induced joints are provided by conventional sawcutting, the sawcut shall be 3 ± 1 mm wide. Sawcutting shall proceed in a timely manner so as to prevent cracking of the base concrete other than at the sawcut.

[1]Intimate bond at the microtexture level induces spalling at arrises under hinging movements. Corrugations and scabbling provide transfer of shear loads at the macrotexture level but it is intended that the joint remain free to hinge in order to reduce curling stresses.

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The surface of the sawn joint shall not exhibit more than 10 mm width of vertical or horizontal edge ravelling. The cumulative length of edge ravelling with dimensions exceeding 3 mm shall not exceed 300 mm in any 3.0 m length of joint on each edge. If nonconformance occurs, the Contractor shall immediately implement Corrective Action.

The joint shall be cleaned and sealed in accordance with Clauses 10.2.3 and 10.2.4.

Sawcutting for detector loops is not allowed.

10.2.3 Cleaning and sealing of joints

10.2.3.1 Cleaning

Immediately after sawing, the sawcut shall be cleaned of all debris. The cleaning method used shall not damage the sawcut nor leave any substance deleterious to the concrete or to the adhesion of the joint sealants to be used. The method shall incorporate a liquid or liquid/air jet at a sufficiently high pressure to clean the joint. Gravity-fed liquid from tanks shall not be acceptable. Grit blasting shall not be used.

10.2.3.2 Temporary sealing

Within a maximum of two hours after cleaning, the joint shall be temporarily sealed by a continuous strip of UV stabilised closed-cell polyethylene backer rod as shown on the Drawings. Sealing shall include the vertical faces of the slab at the ends of sawcuts in order to prevent ingress of materials from subsequent operations.

The top of the backer rod/seal shall be neither higher than the concrete surface nor more than 5 mm below it.

The temporary sealant shall be maintained in sound condition by the Contractor until the joint is sealed permanently. Damaged or disturbed temporary sealants shall be removed, the joint re-cleaned and a new temporary sealant inserted.

10.2.3.3 Permanent sealing

A permanent seal shall be placed in the joint within ten days of initial sawing and within two hours of removing the temporary seal.

Except where the Contractor's Quality Plan includes an alternative sealant system approved by the Administrator, the permanent sealant shall be an insitu cast silicone sealant, the properties and installation of which shall comply with Clause 10.2.4.

10.2.4 Silicone sealants

Silicone sealants shall comply with the requirements listed in Table 10.2.5.

A full technical description of the proposed sealant, including its operating parameters and the method of installation recommended by its manufacturer, shall be submitted to the Administrator for approval at least 20 working days prior to its use. **Hold Point 17**

The Contractor shall obtain a Certificate of Conformance, showing that the sealant meets all the requirements of Table 10.2.5. All relevant test results shall accompany the Certificate.

The sealant shall be stored and installed in accordance with the manufacturer's written instructions.

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The backer rod shall be located to a depth such that the bottom of the silicone sealant shall be at the planned location and of the correct shape. If the backer rod is damaged in any way it shall be replaced.

Installation of the sealant shall take place only when the side walls of the groove have been cleaned and are dry.

Immediately prior to introducing the silicone sealant into the groove, any foreign or disturbed material shall be cleaned from the joint and from the top of the backer rod by dry oil-free air jet, and the joint shall be fully surface dry at the time of installation and be primed in accordance with the recommendations of the sealant manufacturer. Grit blasting shall not be used.

10.2.5 Longitudinal butt-formed untied, longitudinal formed-tied and untied joints

The first-placed joint face shall be dense and fully compacted. It shall be free of honeycombing and re-entrant angles. Where the first-placed face is nonconforming or the edge is damaged, it shall be reinstated or repaired prior to the placement of adjoining concrete. The repair material shall not be placed integrally with the adjoining concrete.

The first-placed face of the joint shall be de-bonded by application of a solvent-based wax emulsion de-bonding compound, in accordance with MRTS42 *Supply of Wax Emulsion Curing Compound For Concrete* and at the nominated rate in MRTS42 *Supply of Wax Emulsion Curing Compound For Concrete* plus 25%, not more than three days nor fewer than one day prior to placing the abutting concrete. The coating shall be intact and effective at the time of subsequent concrete placement.

Steel tie bars shall not be sprayed and any overspray shall be removed.

Table 10.2.5 – Requirements for silicone joint sealants

Property	Test Method	Requirement
Relative Density	ASTM-D 792-91 (Method A)	1.1 – 1.55
Durometer Hardness	ASTM-D 2240-95 (Standard Testing)	10 – 25
Extrusion Rate	MIL-S-8802	90 – 250 g/min.
Tack-Free Time	MIL-S-8802	30 – 70 mins
Accelerated Weathering	ASTM-C 793-91	No chalking, cracking or bond loss at 5000 hrs.
Adhesion	ASTM-C 794-93	Minimum 35N average peel strength
Durability	Q461	Extension to 70%, Compression to 50%
Colour	N/A	Grey, compatible with concrete base

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10.2.6 Inspection

The Contractor shall inspect each joint within 24 hours of its construction. If non-conformance is detected in relation to joint alignment and edge ravelling, the Contractor shall immediately implement Corrective Action in accordance with the Quality System requirements.

10.3 Transverse contraction joints

10.3.1 General

Transverse contraction joints shall be sawn and shall be continuous across the full width of the base slab between free edges and shall not have steps or offsets in any axis.

The sequence of spacing which shall be repeated throughout the works, and the skew and shape of the contraction joints shall conform to the details shown on the Drawings. The skew may be reduced locally to accommodate construction joints and slab anchors but shall not be more acute than 1 in 10 unless specifically shown otherwise in the Drawings.

Joints (and underlying induced cracks) shall be maintained at all times free of incompressible material and/or foreign materials. To prevent the ingress of such materials, sealing at all formed edges shall include the vertical face of joints and any underlying crack which exceeds 2 mm width.

Where asphalt surfacing is specified, the transverse contraction joints shall comply with Clause 10.3.7.

10.3.2 Sawcutting

Except for SFRC, joints shall be sawn by a two-cut operation, comprising an initial sawcut designed to induce cracking, and a widening sawcut (shallower than the original) for the purpose of creating a sealant reservoir. Joints in SFRC shall be formed and not induced or saw cut.

Initial sawcuts shall be 3 mm ± 1 mm wide and to a depth of one quarter the slab thickness.

The width of transverse contraction joints in JRC and SFRC base shall be as shown in Table 10.3.2.

Table 10.3.2 – Joint widths for JRC and SFRC base

Joint Spacings	Joint Width (mm)	Sealant Depth[1] (mm)
Less than or equal to 4.2 m	7[2]	8(-3,+3)
6	10(-0,+3)	9(-3,+3)
8	11(-0,+3)	9(-3,+3)
10	12(-0,+4)	10(-3,+3)
12	15(-0,+4)	12(-3,+3)

Notes

1. sealant depth applicable to silicone sealants conforming to and installed in accordance with Clause 10.2.4.
2. see Clause 10.3.6.1.

For jointed unreinforced base, joint width and spacings shall be as shown on the Drawings.

Sawcutting shall proceed so as to prevent cracking of the base concrete other than at the bottom of the sawcut.

The Contractor shall use the type of blade and equipment and the method of control best suited to the hardness of the concrete being sawn, and shall have sufficient standby equipment available on site to maintain continuity of sawing.

The line of the transverse contraction joint shall be without any discontinuities. No edge shall deviate from a 3 m straight-edge by more than 10 mm.

The surface of the transverse contraction joint shall not exhibit more than 10 mm of vertical or horizontal edge ravelling. The cumulative length of edge ravelling with dimensions greater than 3 mm shall not exceed 300 mm in any 3 m length of joint on each edge. The vertical face at the edge of the

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slab shall not exhibit ravelling greater than 20 mm in any axis at the point of intersection with the sawn joint. Where a non-conformance occurs, a Corrective Action statement shall be given to the Contractor and Corrective Action shall be implemented immediately.

Sawcutting for detector loops is not allowed.

10.3.3 Cleaning

Immediately after any sawing, the sawcut shall be cleaned of all debris. The cleaning method used shall not damage the sawcut nor leave any substance deleterious to the concrete or to the adhesion of the joint sealant to be used. The method shall incorporate a liquid or liquid/air jet at a sufficiently high pressure to clean the joint. Gravity-fed liquid from tanks shall not be acceptable. Grit blasting shall not be used.

10.3.4 Preliminary sealing

Within a maximum of two hours after cleaning the initial sawcut, a continuous strip of UV-stabilised closed-cell polyethylene backer rod shall be installed at the top of the sawcut, but passing under any sealant inserted into sawn longitudinal joints. The top of the backer rod/seal shall be neither higher than the concrete surface nor more than 5 mm below it. Sealing shall include the vertical faces of the slab at the ends of sawcuts.

For a 3 mm sawcut width, the uncompressed diameter of the backer rod/seal shall be 6 mm.

The preliminary seal shall be maintained in sound condition by the Contractor until the joint is temporarily or permanently sealed.

The preliminary seal shall remain in position until pushed to the bottom of the initial sawcut immediately prior to commencing the widening of the sawcut for the final seal.

10.3.5 Temporary sealing

Following the widening of the sawcut and immediately after cleaning, the joint shall be temporarily sealed by a continuous closed-cell polyethylene backer rod of diameter shown on the Drawings, or in accordance with the sealant manufacturer's requirements. Sealing shall include the vertical faces of the slab at the ends of sawcuts.

The top of the backer rod shall be neither higher than the concrete surface nor more than 10 mm below it. The backer rod shall pass over any longitudinal joint seal already in place.

The temporary seal shall be maintained in sound condition by the Contractor until the joint is permanently sealed. Damaged or disturbed temporary sealants shall be removed, the transverse contraction joint cleaned again and a new temporary seal inserted.

10.3.6 Permanent Sealing

10.3.6.1 General

The permanent seal shall be placed in the joint within ten days of initial sawing and within a maximum of two hours of removing or depressing the existing temporary seal. The permanent seal of joints and any cracking exceeding 2 mm width shall extend down the edges of the base against which granular material and/or concrete is to be placed so as to prevent the ingress of any incompressible material from adjacent works.

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The permanent sealant shall be an in-situ cast silicone sealant. A full technical description of the proposed sealant, including its operating parameters and the method of installation recommended by its manufacturer, shall be submitted as part of the Quality Plan.

The operating parameters for silicone sealants shall include:

a) the recommended and minimum groove widths at time of sealant installation, W_1 and W_2; and

b) the maximum operating width of the sealant, W_3, such that $W_3 – W_2$ is not less than 2.0 mm.

The Contractor shall obtain a Certificate of Compliance, showing that the sealant meets all the requirements of ASTM D 2628-91 in respect of neoprene compression sealants and Table 10.2.5 in respect of silicone sealants. All relevant test results shall accompany the Certificate.

10.3.6.2 Silicone sealants

Silicone sealants shall comply with the requirements listed in Table 10.2.5. Each production batch shall be evidenced for conformance by a certificate from the manufacturer.

The sealant shall be stored and installed in accordance with the manufacturer's written instructions.

The backer rod shall be located to a depth such that the bottom of the silicone sealant shall be at the planned location and of the correct shape. If the backer rod is damaged in any way it shall be replaced for the full length of the joint.

Installation of the sealant shall take place only when the side walls of the groove have been cleaned and are fully surface dry. Grit blasting shall not be used.

Immediately prior to introducing the silicone sealant into the groove, any foreign or disturbed material shall be cleaned from the joint and from the top of the backer rod by dry oil-free air jet, and the joint shall be fully surface dry at the time of installation and be primed in accordance with the recommendations of the sealant manufacturer. Grit blasting shall not be used.

Permanent sealing shall extend to the full depth of the transverse saw cuts in the base on the edges.

10.3.6.3 Inspection of sealants

The Contractor shall inspect each joint within 24 hours of its construction. If non-conformance is detected in relation to joint sealing, the Contractor shall immediately implement corrective action in accordance with the Quality Plan.

10.3.7 Treatment prior to asphalt overlay

Where asphaltic surfacing over the concrete base is specified, only the initial 3 mm wide sawcut shall be provided and filled with silicone joint sealant in accordance with Clause 10.

10.4 Other joints

10.4.1 Longitudinal joint with kerb and/or gutter

Kerb longitudinal joints shall be continuous over their full length without steps or offsets in any axis. The line shall not deviate from a 3 m straight-edge placed along the joint by more than 20 mm, after due allowances for any planned curvature.

Drawings for kerb and/or gutter typically show a 20 mm (nominal) edge rounding at the front lip. Where a kerb and/or gutter abuts a concrete base, the rounding shall not be greater than 5 mm.

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Where the kerb and/or gutter is not constructed integrally with the concrete base, tie bars shall be inserted in accordance with Clause 8.6, unless otherwise shown in the Drawings. Tie bars shall not be placed closer than 150 mm to a transverse tied joint nor closer than 500 mm to a transverse untied joint, such as a contraction or an isolation joint.

Untied joints shall be sealed in accordance with the Drawings. Tied joints need not be sealed.

Unless otherwise specified in the Drawings, concrete in kerb types shall comply with Clause 4.2 of this Technical Specification or alternatively shall be normal class concrete with strength grade N32E7 or N40E7 in accordance with AS 1379. These kerb types shall not be extruded unless otherwise shown in the Drawings.

At all kerb joints, the first-placed joint face shall be treated in accordance with Clause 10.5. Where the first-placed face is nonconforming or the edge is damaged, it shall be reinstated or repaired prior to the placement of adjoining concrete and the repair material shall not be placed integrally with the adjoining concrete.

Slabs containing pit openings shall be reinforced in accordance with the Drawings and Clause 8.

10.4.2 Isolation and expansion joints

Isolation joints shall be provided at the locations and to the details shown on the Drawings.

The line of the isolation joint shall not deviate from the specified position by more than 25 mm. The line of the joint shall not deviate from a 3 m straight-edge by more than 20 mm. The joint shall be constructed square to the finished top surface of the base with a tolerance of ± 5º.

Joints shall be maintained at all times free of incompressible and/or foreign materials. At free edges (as defined in Table 3, the sealant shall extend down the full vertical face of the joint. At all other edges (such as formed joints), the filler shall extend to the edge of the base (with a tolerance of + 10, – 0 mm) to prevent the ingress of concrete or other incompressible and/or foreign materials during subsequent work.

The joint shall be filled with silicone complying with the requirements of Clause 10.3.6.2. The sealant requirements and installation shall be in accordance with Clause 10.3.6, except for reference to backing rods.

Expansion joints shall have dowels in accordance with the Drawings.

10.4.3 Transverse joints in structural shoulders

Transverse joints in integral shoulders shall be in accordance with Clauses 10.1 and 10.3. They shall be continuous with, and for shoulders greater than 2.0 m wide, at the same angle as, the transverse joints in the base. For shoulder slabs less than or equal to 2.0 m wide, the angle shall be square to the longitudinal edge. The joint shall be sealed with silicone (Clause 10.3.6.2).

10.4.4 Inspection

The Contractor shall inspect each joint within 24 hours of its construction. If non-conformance is detected in relation to joints, the Contractor shall immediately implement Corrective Action in accordance with the Quality System requirements.

SUPERSEDED

10.5 Joint bond condition

This Clause specifies the condition and treatment of joint faces where it is intended that the faces be constructed without intimate microtexture bond.[2]

The first-placed joint face shall be dense and fully compacted. It shall be free of honeycombing and re-entrant angles. Where the first-placed face is nonconforming or the edge is damaged, it shall be reinstated or repaired prior to the placement of adjoining concrete, and the repair material shall not be placed integrally with the adjoining concrete.

The first-placed face of the joint shall be re-sprayed with curing compound not more than ten days nor fewer than one day prior to placing the abutting concrete. All aspects of the treatment shall be in accordance with Clause 9.6 except that the compound shall be a wax emulsion complying with MRTS42 *Supply of Wax Emulsion Curing Compound for Concrete* and a single application shall be used at the specified rate plus an increase of 25%. The coating shall be intact and effective at the time of subsequent concrete placement.

Steel tie bars shall not be sprayed.

11 Ancillary detailing

11.1 Anchors

Anchors shall be cast separately from the overlying base. The anchor is deemed to be the part below the horizontal construction joint. Anchors in CRC base are referred to as terminal anchors as they form part of the terminal design. Anchors in jointed concrete base are referred to as slab anchors.

Anchors shall be constructed at the locations and to the details shown on the Drawings. Anchors shall be placed not less than 48 hours prior to placing any basecourse over the anchor.

All loose material shall be removed and the vertical faces trimmed to neat lines. Where required, the bottom of the trench shall be recompacted to the degree of consolidation of the adjacent undisturbed material.

Anchors shall be cast separately from the base up to the level of the top surface of the sub-base. A fully scabbled horizontal construction joint shall be incorporated at this level, with the protruding steel subsequently straightened for incorporation into the base slab.

For continuously reinforced concrete, anchor stirrups shall be lapped to the longitudinal reinforcement.

For jointed reinforced concrete, the stirrups shall be lapped to the reinforcing mesh. There shall be no transverse laps in the reinforcing mesh within the area of the stirrups (i.e. within 1.3 m of the anchor axis).

Concrete supplied for slab anchors shall comply with the requirements of the base concrete (see Clause 4.2) except for air content, or alternatively shall be normal class concrete with strength grade N32E7 in accordance with Table B3 of AS 1379, 20 mm maximum nominal size of aggregate and

[2] Intimate bond at the microtexture level induces spalling at arrises under hinging movements. Corrugations and scabbling provide transfer of shear loads at the macrotexture level but it is intended that the joint remain free to hinge in order to reduce curling stresses.

SUPERSEDED

80 mm slump at the point of placement. Concrete shall be placed and compacted in accordance with this Technical Specification.

Where shown on the Drawings, transverse expansion joints shall be provided for terminal slab anchors.

The location of anchors shall be marked by stamp imprint into the surface with the letter 'A' as shown in the Drawings. The stamp shall be placed centrally above the anchor and within 0.5 m longitudinally of each extremity, preferably within a low-trafficked area. Where an anchor is discontinuous (such as under islands), a stamp shall mark each end. The imprint shall be to a depth of 4 ± 1 mm below the circular surround.

Where an anchor is required at the junction of a flexible pavement, a straight sawcut to the full depth of any asphalt shall be made in the flexible pavement along the joint line. Excavation of the trench shall then take place as described above, without disturbance or damage to the existing flexible pavement. Any disturbance or damage to the flexible pavement shall be made good. Drainage of the interface between flexible and rigid pavements shall be as shown on the Drawings.

11.2 Bridge relieving slabs

Bridge relieving slabs shall be constructed at bridge abutments to the dimensions and details shown on the Drawings.

11.3 Terminal slabs in jointed unreinforced base

Terminal slabs shall be constructed adjoining bridge relieving slabs and at chainges from rigid pavement to flexible pavement. Terminal slabs shall be constructed to the dimensions and details shown on the Drawings.

12 Conformance testing of placed concrete

12.1 General

The process requirements shall be checked for conformance to the specified requirements during and after the construction operation, as relevant. Compliance checking shall be carried out in accordance with any maximum lot sizes, minimum testing frequencies and minimum test numbers as given in MRTS40.

12.2 Compaction of concrete

12.2.1 Reference density

All pairs of specimens employed for the determination of 28-day compressive strength of the concrete (see Clause 6.1.5) shall be removed from the bath at seven days and have the hardened density determined in accordance with AS 1012.12.2, amended as follows:

a) Cylinder specimens shall be tested in the saturated surface-dry condition,

b) Cylinders shall not be dressed for voids, and

c) The density mass for a pair of cylinders shall be taken as the average of the two results unless they differ by more than 10% when expressed relative to the average, in which case the higher result shall be taken to represent the density of the pair.

The cylinders shall be returned to the bath as soon as possible, but no later than one hour after their removal.

SUPERSEDED

For each nominated mix in use, a statistical check shall be made of the density for pairs of 28-day cylinders (tested at seven days) as defined under sub-Clause (c).

For the trial concrete base, the reference density for the trial shall be taken as the arithmetic mean of all pairs from that trial, regardless of the number.

Thereafter, the reference density for any lot shall be taken as the rolling arithmetic mean of the latest six consecutive pairs prior to and including that lot. For the purpose of reference density calculations, cylinder unit mass results for transition lots shall be grouped with those from adjacent lots of the same nominated mix.

In situations where fewer than six pairs of a nominated mix are available, the reference density shall be taken as the arithmetic mean of all available pairs.

Results for all cylinders shall be reported.

12.2.2 Extraction of cores

Test specimens for determining the compaction of concrete placed in the works shall be cores, 75 to 100 mm in diameter, cut from the works. Cores shall be extracted from the full depth of the concrete base in accordance with AS 1012.14. Coring of the base shall be strictly controlled and limited to minimise its potential detrimental effects.

Subject to the weather and other conditions pertinent to the site (including whether base or sub-base is being tested), the concrete shall be between 2 – 4 days of age before the extraction of cores.

The location of coring shall be chosen to exclude joints and, where applicable, steel reinforcement or tie bars (located with the aid of a metal detector or other similarly appropriate device). The Contractor's Quality Plan shall detail the proposed method of stratified random sampling for cores within a lot.

Cores shall be placed immediately either in a tank of lime-saturated water or in individual plastic bags and sealed to prevent moisture loss. Cores stored in plastic bags shall be kept in the shade.

Cores shall not be subjected to temperatures in excess of either ambient temperature or 27ºC, whichever is the higher, and they shall not be subjected to a temperature more than 5ºC below ambient temperature, until tested.

SUPERSEDED

12.2.3 Frequency of coring

For mechanically paved base, the Contractor shall take from each lot one core specimen per 100 m³ of concrete base, with a minimum of one and a maximum of 20 cores.

For transition lots, the Contractor shall take from each lot one core specimen per 50 m³ of concrete base, with a minimum of two cores and a maximum of 10 cores.

12.2.4 Testing of cores for density

Testing of cores for density shall be carried out in accordance with AS 1012.12.2, amended as follows:

a) Cores shall be assessed in accordance with Test Method Q473 for excessive voids and, if warranted, shall be dressed prior to testing

b) Core specimens shall be wet-conditioned immediately prior to testing in accordance with AS 1012.14

c) Density shall be measured at age not less than three days nor more than seven days

d) For cores which contain steel reinforcement, an adjustment shall be made in accordance with Test Method Q473

e) For routine core testing, the test shall be carried out on the full depth of core except as follows. Non-concrete materials such as bitumen shall be removed. Surface texture may be removed. Removal of base concrete shall be limited to 10 mm maximum from each end of the core, and

f) The height and diameter at test shall be reported.

12.2.5 Determination of relative compaction

The density of each core determined in accordance with Clause 12.2.4 shall be compared with its relevant reference density determined in accordance with Clause 12.2.1 and expressed as the percentage relative compaction recorded to the nearest 0.1%.

If there are five or more cores in a lot, the characteristic relative compaction (RC_c) shall be determined as follows:

$RC_c = MRC – ks_{com}$

where:

MRC = mean of relative compaction results of all cores from the lot,

s_{com} = standard deviation of relative compaction results of all cores from the lot, and

k = the appropriate coefficient dependent on the number of cores per lot and determined from Table 12.2.5.

Table 12.2.5 – Constant k

Number of cores per lot	k
5	1.48
6-7	1.42
8-10	1.38
11-15	1.35
16-40	1.32

The relative compaction of each lot of base shall be assessed for conformance to Clause 9.3.6. Lots which do not comply with the above are deemed to be nonconforming.

12.2.6 Repair of core holes

The Contractor shall clean and restore all core holes with non-shrink cementitious concrete having a compressive strength not less than that specified herein for the adjoining concrete, and a maximum nominal aggregate size of 10 mm.

For a wearing course, the surface of the restored hole shall be similar to the surrounding surface in texture and colour.

Prior to trafficking, the concrete shall be cured sufficiently to achieve an estimated compressive strength of 15 MPa.

The cost of restoring core holes shall be borne by the party which has secured the cores.

SUPERSEDED

12.3 Horizontal alignment

The Contractor shall survey to assess alignment for conformance to this Technical Specification, within 24 hours of paving or as otherwise approved by the Administrator. If a non-conformance is detected, the Contractor shall immediately implement Corrective Action in accordance with the Quality System requirements.

The outer edges of the base shall be checked using a 3 m straight-edge for conformance to Clause 9.4.1 at locations determined by stratified random sampling.

12.4 Three metre straight-edge tolerance

The Contractor shall survey to assess straight-edge tolerances for conformance to this Technical Specification, within 24 hours of paving or as otherwise approved by the Administrator. If a nonconformance is detected, the Contractor shall immediately implement Corrective Action in accordance with the Quality System requirements.

The top surface of each lot of base shall be assessed for conformance to the requirements of Clause 9.4.

The lot shall be tested under a 3 m straight-edge laid in any direction. Where the straight-edge is placed on convex sections, the cantilever length shall not exceed 0.75 m.

12.5 Surface heights

The surface height of each finished base layer lot shall be measured for conformance with the requirements of Clause 9.4 within four working days of placing the base.

Using a flat-based staff, levels shall be taken on at least the following locations:

a) at the cross-sections offsets given in Figure 12.5, with a tolerance of ± 0.05 m

b) at longitudinal spacings of 7.5 m

c) at the same locations as the measurements carried out on the sub-base, and

d) at least 10 other random locations per 500 lane metres.

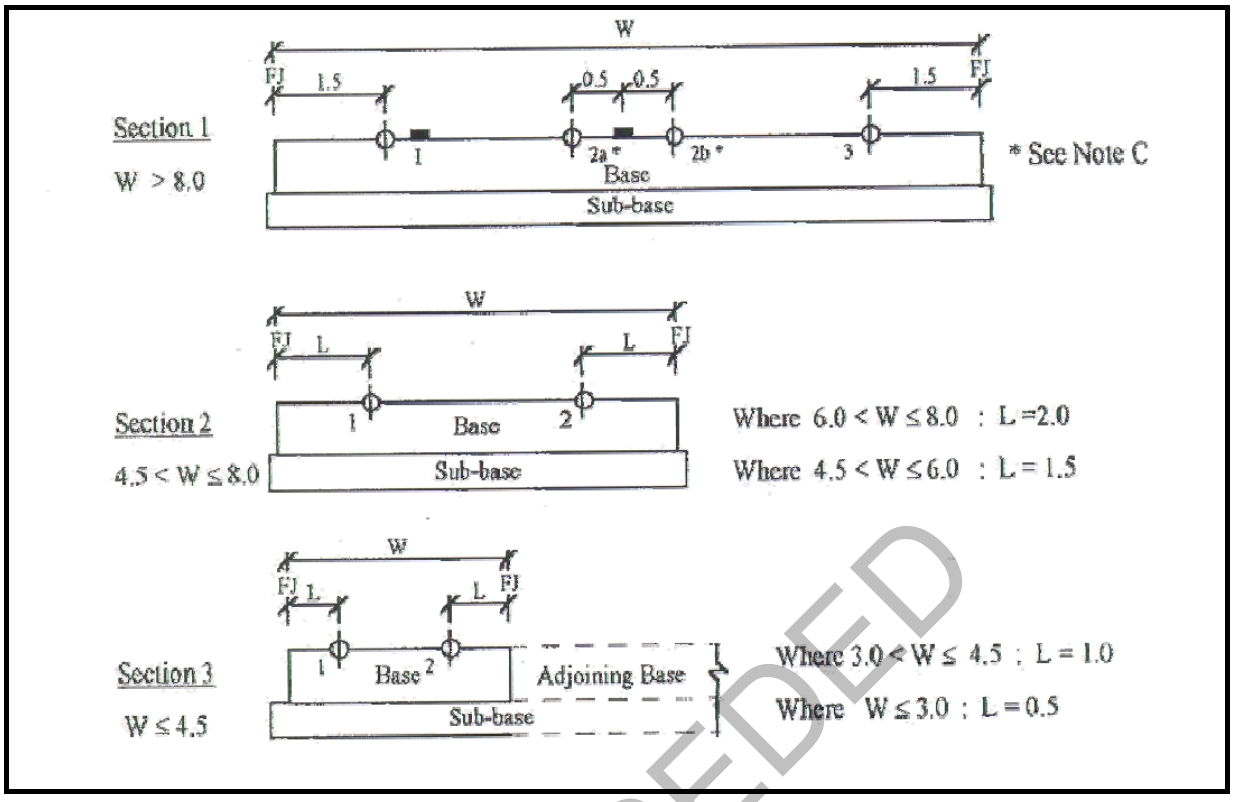
Levels shall be surveyed at each cross-section survey point shown in Figure 12.5 according to the paving width between formed longitudinal joints and at random locations for at least 10 other points. However, in locations where the distance between a formed edge and the adjacent lane line is variable (tapered), the survey point shall be altered to a location which is offset by 0.5 m from that lane line.

Additional surveys shall be carried out after surface correction measures such as rectification under Clause 13.

Levels shall be reported to the nearest millimetre.

SUPERSEDED

Figure 12.5 – Survey height cross-sections.



Notes to Figure 12.5

All dimensions are in metres (m).

Induced longitudinal joints shall be ignored for the purpose of locating survey points and are not shown in Figure 12.5.

In Section 1, the Contractor shall nominate to take a survey either at point 2a or 2b.

Symbols used in Figure 12.5:

Symbol	FJ	W	,	–
Meaning	Formed joint or edge	Paving width between formed joints or edges	Lane lines	Survey points

SUPERSEDED

12.6 Concrete base thickness

The thickness of the concrete base shall be determined by two methods:

a) Levelling
   Subtracting the heights of the lean mix sub-base, which includes the thickness of any bitumen seal or other treatment (see Clause 9.3.3.2) from the heights of the base at the same longitudinal plan and offset locations as the sub-base.

b) Coring
   Determining the thickness from cores at intervals not exceeding 25 metres, or at the slab edges at intervals not exceeding 10 metres, and vertical by cores at intervals not exceeding 100 metres.

The mean thickness for each lot shall be calculated using all survey and core results from that lot, with the exception of any survey results omitted as specified below. The result shall be rounded to the nearest 1 mm.

The Administrator may authorise coring in areas where the thickness as calculated from survey results is nonconforming, in which case 40 mm diameter cores shall be taken.

Wherever a core result differs by 5 mm or more from a survey result(s) which is located within 1.5 m of the core, or by 10 mm or more from a survey result(s) which is located between 1.5 m and 2.5 m from the core, the core result shall be accepted and the survey result(s) shall be omitted from the assessment.

12.7 Surface evenness

12.7.1 General

Surface evenness shall be measured within the sections nominated in Table 9.4.5, using an Austroads roughness meter vehicle in accordance with Test Method Q708.

Testing shall be carried out at the following speeds given in Table 12.7.1.

Table 12.7.1 – Testing Speeds

Posted Speed	Testing Speed
where the posted speed is less than 80 km/h	50 km/h
where the posted speed is 80 km/h or greater	80 km/h

The timing of roughness testing shall comply with Clause 9.7.2.

Surface lot sizes shall be determined by the Contractor but in no case less than 100 m.

The surface evenness shall be assessed for conformance to Clause 9.4.5.

Lots which do not comply with the surface evenness requirements are deemed to be nonconforming.

12.8 Transverse texturing of surface

Where transverse texturing is specified, the average texture depth shall be measured by one of the following methods:

a) TRL Mini Texture Meter, or

b) Sand Patch Test Method Q705.

The choice of test method shall be at the Contractor's discretion and testing is exempt from the requirement for NATA registration.

12.9 Curing compound rate of application

The application rate of curing compound shall be checked for conformance to the requirements of this Technical Specification:

a) by calculating the average application rate from the total measured quantity of compound applied over each paving run

b) by testing the local amount of curing compound as measured on test mats placed on the concrete pavement. The application rate shall be calculated as the mean of the local rates falling on three felt mats, each approximately 0.25 m^2 in area and placed randomly within an area of 100 m^2 on the surface to be treated. Testing shall be carried out at a frequency of once per 2000 m^2 of base, and

c) where the edge of a slab is sprayed by mechanical means, the local application rate on the edge shall be tested in accordance with (b) at a frequency of once (i.e. three mats) per

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3000 m^2 of upper surface paving. The three mats shall be placed randomly within a total edge length of 20 linear m.

Application shall be deemed to be conforming if the average result is not less than the specified rate and if no single result is more than 5% below the specified rate.

Any section of a lot on which the application does not conform shall be resprayed within six hours at an application rate not less than twice the deficiency in the original application.

12.10 Tie bars

Tie bars which have been inserted into the slab edge shall be tested for anchorage strength. Pull-out testing of tie bars shall be carried out in accordance with Q475 at the following frequency, independent of transverse construction joints, and commencing 5 m from the start of base paving for the works:

a) one test per 50 linear metres until 4 consecutive conformances are achieved; and thereafter,

b) at a rate of 1 per 100 linear metres until a further 4 consecutive conformances are achieved; and thereafter,

c) at a rate of 1 per 200 linear metres.

Upon encountering a nonconformance at any stage of the test, consecutive bars shall be tested alternately each side of the failure until 4 consecutive tests are performed without failure, whereupon testing shall revert to frequency (a). A minimum of 5 bars shall be tested in any trial section of paving.

Bars found to be nonconforming in terms of anchorage shall be removed and reset by using a suitable epoxy or polyester setting system to develop an anchorage strength of at least 85% of the yield strength of the bar. Bar replacement shall not disturb the concrete surface. Replaced bars shall be tested at a frequency of 1 in 2.

For tie bars which cannot be tested for anchorage because of full encasement[3] in concrete, the Contractor shall extract cores to ensure that the method of placement provides full compaction of concrete around the bars. Testing shall be carried out as follows:

a) For location: at a frequency equal to that for anchorage testing as detailed above, and

b) For compaction

   i. in the trial base: one core per 40 linear metres of paving, or part thereof, and

   ii. elsewhere: one core per 500 linear metres of paving.

Cores shall be located to intersect a tie bar but shall be offset from the longitudinal joint by 250 ± 100 mm and shall be no closer than 1.5 m to a transverse contraction joint nor closer than 3.0 m to a transverse construction joint. Compaction shall be assessed by visual comparison with conforming cores which have been taken for compaction testing in accordance with Clause 12.2. If compaction around the bar is visibly inferior then the Contractor shall immediately implement Corrective Action in accordance with the Quality System requirements.

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[3] Note that this testing requirement applies to induced joints but not to formed joints

13 Rectification

13.1 Removal of concrete base

13.1.1 General

At least seven days prior to the commencement of base removal, the Contractor shall submit to the Administrator details of the proposed methods of carrying out the work, including precautions to prevent damage to the adjoining base and the underlying sub-base. **Hold Point 18**

13.1.2 Jointed concrete base

A transverse sawcut shall be made for the full depth of the base layer at each end of the section of base to be removed. These sawcuts shall be normal to the control line within a tolerance of ± 5E and not closer than 1.5 m to an existing contraction joint in the base. No oversawing into the adjoining base or underlying sub-base shall be permitted.

Longitudinal sawcuts shall be made along existing longitudinal joints to define the edges of the base section to be removed. These shall not extend more than 250 mm past the transverse sawcut at each end of the section to be removed, nor into the underlying sub-base.

The Contractor shall dispose of the removed base slabs. Any base adjoining the removed slabs which is damaged by the Contractor's operations shall also be removed and replaced.

13.1.3 Continuously reinforced concrete base

Breaking up of concrete shall not proceed until adjoining concrete for 100 m each side of the section (including adjacent paving lengths) to be removed has achieved the specified 28-day compressive strength.

A transverse sawcut shall be made at each end of the section to be removed:

a) in a straight line and continuous between adjacent longitudinal joints and at an angle of not less than 85º to the longitudinal joint

b) to a depth of 50 ± 5 mm, and

c) at a location not closer than 500 mm to an existing transverse crack in the concrete which is to remain.

The nonconforming concrete shall be removed within these sawcuts in such a way that:

a) the face of the construction joint is left scabbled below, but not within, the depth of the sawcut, and

b) not less than 1.0 m of every longitudinal bar is left protruding and undamaged beyond these joints.

Oversawing into the adjoining base shall not be permitted.

At each longitudinal edge of the nonconforming base, the concrete shall be removed:

a) to an existing longitudinal joint or edge, and

b) in such a way that the exposed face complies with the criteria for longitudinal construction joints as defined in this Technical Specification.

Longitudinal sawcuts shall not extend beyond the transverse sawcuts which define the limits of removal.

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Should the Contractor elect to make additional sawcuts (either longitudinal or transverse) within the nonconforming concrete to facilitate its removal, these shall not extend beyond the limits of the removal into either the adjacent base or the underlying sub-base.

Damage to new concrete in repairs by thermal movement in the adjacent CRCP must be avoided by using adjacent lane(s) as a prop or providing a 'stitch'.

A suitable 1 m stitch has been developed using, in addition to normal longitudinal steel, 3 bundled 32 mm diam bars, fully lapped at 500 mm spacing, the bottom 2 bars embedded 1.5 m in one side and the top bar 1.5 m in the other. Additional 12 mm diam transverse tie bars are provided to give a 150 mm maximum spacing. The top 32 mm bar is welded to each of the lower bars using four 100 mm weld runs equally spaced.

Concrete must not be cast on longitudinal reinforcing steel in compression, which often exhibits as buckling.

13.2 Replacement of base

13.2.1 General

Nonconforming base which extends less than 25 m longitudinally shall be replaced by hand-placed means, and that which extends more than 25 m longitudinally shall be replaced by mechanical means unless the slabs are odd-shaped or mismatched. Replacement shall be in full slab widths between longitudinal joints and/or external edges.

13.2.2 Jointed concrete base

Prior to the construction of the replacement base, the sub-base shall be prepared and de-bonded in accordance with MRTS39 *Lean Mix Concrete Sub-base for Pavements* and MRTS40.

All work involved in the replacement of base shall comply with the Technical Specification and include the following additional requirements:

a) The joint faces on the adjoining slab at the transverse sawcuts shall be smooth from the top of the base to 50 ± 5 mm below the top of the base. The areas from 50 ± 5 mm below the top of the base to the bottom of the base shall be deeply scabbled. Tie bars shall be provided to form a transverse joint in accordance with Clause 10.1

b) Transverse contraction joints shall be continuous across the full width of the base containing the replaced section. The length of the joint across the full width of the base shall be sealed with a silicone sealant in accordance with Clause 10.2.4

c) The lower two-thirds of the depth of the longitudinal joint faces shall be deeply scabbled and any nonconforming concrete shall be removed. A crack-inducer ribbon shall be attached to the surface of any formed longitudinal joint in the replacement base and tie bars provided to form a longitudinal tied joint in accordance with Clause 10.2

d) Tie bars placed into hardened concrete shall be set by the use of a suitable epoxy or polyester resin setting system to develop an anchorage strength at least 85% of the yield strength of the bar

e) All exposed faces shall be assessed and treated in accordance with Clause 10.5, and

f) All joints (and underlying cracks) which have been exposed (at all edges and corners) by the removal shall be sealed.

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13.2.3 Continuously reinforced concrete base

Prior to construction of the replacement base, the sub-base shall be prepared and de-bonded in accordance with MRTS39 *Lean Mix Concrete Sub-base for Pavements* and MRTS40.

All work involved in the replacement of base shall comply with the Technical Specification, and include the following requirements:

a) The joint faces on the adjoining slab at the transverse sawcuts shall be smooth from the top of the base to 50 ± 5 mm below the top of the base. The areas from 50 ± 5 mm below the top of the base to the bottom of the base shall be deeply scabbled. Tie bars shall be provided to form a transverse joint in accordance with Clause 10.1;

b) At longitudinal joint faces, the lower two-thirds of the depth shall be deeply scabbled and any nonconforming concrete shall be removed;

c) At tied longitudinal joints, tie bars shall be provided in accordance with Clause 10.2;

d) Tie bars placed into hardened concrete shall be set by the use of a suitable epoxy or polyester resin setting system to develop an anchorage strength at least 85% of the yield strength of the bar;

e) All exposed faces shall be assessed and treated in accordance with Clause 10.5, and

f) All joints (and underlying cracks) which have been exposed (at all edges and corners) by the removal shall be sealed with silicone over the full exposed face, to prevent the ingress of mortar and other incompressible material.

13.3 Rectification of finished surface and surface evenness nonconformance

Individual locations identified as nonconforming in accordance with Clauses 9.4.3 or 9.4.5 shall be rectified to achieve conformance by grinding with purpose-built equipment employing gang-mounted diamond saw blades.

Impact methods such as rotomilling shall not be used.

Grinding shall not be carried out until all necessary slab replacements have been completed within the area to be ground.

The equipment shall be capable of grinding to a width of not less than 1.0 m in a single pass and shall create a line-type texture as follows:

a) Grooves shall be uniformly spaced and shall number between 170 and 200 per metre of width to suit the particular concrete and to produce grooves as per (b).

b) The height between the peaks and troughs shall be 2 ± 1 mm.

Where grinding is required, it shall be carried out over the full width of a traffic lane.

Grinding shall be carried out in such a way that positive lateral drainage is provided by maintaining a uniform slope without steps across the ground surface. Grinding shall be transitioned at all edges of the pavement to maintain drainage and to provide acceptable ride quality. After grinding, deviations on the finished surface shall be measured (both within the pavement and across boundaries) and shall not exceed 5 mm under a 3 m straight-edge when measured in any direction. The base thickness after grinding shall comply with Clause 9.4.4.

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Grinding residue shall be controlled and removed from the pavement and shall not be permitted to flow into the drainage system or across lanes which are in public use.

Following grinding, the surface shall be re-assessed in accordance with Clauses 12.4, 12.5 and 12.6.

Sealants shall be restored in accordance with this Technical Specification and transverse texturing shall be restored in accordance with Clause 9.5.

Where surface correction results in water ponding on any part of the carriageway (including shoulders), transverse grooving shall be carried out to the extent necessary to remedy the ponding.

13.4 Rectification of transverse texturing nonconformance

Lots which are nonconforming with respect to transverse texture (Clause 9.5) shall be transversely saw-grooved to meet the average texture requirements. Saw grooves shall be of the following dimensions:

> 3 mm wide, 3 mm deep, spaced in a random pattern and with spacings neither less than 10 mm nor more than 18 mm. The mean spacing shall be between 12 mm and 15 mm.

Grooving residue shall be controlled and removed from the concrete pavement and shall not be permitted to flow into the drainage system or across lanes which are in public use.

14 Edge drains

14.1 General

This part of MRTS40 refers to construction of edge drains. Edge drains are generally located on the downside of the concrete carriageway and drain the water entering joints between the subbase and base.

14.2 Materials

14.2.1 Filter material

Filter material for edge drains shall be 20 mm no fines concrete as specified in MRTS70 *Concrete*.

When combined with subsoil drains, the filter material in the subsoil drain part shall comply with the requirements of Type 1.1 in MRTS05 *Unbound Pavements* except that the grading shall be as specified in Table 14.2.1.

Table 14.2.1 – Filter material grading

AS Sieve Size	Percent Passing by Mass
26.5 mm	100
19.0 mm	95 – 100
13.2 mm	50 – 70
6.7 mm	30 – 55
2.36 mm	20 – 30
0.300 mm	0 – 5

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14.2.2 Drainage pipe

The properties of corrugated perforated plastic drainage pipe and unslotted plastic pipe and fittings shall comply with the requirements of MRTS03 *Drainage, Retaining Structures and Protective Treatments* and AS 2439.1.

The properties of the geocomposite plastic drainage pipe shall comply with the requirements of MRTS03 *Drainage, Retaining Structures and Protective Treatments*.

14.2.3 Geotextiles

Where shown on the Drawings, a geotextile complying with MRTS03 *Drainage, Retaining Structures and Protective Treatments* shall be installed.

14.3 Installation of edge drains

14.3.1 General

Edge drains are to be constructed where shown on the Drawings.

Where the edge drain is constructed in combination with a subsoil drain, the trench shall be excavated to the required line, grade, width and depth as shown on the Drawings or as directed by the Administrator.

Where edge drains are to be installed after the construction of the shoulder, the shoulder material shall be excavated to the required line, grade, width and depth as shown on the Drawings or as directed by the Administrator.

Where the grade of the roadway is equal to or greater than 0.5%, the bottom of the trench is to be constructed at the same grade as the roadway and in such a manner that localised ponding of water does not occur. Where the grade of the roadway is less than 0.5%, the trench shall be excavated to provide a minimum grade of 0.5%.

The geotextile is to be located as shown on the Drawings and is not to hinder the flow of water from the interface between the concrete base and sub-base.

Where a kerb and gutter or dish drain is to be constructed, the edge drain is to be extended to provide support for the full width of the drainage structure as shown on the Drawings. The edge drain shall be combined with a subsoil drain as shown on the Drawings. The trench shall be excavated to the required line, grade, width and depth as shown on the Drawings or as directed by the Administrator.

Witness Point

14.3.2 Laying of pipe

Corrugated perforated plastic drainage pipe shall be laid on a bed of filter material 25 mm or 50 mm in thickness as shown on the Drawings. The drainage pipe shall be laid to the required line and grade.

The number of joints shall be kept to the minimum and, where required, joints shall be made using a suitable external joint coupling.

14.3.3 Placement of the geocomposite plastic drainage pipe

Where edge drains are to be installed before the placement of verge material, strip filters must not be used as edge drains. Where a geocomposite plastic drainage pipe is specified, the drainage pipe without the geotextile wrapping shall be used in the drain, unless otherwise approved by the Administrator.

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14.3.4 Backfilling

Where a pipe is used in the edge drain, it shall be covered with filter material as shown on the Drawings.

Aggregate filter material shall be compacted to its full depth to avoid post-construction consolidation. Aggregate filter material shall be compacted to a relative density of not less than 100% as determined by Test Method Q110A.

No fines concrete shall be compacted by hand tamping.

Care shall be taken not to damage or distort the drainage pipe during compaction of the filter material.

When placing and compacting verge material, care shall be taken to avoid damage or disturbance to the drain and drainage pipe.

14.3.5 Cleanouts

Cleanouts are to be provided at the commencement and end of each run of edge drain line and at intervals as shown on the Drawings.

Details of the required cleanout construction are shown on the Drawings.

14.4 Outlets

Outlets shall be provided at intervals as shown on the Drawings. Where possible, edge drains shall discharge into gully pits and other stormwater drainage structures. Where it is practicable or as shown on the Drawings, edge drains shall be connected to the subsurface drainage system. Where this is not practicable, an outlet shall be constructed of unslotted plastic drainage pipe of the same diameter as the main run to discharge water below the edge of the road shoulder. An outlet structure in accordance with the Drawings shall be constructed at the discharge end.

There are two types of outlets; flat batter outlets and steep batter outlets. Steep batter outlets are to be used on batters with slopes steeper than 4:1 and flat batter outlets are to be used on batters with slopes equal to or less than 4:1.

14.5 Marking of drains

The Contractor shall keep a detailed record of all edge drain installations. Work-as-executed drawings of the completed drainage system shall be marked on relevant extracts of half-size drawings for the works and shall be submitted to the Administrator within 28 days of completion of the work.

Witness Point

Cleanout caps shall be marked with a suitable letter/number punch on the smooth ground area provided.

Drains shall be marked on the ground using maintenance marker posts as shown on Standard Drawing 1358. Markers shall be placed at the outlet of drains, and opposite junctions, bends and sump, if any.

15 Lot sizes and testing

15.1 General

This clause details requirements for the manufactured and lot sizes and testing placement of concrete and all constituent materials.

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15.2 Lot sizes, tests and testing frequencies

15.2.1 General

The Contractor shall be responsible for selecting the lot sizes, tests, inspections and testing and inspection frequencies to ensure that the work complies with all the standards and requirements of the Technical Specifications.

The lot sizes, tests, inspections and the testing and inspection frequencies represent absolute minimum requirements. The reduced level shall apply after no nonconformances have been detected in two consecutive lots. These are absolute minimum levels and the Contractor shall be testing more frequently where necessary (particularly at the commencement of new activities).

There are two levels of maximum lot sizes and minimum testing frequencies given below. The Contractor shall comply with the requirements of the Normal Level unless approval is given by the Administrator to revert to the Reduced Level.

Where a Contractor is operating at the Reduced Level and a nonconformance occurs for any standard or requirement in a lot, the Contractor shall immediately go back to the Normal Level of testing, until no nonconformances have been detected in two consecutive lots.

The Contractor remains responsible for performing sufficient tests and inspections to ensure that the lot complies with all the standards and requirements of this Technical Specification.

15.2.2 Description of lots

This Technical Specification is based on the use of lots, which are homogeneous (in the context of the requirements of the Technical Specifications) identifiable quantities defined in forms such as:

a) length, e.g. linear metres

b) area, e.g. square metres

c) volume, e.g. cubic metres

d) mass, e.g. tonnes, and

e) units of manufacture, such as batches, etc,

and of items and material types identified by name and requirements of the Technical Specification such as:

a) aggregate

b) cement

c) fly ash

d) slag

e) additives

f) steel, and

g) class and size of concrete,

from which samples are taken and about which decisions are made on the basis of such processes as:

a) tests

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b) inspections

c) test procedures

d) observations, and

e) auditing.

Lot sizes are given in MRTS40.

The minimum and/or maximum lot sizes and/or testing frequencies given this Technical Specification are not sufficient to check the lot for homogeneity. The Contractor shall check for homogeneity on a regular basis but not less than the frequency given in MRTS40. The lot can be audited for homogeneity at any time.

Homogeneity can be assessed by utilisation of the requirements of the Technical Specification for the particular item or material and by:

a) conducting a statistically significant number of tests, at least 30, and/or

b) subdividing the initially chosen lot in any number and size of smaller lots and testing each smaller lot as required, and in accordance with the minimum testing frequencies given in MRTS40.

15.2.3 Concrete lots

A concrete lot shall consist of batches of concrete of the same class, produced and placed in an essentially uniform and continuous manner. A lot shall not extend beyond the boundaries of a section of pavement cast or paved in one continuous operation up to a maximum operating time of one calendar day and/or beyond any construction joint.

Concrete base lots which are not placed with a mechanical paver (see Clause 9.2.2), and including the sections specified below, shall be deemed 'transition lots'. At transverse construction joints in mechanically paved base, the work within 3 m each side of the joint is deemed to constitute two discrete transition lots, regardless of the methods employed at the joint. Transition lots shall be treated in the same manner as other lots except for relative compaction testing.

At transitions (from machine paving to hand paving) which are remote from a transverse construction joint, the work within 3 m each side of the transition point is deemed to constitute two discrete transition lots, regardless of the methods employed at the transition.

15.2.4 Aggregate lots

An aggregate lot shall consist of a discrete stockpile solely for use on the works. These materials shall not be used for any other work. The stockpile shall be formed by either of the following methods:

a) a stockpile for each lot, or

b) a continuous, rectangular-in-plan-view shaped stockpile where material is added at one end and withdrawn at the other end, with lots being identified by pegged locations within the stockpile.

15.3 Testing in referenced documents

Notwithstanding the requirements in any referenced standards and/or documents such as Australian Standards, the full range of tests given in the referenced standards or documents shall be carried out

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for the material or product within a period of one month prior to the material or product being used for the first time on or in the works.

15.4 Silicone for use in joint sealants

Unless specified otherwise, silicone shall be used for joint sealing.

At least 10 working days prior to the use of a specific brand and type of silicone, the complete details of the product, including all test results, shall be forwarded to the Administrator for checking and certification. **Hold Point 19**

15.5 Minimum frequency of testing

15.5.1 Constituent materials

Details of the characteristics, lot sizes and testing frequencies for constituent materials are included in Table 15.5.1.

Table 15.5.1 – Constituent materials testing

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
Cementitious Materials Cement: AS 3972 Fly Ash: AS 3582.1 Slag: AS 3582.2 Testing site blended cementitious material for compliance with Type SL	1500 tonnes	1500 tonnes	once	once
Loss on Ignition and Fineness for Fly Ash	per tanker delivery	Per tanker delivery	once	subject to air content conforming to specified requirements, one in ten
Water Impurities in Mixing Water	30 000 m^3	30 000 m^3	once	once
Chemical Admixtures AS 1478.1	batch	batch	once	once

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15.5.2 Coarse aggregate

Details of the characteristics, lot sizes and testing frequencies for coarse aggregate are included in Table 15.5.2.

Table 15.5.2 – Coarse aggregate testing

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
Water Absorption	2000 tonnes	5000 tonnes	1	1
Bulk Density	2000 tonnes	5000 tonnes	3	3
Material < 75 micrometre	2000 tonnes	5000 tonnes	3	3
Material < 2 micrometre	2000 tonnes	5000 tonnes	3	3

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
Particle Shape: (3:1 ratio) and (2:1 ratio)	2000 tonnes	5000 tonnes	3	3
Flakiness Index	2000 tonnes	5000 tonnes	3	3
Light Particles	2000 tonnes	5000 tonnes	1	1
Weak Particles	2000 tonnes	5000 tonnes	1	1
Iron Unsoundness	2000 tonnes	5000 tonnes	1	1
Falling or Dusting Unsoundness	2000 tonnes	5000 tonnes	1	1
Crushed Particles	2000 tonnes	5000 tonnes	1	1
10% Fines Value (Wet)	2000 tonnes	5000 tonnes	1	1
Wet/dry Strength Variation	2000 tonnes	5000 tonnes	1	1
Degradation Factor	2000 tonnes	5000 tonnes	1	1
Coarse Aggregate Grading	2000 tonnes	5000 tonnes	3	3

15.5.3 Fine aggregate testing of source rock for manufactured sands

Details of the characteristics, lot sizes and testing frequencies for source rock for manufactured sands are included in Table 15.5.3.

Table 15.5.3 – Source rock testing

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
Light Particles	2000 tonnes	5000 tonnes	1	1
Weak Particles	2000 tonnes	5000 tonnes	1	1
10% Fines Value (Wet)	2000 tonnes	5000 tonnes	1	1
Wet/dry Strength Variation	2000 tonnes	5000 tonnes	1	1
Degradation Factor	2000 tonnes	5000 tonnes	1	1

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15.5.4 Fine aggregate

Details of the characteristics, lot sizes and testing frequencies for fine aggregate are included in Table 15.5.4.

Table 15.5.4 – Fine aggregate testing

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
Water Absorption	2000 tonnes	5000 tonnes	1	1
Bulk Density	2000 tonnes	5000 tonnes	3	3
Material < 75 micrometre	2000 tonnes	5000 tonnes	3	3

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
Material < 2 micrometre	2000 tonnes	5000 tonnes	3	3
Organic Impurities	2000 tonnes	5000 tonnes	3	3
Sugar Content	2000 tonnes	5000 tonnes	3	3
Iron Unsoundness	2000 tonnes	5000 tonnes	1	1
Falling or Dusting Unsoundness	2000 tonnes	5000 tonnes	1	1
Moisture Content	Stockpile	Stockpile	3 per day and after rain	3 per day and after rain

15.5.5 Combined aggregate

Details of the characteristics, lot sizes and testing frequencies for combined aggregate are included in Table 15.5.5.

Table 15.5.5 – Combined aggregate testing

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
Combined Aggregate Grading	2,000 tonnes	5,000 tonnes	3	3

15.5.6 Alkali reactive testing

Details of the characteristics, lot sizes and testing frequencies for alkali reactivity are included in Table 15.5.6.

Table 15.5.6 – Alkali reactive testing

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
Alkali Silica Reactivity for concrete with cementitious material with less than 20 % fly ash	15,000 tonnes	15,000 tonnes	1	1

15.5.7 Concrete production and supply

Details of the characteristics, lot sizes and testing frequencies for concrete supplies are included in Table 15.5.7.

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Table 15.5.7 – Testing of concrete production and supply

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
7-day Compressive Strength Non-Transition Lots	800 m^3	a day's continuous production or between construction joints	10 samples	10 samples
7-day Compressive Strength Transition Lots	each lot	each lot	1 sample per 50 m^3 with a minimum of 2 samples	1 sample per 50 m^3 with a minimum of 2 samples
28-day Compressive Strength Non-Transition Lots	800 m^3	a day's continuous production or between construction joints	10 samples	10 samples
28-day Compressive Strength Transition Lots	each lot	each lot	1 sample per 50 m^3 with a minimum of 2 samples	1 sample per 50 m^3 with a minimum of 2 samples
7-day Flexural Strength	first two lots used for 28-day compressive strength testing	not required	set of 6 samples for the first two lots	not required
28-day Flexural Strength	first two lots used for 28-day compressive strength testing	every tenth lot used for 28-day compressive strength testing	set of 6 samples for the first two lots	set of 6 samples every tenth lot
Drying Shrinkage	first two lots used for 28-day compressive strength testing	every tenth lot used for 28-day compressive strength testing	once for first two lots	once every tenth lot
Air Content	truck load	200 m^3	once per load	once per load
Mixer Uniformity	30,000 m^3	30,000 m^3	Clause 5.5.4	Clause 5.5.4
Chemical Content	5,000 m^3	10,000 m^3	once	once

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15.5.8 Consistency testing – slump testing requirements

Details of the events and activities tested for consistency are included in Table 15.5.8.

Table 15.5.8 – Consistency

Event	Activity
a) Commencement of slump testing on each class of work	Test every load prior to discharge until 8 consecutive conforming loads are tested. Calculate the standard deviation (SD) of test results from these 8 loads.
b) If SD > 8.0 mm:	Continue slumping every load until test results from any 8 consecutive loads have an SD < 8.0 mm.

Event	Activity
c) If SD ≤ 8.0 mm:	Go to process slump testing (d)
d) Process slump testing	Process slump testing involves slump testing every fourth load until a nonconforming slump is measured.
e) Nonconformance slump	Following a nonconformance, all loads thereafter shall be slump tested (prior to discharge) until the SD of test results from 6 consecutive loads is less than or equal to 8 mm. When this occurs, slump testing may revert to process slump testing of each fourth load as per (d).

15.5.9 Air content

Air content measurement shall be carried out on all air-entrained concrete prior to placement. Testing shall be carried out in accordance with AS 1012.4.2. Concurrently, the mass per unit volume of the freshly mixed concrete shall be determined in accordance with AS 1012.5.

Testing shall be carried out on production days at the following frequency:

a) one per load until three conforming results are obtained, and thereafter

b) one per 50 m^3 until four consecutive conforming results are obtained, and thereafter

c) one per 200 m^3 for the remainder of the day.

Testing under (b) and (c) shall be on batches of concrete from which cylinders are moulded for 28-day compressive strength under Clause 6.1.5.

If for any sample the measured air content is not within the limits specified (see Clause 5.4.4), one repeat test shall be made immediately from another portion of the same sample.

If the value obtained from the repeat test falls within the specified limits, the concrete represented by the sample shall be deemed to conform to the specified limits.

If the value obtained from the repeat test falls outside the specified limits, the testing frequency shall revert to that specified in Sub-Clause (a) above.

Concrete with an air content less than 3% or higher than 6% shall be deemed to be nonconforming and shall not be used in the base but may be used elsewhere in the works, subject to the concrete complying with the requirements for the particular application.

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15.5.10 Protection layer treatment

Details of the characteristics, lot sizes and testing frequencies for protection layer treatment are included in Table 15.5.10.

Table 15.5.10 – Testing of protection layer treatment

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
Wax as per MRTS42	Wax as per MRTS42	Wax as per MRTS42	Wax as per MRTS42	Wax as per MRTS42

15.5.11 Placement of concrete base

Details of the characteristics, lot sizes and testing frequencies for concrete base placement are included in Table 15.5.11.

Table 15.5.11 – Testing of placement of concrete base

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	**Reduced Level**	**Normal Level**	**Reduced Level**
Curing Compound				
Wax as per MRTS42				
Compliance of Curing Compound	batch	batch	once per batch	once per batch
Application Rate	standard lot	standard lot	once per 2000 m^2	once per 2000 m^2
Temperature				
Air and Concrete	same frequency as testing for consistency	same frequency as testing for consistency	same frequency as testing for consistency	same frequency as testing for consistency
Relative Compaction				
Non-Transition Lots	800 m^3	a day's continuous production or between construction joints	1 per 100 m^3 with a minimum of 2 cores and a maximum of 20 cores per lot	1 per 100 m^3 with a minimum of 2 cores and a maximum of 20 cores per lot
Transition Lots	each lot	each lot	1 per 50 m^3 with a minimum of 2 cores and a maximum of 10 cores	1 per 100 m^3 with a minimum of 2 cores and a maximum of 10 cores
Tie Bar Anchorage and Location	800 m^3	a day's continuous production or between construction joints	Clause 12.10	Clause 12.10
Geometrics, Non Transition Lots				
Horizontal Alignment	800 m^3	a day's continuous production or between construction joints	Clause 9.4	Clause 9.4

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Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
3 m Straight-Edge	800 m^3	a day's continuous production or between construction joints	one test per 50 m^2 and also, at each superelevation transition, at least 3 random locations within 10 metres of the transition.	one test per 150 m^2 and also, at each superelevation transition, at least 3 random locations within 10 metres of the transition.
Surface Heights	800 m^3	a day's continuous production or between construction joints	Clause 12.5	Clause 12.5
Thickness	800 m^3	a day's continuous production or between construction joints	Clause 12.6	Clause 12.6
Surface Evenness	whole road in no less than 100 metre stretches	whole road in no less than 100 metre stretches	once each lane	once each lane
Surface Texture				
Longitudinal & Transverse Texture Meter and Sand Patch	800 m^3	a day's continuous production or between construction joints	5 samples in each wheel path	5 samples in each wheel path
Geometrics, Transition Lots				
Horizontal Alignment	each lot	each lot	one	one
3 m Straight-Edge	each lot	each lot	one	one
Surface Heights	each lot	each lot	once as per Clause 12.5	once as per Clause 12.5
Thickness	each lot	each lot	once as per Clause 12.6	once as per Clause 12.6

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15.5.12 Pavement joints

Details of the characteristics, lot sizes and testing frequencies for pavement joints are included in Table 15.5.12.

Table 15.5.12 – Pavement joints testing

Characteristic Tested	Maximum Lot Size		Minimum Testing Frequency	
	Normal Level	Reduced Level	Normal Level	Reduced Level
Transverse Construction Joints	each joint	every third joint	inspect each joint	inspect each joint
Longitudinal Tied Joints – Sealant Installation Compliance	each joint	every third joint	inspect each joint	inspect each joint
Plain Base Transverse Contraction Joints- Sealant Installation Compliance	each joint	every third joint	inspect each joint	inspect each joint
Other Joints	each joint	every third joint	inspect each joint	inspect each joint
Sealant Characteristic Compliance	batch	batch	Once	once
Filler Characteristic Compliance	batch	batch	Once	once
Longitudinal Tied Joints – Tie Bar Pull-out	As per Clause 12.10	As per Clause 12.10	As per Clause 12.10	As per Clause 12.10

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15.5.13 Edge drains

15.5.13.1 Unbound granular filter material and aggregate for no fines concrete

Details of the characteristics and testing frequencies for combined aggregate in lot sizes of 5,000 tonnes are included in Table 15.5.13.1.

Table 15.5.13.1 – Testing of combined aggregate for non fines concrete

Property	Test Frequency	
	Normal	Reduced
Ten Percent Fines Value (wet) (standard test)	1	1
Wet/Dry Variation (standard test)	1	1
Wet/Dry Variation (size)	1 per 10 lots	1 per 20 lots
Crushed Faces	3	1
Flakiness Index	3	1
Water Absorption	1	1
Degradation Factor	1	1
Weak Particles	2	1
Material Finer than 0.300 mm	2	1

15.5.13.2 No fines concrete

Details of the characteristics and testing frequencies for combined aggregate in lot sizes of 1000 tonnes are included in Table 15.5.13.2.

Table 15.5.13.2 – Non fines concrete testing

Property	Test Frequency	
	Normal	Reduced
Grading	1	1
28-day Compressive Strength	1	1

15.5.13.3 Perforated plastic pipe, geotextile, fittings

Lot Size: Each delivery of each product

Details of the characteristics and testing frequencies for perforated plastic pipes, geotextiles and fittings are included in Table 15.5.13.3.

Table 15.5.13.3 – Perforated plastic pipe, geotextile, fittings testing

Property	Test Frequency per Lot	
	Normal	Reduced
Referenced Properties	1	1

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