DELIVERING FOR QUEENSLAND

Technical Specification

Transport and Main Roads Specifications
MRTS40 Concrete Pavement Base

May 2026

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Queensland Government

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Feedback

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Purpose

This ancillary document outlines the adopted national Austroads Technical Specification ATS 3530 *Concrete Pavement Base* and modified Queensland-specific content with tracked changes.

The following table summarises the relationship between the Austroads Technical Specification ATS 3530 *Concrete Pavement Base* and this document:

Type of Content	Display
National content adopted	National content adopted
National content not adopted	~~National content not adopted~~
Queensland-specific content	Queensland-specific content

About this document

The document adopts and modifies Austroads Technical Specification ATS 3530 *Concrete Pavement Base* as part of national harmonisation. It sets out the requirements for the supply of concrete and construction of concrete base in large-scale applications that carry substantial traffic volumes, such as highways, arterial roads and busways.

How to use this document

This document includes the national guidance and Queensland-specific advice while following the structure established in Austroads Technical Specifications.

Queensland-specific advice includes practices which vary from national practice because of local environmental conditions (such as geography, soil types, climate); different funding practices; local research; local legislation requirements; and to expand instruction on particular issues.

This document:

- sets out how the Austroads Technical Specification ATS 3530 *Concrete Pavement Base* applies in Queensland
- has precedence over the Austroads Technical Specification ATS 3530 *Concrete Pavement Base* when applied in Queensland
- has the same clause numbering and headings as the Austroads Technical Specification ATS 3530 *Concrete Pavement Base*.

Transport and Mains Roads provides an ancillary document which outlines adopted national and modified Queensland-specific content with tracked changes. To access a copy click on the below link: Ancillary documents for harmonised Technical Specifications.

Terminology

The following general amended definitions apply when reading this document.

Reference to...	Means
Shall	Denotes mandatory requirements

Reference to...	Means
Must	Denotes mandatory requirements
Principal	The State of Queensland acting through the Department of Transport and Main Roads.
Administrator	The Administrator will be responsible for the overall administration of this Contract.

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1 Scope

1.1 This~~Austroads~~ Technical Specification ~~ATS 3530~~ sets out the requirements for the supply of concrete and construction of the base (upper) layer of the following formats:

a) plain concrete pavement (PCP)

b) continuously reinforced concrete pavement (CRCP)

c) jointed reinforced concrete pavement (JRCP), and

d) steel fibre reinforced concrete pavement (SFCP), for which the provisions of Clause 32 apply.

1.2 It includes the requirements for:

a) constituent materials for concrete

b) concrete mix design

c) process control and manufacture of base

d) end product criteria for base, and

e) quality systems, minimum process standards, plant, sampling and testing.

1.3 This Technical Specification covers the construction of road pavements in large-scale applications that carry substantial traffic volumes ~~of commercial road vehicles~~, such as highways, arterial roads and busways. It is not applicable to other applications (such as industrial, commercial or residential pavements, bus bays and minor roads) without suitable modification.

MRTS41 *Concrete Pavement Base (Ancillary Works)* should be used for concrete road pavements in small-scale applications. MRTS41 *Concrete Pavement Base (Ancillary Works)* applies to the construction of concrete pavement base in ancillary works using fixed forms.

Examples of ancillary works are:

- bus interchanges
- bus parking facilities
- car parking facilities
- indented bus bays
- intersections/roundabouts
- floodways, and
- short sections of widening of existing concrete pavements.

1.4 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.

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

The Administrator should implement an audit and surveillance plan. Typically, a minimum of 10% of lots should be audited on the department's projects. An increased or reduced frequency may apply based on the Contractor's historical performance and the project's risk profile.

2 Referenced documents

2.1 ~~The following documents are referenced in this specification:~~The requirements of the referenced documents listed in Table 2.1 below apply to this Technical Specification. Where there are inconsistencies between this Technical Specification and the referenced documents, the requirements in this Technical Specification shall take precedence.

Table 2.1 – Reference documents

Reference	Title
Australian / New Zealand Standards	
AS 1012	*Methods of testing concrete*
AS 1012.1 ~~Method 1~~	*Sampling of concrete*
AS 1012.3.1 ~~Method 3.1~~	*Determination of properties related to the consistency of concrete – Slump test*
AS 1012.3.3 ~~Method 3.3~~	*Determination of properties related to the consistency of concrete – Vebe test*
AS 1012.4.2 ~~Method 4.2~~	*Determination of air content of freshly mixed concrete – Measuring reduction in air pressure in chamber above concrete*
AS 1012.5 ~~Method 5~~	*Determination of mass per unit volume of freshly mixed concrete*
AS 1012.6	*Determination of bleeding of concrete*
AS 1012.8.1 ~~Method 8.1~~	*Method for making and curing concrete – Compression and indirect tensile test specimens*
AS 1012.8.2 ~~Method 8.2~~	*Method for making and curing concrete – Flexure test specimens*
AS 1012.9 ~~Method 9~~	*Compressive strength tests – Concrete, mortar and grout specimens*
AS 1012.10	*Determination of indirect tensile strength of concrete cylinders ('Brazil' or splitting test)*
AS 1012.11 ~~Method 11~~	*Determination of the modulus of rupture*
AS 1012.12.2 ~~Method 12.2~~	*Determination of mass per unit volume of hardened concrete – Water displacement method*
AS 1012.13 ~~Method 13~~	*Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory*
AS 1012.14 ~~Method 14~~	*Method for s~~S~~ecuring and testing cores from hardened concrete for compressive strength and mass per unit volume*
AS 1012.20.1 ~~Method 20.1~~	*Determination of chloride and sulfate in hardened concrete and ~~concrete~~ aggregates – Nitric acid extraction method*
AS 1141	*Methods for sampling and testing aggregates*
AS 1141.3.1 ~~Method 3.1~~	*Sampling – Aggregates*

Reference	Title
AS 1141.4 ~~Method 4~~	*Bulk density of aggregate*
AS 1141.5 ~~Method 5~~	*Particle density and water absorption of fine aggregate*
AS 1141.6.1 ~~Method 6.1~~	*Particle density and water absorption of coarse aggregate – Weighing-in-water method*
~~AS 1141 Method 6.2~~	~~*Particle density and water absorption of coarse aggregate – Pycnometer method*~~
AS 1141.11.1 ~~Method 11.1~~	*Particle size distribution – Sieving method*
AS 1141.12 ~~Method 12~~	*Materials finer than 75 µm in aggregates (by washing)*
AS 1141.13 ~~Method 13~~	*Material finer than 2 µm*
AS 1141.14 ~~Method 14~~	*Particle shape, by proportional caliper*
AS 1141.15	*Flakiness Index*
AS 1141.18 ~~Method 18~~	*Crushed particles in coarse aggregate derived from gravel*
~~AS 1141 Method 20.1~~	~~*Average least dimension – Direct measurement (nominal size 10 mm and greater)*~~
AS 1141.20.3	*Average least dimension – Calculation (nomograph)*
AS 1141.22 ~~Method 22~~	*Wet/dry strength variation*
AS 1141.24 ~~Method 24~~	*Aggregate soundness – Evaluation by exposure to sodium sulphate solution*
AS 1141.31 ~~Method 31~~	*Light particles*
AS 1141.32 ~~Method 32~~	*Weak particles (including clay lumps, soft and friable particles) in coarse aggregates*
AS 1141.34 ~~Method 34~~	*Organic impurities other than sugar*
AS 1141.35 ~~Method 35~~	~~*Sugar*~~*Detection of sugar contamination in concrete aggregates*
~~AS 1141 Method 60.1~~	~~*Potential alkali-silica reactivity – Accelerated mortar bar method*~~

Reference	Title
~~AS 1141 Method 60.2~~	~~*Potential alkali-silica reactivity – Concrete prism method*~~
AS 1141.66 ~~Method 66~~	*Methylene blue adsorption value of fine aggregate and mineral fillers*
AS 1289	*Methods of testing soils for engineering purposes*
~~AS 1289 Method 4.1.1~~	~~*Soil chemical tests – Determination of the organic matter content of a soil – Normal method*~~
AS 1289.1.4.2	*Sampling and preparation of soils - Selection of sampling or test sites - Stratified random number method*
AS 1289.4.2.1 ~~Method 4.2.1~~	*Soil chemical tests – Determination of the sulfate content of a natural soil and the sulfate content of the groundwater – Normal method*
AS 1379	*Specification and supply of concrete*
AS 1478.1	*Chemical admixtures for concrete, mortar and grout- Admixtures for concrete*
~~AS 2008~~	~~*Bitumen for pavements*~~
AS/NZS 2310	*Glossary of paint and painting terms*
AS 2341.18	*Methods of testing bitumen and related roadmaking products – Determination of softening point (ring and ball method)*
AS 2350.2	*Methods of testing Portland, blended and masonry cements – Chemical composition*
AS 2350.8	*Methods of testing Portland and blended cements – Fineness index of Portland cement by air permeability*
AS 2706	*Numerical values – Rounding and interpretation of limiting values*
AS 2758.1	*Aggregates and rock for engineering purposes – Part 1: Concrete aggregates*
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 and Blended Cement - Slag - Ground Granulated Iron Blast-Furnace*
AS 3600	*Concrete structures*
AS 3679.1	*Structural Steel - Hot-rolled Bars and Sections*
AS 3799	*Liquid membrane-forming curing compounds for concrete*
AS 3940	*Quality control – Guide to the use of control chart methods including Cusum techniques*
AS 3942	*Quality control – Variables charts – Guide*

Reference	Title
AS 3972	*General Purpose and Blended Cements*
~~AS/NZS 4671~~	~~*Steel reinforcing materials*~~
AS/NZS 4680	*Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*
AS/NZS ISO 9001	*Quality management systems – Requirements*
AS ISO/IEC 17000	*Conformity assessment – Vocabulary and general principles*
AS ISO/IEC 17025	*General requirements for the competence of testing and calibration laboratories*
Austroads	
~~ATS 1120~~	~~*Quality Management Requirements*~~
ATS 2245	*Kerb and Channel*
~~ATS 3050~~	~~*Supply of Recycled Crushed Glass Sand*~~
ATS 3505	*Preformed Joint Filler for Concrete Road Pavements and Structures*
~~ATS 3520~~	~~*Lean-mix Concrete Subbase*~~
ATS 3550	*Diamond Grinding of Concrete Pavement*
~~ATS 4110~~	~~*Longitudinal Pavement Marking*~~
~~ATS 5310~~	~~*Steel for the Reinforcement of Concrete*~~
~~AGAM-T001~~	~~*Pavement Roughness Measurement with an Inertial Profilometer*~~
~~AGAM-T013~~	~~*Pavement Surface Texture Measurement with a Laser Profilometer*~~
~~AGPT-T~~ATM 250	*Modified Surface Texture Depth (Pestle Method)*
ATM 453	*Surface Deviation Using a Straightedge*
Australian Technical Infrastructure Committee	
ATIC-SPEC SP43	*Cementitious Materials for Concrete*
International / European Standards	
EN 14889-1	*Fibres for concrete – Part 1: Steel fibres – Definitions, specifications and conformity*
ASTM International	
ASTM-C603	*Standard Test Method for Extrusion Rate and Application Life of Elastomeric Sealants*
ATSM-C661	*Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer*
ASTM-C679	*Standard Test Method for Tack-Free Time of Elastomeric Sealants*

Reference	Title
ASTM-C793	*Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants*
ASTM-C794	*Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants*
ASTM-C1064M	*Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete*
ASTM-D792	*Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement*
~~ASTM-D7428~~	~~*Standard Test Method for Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus*~~
~~ASTM E384-11~~	~~*Standard Test Method for Knoop and Vickers Hardness of Materials*~~
Transport for New South Wales	
Standard Drawing DS2012/001191	*Plain concrete pavement (PCP) – construction (TS 02732)*
Standard Drawing DS2012/001190	*Continuously reinforced concrete pavement (CRCP) – construction (TS 02731)*
Standard Drawing DS2014/005559	*Jointed reinforced concrete pavement (JRCP) – construction (TS 02733)*
Standard Drawing DS2013/001895	*Steel fibre reinforced concrete pavement (SFCP) for roundabouts (TS 02734)*
Standard Drawing DS2013/001838	*Plain concrete pavement (PCP) – maintenance (TS 02735)*
~~TfNSW T183~~	~~*Surface Deviation Using a Straightedge*~~
TfNSW T192	*Determination of the texture depth of road surfacing by the TRL mini texture meter (TS 02795.50)*
~~TfNSW T215~~	~~*Wet/Dry Strength Variation (TS 02799.13)*~~
~~TfNSW T239~~	~~*Fractured Faces of Coarse Aggregate*~~
~~TfNSW T240~~	~~*Road Surface Texture Depth (Sand Patch)*~~
~~TfNSW T276~~	~~*Foreign Materials Content of Recycled Crushed Concrete (TS 02799.51)*~~
TfNSW T279	*Flow Time and Voids Content of Fine Aggregate by Flow Cone (TS 02799.54)*
TfNSW T304	*Moulding of Concrete Specimens for Testing in Compression, Indirect Tension and Flexure (TS 02800.05)* ~~*Drying Shrinkage of 100 x 100 x 280 mm Concrete Prisms (TS 02800.21)*~~
TfNSW T329	*Wet Sieving of Concrete (TS 02800.26)*
TfNSW T366	*Dowel Pull-Out Test (TS 02800.41)*

Reference	Title
TfNSW T367	*Field Simulated Curing And Testing of Moulded Concrete Specimens (TS 02800.42)*
TfNSW T368	*Dressing of Voids in Concrete Specimens and Unit Mass Adjustment for Embedded Steel (TS 02800.43)*
~~TfNSW T369~~	~~*Longitudinal Profile Testing*~~
TfNSW T379	*Cleanliness of Sawn Concrete Pavement Joints (TS 02800.53)*
TfNSW T380	*Field Adhesion of Joint Sealant to Concrete (TS 02800.54)*
TfNSW T381	*Relative Compaction of Pavement Concrete (TS 02800.55)*
~~TfNSW T659~~	~~*Methylene Blue Adsorption Value Of Road Construction Material (TS 02806.36)*~~
TfNSW T862	*Stability of Wax Emulsion Curing Compound (TS 02809.16)*
TfNSW T1005	*Recording the Infrared Spectrum of Materials (TS 02811.05)*
TfNSW T1192	*Adhesion of Sealant (TS 02816.01)*
TfNSW T1193	*Accelerated Aging of Cured Sealant (TS 02816.02)*
~~Texas Department of Transportation document~~	
~~Tex-612-J~~	~~*Acid insoluble residue for fine aggregate*~~
Transport and Main Roads Technical Documents	
MRTS01	*Introduction to Technical Specifications*
MRTS03	*Drainage Structures, Retaining Structures and Slope Protections*
MRTS05	*Unbound Pavements*
MRTS17	*Bitumen and Multigrade Bitumen*
MRTS36	*Recycled Glass Aggregate*
MRTS39	*Lean-mix Concrete Subbase*
MRTS45	*Road Surface Delineation*
MRTS50	*Specific Quality Systems – Requirements*
MRTS51	*Environmental Management*
MRTS70	*Concrete*
MRTS71	*Reinforcing Steel*
Q188	*Petrographic Assessment of Aggregates*
Q208B	*Degradation Factor of Coarse Aggregate*
Q229A	*Resistance to Degradation by Abrasion of Fine Aggregate (Micro-Deval)*

Reference	Title
Q708B	*Road Roughness – Surface Evenness – Two Laser Profilometer*
Q708D	*Road Roughness – Surface Evenness – Walking Profiler*
Q712	*Surface Evenness of Road Surface – Three Metre Straightedge*
QRS	*Quarry Registration System*
TMR Surveying Standards	*TMR Surveying Standards*
-	*Supplier Registration Scheme: Bridges and Other Structures*

3 Definitions

3.1 In addition to the definitions in AS 1379, the following definitions apply to this Technical Specification.

Table 3.1 – Definitions of terms

Definition	Term
Agitator	An item of plant or equipment that maintains the plastic concrete in the mixed state. Consistent with common usage, this term is also used (for convenience) in lieu of 'mobile mixer'.
AF	Age correction factor; refer to Clauses 26.16 to 26.~~20~~18.
~~AGD~~	~~Average Greatest Dimension (of aggregate); refer to Clause 5.9.~~
~~ALD~~	~~Average Least Dimension (of aggregate); refer to Clause 5.9.~~
Anchor slab	The base slab which lies over a slab anchor. See also 'Slab anchor'.
Approach sections	Pavement which is located within 30 m of bridges (or other structures) where the concrete base is discontinuous, or within 30 m of contract limits.
Base	The uppermost pavement structural layer.
Batch	A quantity of concrete containing a fixed amount of ingredients and produced in a discrete operation.
Batching	The process of combining the concrete ingredients in fixed proportions by mass or by volume, including charging and mixing.
Blended cement	As defined in Clause 5. See also 'Cement'.
Cement	A hydraulic cement, as defined in Clause 5, that is manufactured by inter-grinding of Portland cement clinker, calcium sulphate and optional mineral or minor constituents. If blended with supplementary constituents by the manufacturer, it is referred to as 'blended cement'.

Definition	Term
Cementitious	Cements and supplementary cementitious materials, as defined in Clause 5.
Charging (of mixer)	The introduction of constituent materials of the concrete into the mixer, but excluding the addition of water at the slump stand in order to obtain the desired slump.
Coefficient of variation	Ratio of the standard deviation of the test values to the mean of test values multiplied by 100. For 28 day flexural strength, the coefficient of variation is calculated as the ratio of the 5-point rolling standard deviation to the 5-point rolling mean multiplied by 100.
Completion of Batching	a) For a stationary batch mixer discharging into a storage bin or tipper truck, this will be the time at which discharge from the mixer commences. b) For a stationary batch mixer discharging into a mobile mixer, this will be the time at which mixing and slump adjustment ceases at the batching plant or 10 minutes after the completion of charging of the stationary mixer, whichever occurs first. c) For direct charging into a mobile mixer, this will be the time at which mixing and slump adjustment ceases or 10 minutes after the completion of charging, whichever occurs first. d) For a continuous mixer discharging into a tipper truck, this will be the time at which discharge into the truck commences. e) For a continuous mixer discharging into a storage bin, this will be the time of earliest discharge (from the mixer) of that concrete within the bin.
Conformity assessment body	As defined in AS ISO/IEC 17000.
Curing Classes 1, 2 and 3	Refer to Clause 16.
Debond / Debonding treatment	The application of a material to a surface to prevent the formation of bond between the base concrete and the subbase concrete.
Diamond grinding	A surface treatment which conforms to Clause 31 and ATS 3550.
Dowel	Or dowel bar; a round steel bar intended to allow joint opening but to minimise relative shear displacements across the joint.
Drill-tie	A deformed tiebar which is fixed by drilling into existing concrete.
Edge, free	This term is used in the context of limiting all restraint against the free 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.

Definition	Term
Edge, outer (of base)	An edge against which material other than base concrete is to be placed (such as granular backfill, kerb concrete or no fines concrete).
Edge, relief	See 'Relief edge'.
Fixed-form paving	Also referred to as 'manual paving' and 'hand paving'. Paving between fixed formwork using manually operated equipment such as internal vibrators and vibrating screeds.
Formed joint	All joints, except for induced joints. This includes slipformed and fixed-formed joints.
Forming time	The elapsed time measured from the completion of batching to the incorporation of the concrete into the Works, including compaction and hand finishing, but excluding texturing.
Grooving	A surface treatment to produce specified texturing using equipment which conforms to Clause 15.
Joint	A planned discontinuity in the concrete, including an edge, and which conforms to Clause 19.
Joint, mismatched	A joint which terminates at a junction with an adjoining slab. Tied joints may mismatch without restriction. Untied joints are subject to restrictions in accordance with Clause 19.69.
Jointed base	A grouping of PCP, PCP-R, JRCP, SFCP and SFCP-R. In other words, all base formats covered by this Technical Specification, except for CRCP.
Kerb, extruded	A kerb which is paved with a machine that does not impart internal vibration and progresses using a piston mechanism.
Kerb, slipformed	A kerb which is paved with a machine that conforms to Clause 12.9.
Lapped splice (in reinforcement)	A splice in which the bars are in contact over the full lapped length, with at least 2 ties located to ensure bar contact in the hardened concrete.
Load	A single truckload of concrete comprising one or more batches.
Lot	For concrete base, a Lot is a continuous portion of the end product produced within a single day at a discrete location. Concrete base will be assessed on the basis of Sub-Lots, as defined. If the Contractor chooses to define a Lot by a different method, the method must be detailed in the Quality Plan in accordance with ~~ATS 1120~~MRTS50 *Specific Quality System Requirements*. See also 'Sub-Lot' and 'Transition Sub-Lot'.
MBV	Methylene Blue Adsorption Value.

Definition	Term
Mixers	a) **Stationary mixer**: a mixer in a fixed location adjacent to the batching equipment. This category includes stationary batch mixers (such as split-drums and twin-shafts) and stationary continuous mixers. **Stationary batch mixer**: a mixer that produces a fixed amount of concrete produced in a discrete operation. **Stationary continuous mixer or through mixer**: a mixer where ingredients are continuously added to one end of the chamber, while mixed concrete is continuously discharged from the other end. b) **Mobile mixer (or agitator)**: a truck-mounted drum mixer that is used for mixing and delivery. Mobile mixer can function both as a mixer and an agitator. Refer to AS 1379 Clauses 4.2 and 4.3 for further information.
Mixing time	As defined in Clause 10.43. Applicable to batch mixers only.
Monolithic	Constituting a single uniform homogeneous element of concrete between planned joints and/or edges, or a section of concrete of uniform composition and properties which will act as a single structural element.
MUV	Mass per Unit Volume; refer to Clause 33.3.
Odd-shaped slab	See ‘Slab, odd-shaped’.
Paving run	A single length of pavement placed as one continuous pour without an interruption to paving that requires a transverse construction joint.
Process mean	$\overline{\overline{X}}$; see ‘Symbols’.
Ramp junction zones	Refer to Figure 29.7.
Re-entrant angle	An angle formed by joints and/or edges that point inwards towards the concrete slab (for example, at a drainage pit).
Relative compaction	The percentage ratio of the core unit mass of the Sub-Lot to the representative cylinder unit mass (RCUM) for the Sub-Lot. In the case of SFCP, it is the percentage ratio of the core unit mass of the Sub-Lot to the representative beam unit mass (RBUM) for the Sub-Lot.
Relief edge	An edge or joint which relieves contraction stresses in joints and/or sections which are aligned approximately parallel with the joint (or section) under design. A relief edge is provided by an untied joint or by a free edge or by an expansion or isolation joint.
Relief-edge distance (RED)	The distance measured from the joint (or section) under design to the nearest relief edge which is aligned in such a way that it will limit the design stress. The value for RED must take into account all stress contributors such as connected kerbs and barriers. Allowance may also need to be made for likely future widenings.

Definition	Term
Representative beam unit mass	Refer to Clause 32.4442.
Representative cylinder unit mass	Refer to Clause 25.10.
Retemper	The addition of water to a batch after 'completion of batching' to restore consistence. See also 'Temper'. The addition of an admixture (such as a high range water reducer) is not considered to constitute retempering.
Rolling statistical results	Calculated using groups of consecutive results, with progression in single increments.
SF	Shape correction factor; refer to Clauses 26.16 to 26.2018.
Skew, Road	Applicable at locations such as bridge abutments, it is the complement of the Bridge Skew (i.e. 90° minus the Bridge Skew).
Slab	A portion of concrete bounded by joints and/or edges. In jointed pavements, tied transverse construction joints are ignored for the purpose of measuring 'slab length'.
Slab, odd-shaped	a) A slab containing a blockout (for example, for a drainage structure), or b) A slab whose dimensional limits exceed those specified in the Drawings. If dimensions, measured normal and parallel to longitudinal joints, are variable within a slab, the maximum value of the ratio applies.
Slab anchor	A restraining beam cast in the ground, on which a base slab is later cast.
Slab anchor, terminal	A slab anchor where the overlying base slab is a terminal slab.
Slab anchor, intermediate	A slab anchor where the overlying base slab is not a terminal slab.
Slipform paving	Also referred to as 'mechanical paving' and 'machine paving'. Paving by a purpose-built machine with the capacity to spread, compact, screed and finish the concrete in accordance with this Technical Specification and without fixed formwork. Where a slipformer is used over fixed forms, such work is deemed to conform to this definition.
Squared standard deviation	s^2; refer to ~~Clause 3~~Table 3.1(c).
Stitch bar	A deformed reinforcing bar which is installed by angled drilling from the top surface.

Definition	Term
Sub-Lot	Concrete base will be assessed on the basis of Sub-Lots. A Sub-Lot is defined as a continuous pour of volume: • up to 50 m³ for slipformed base, and • up to 30 m³ for fixed-formed base. In transition zones, Sub-Lots are generated in accordance with Clause 25.2. If the Contractor elects to define a Sub-Lot by a method that is different to (a) and (b) above, details the method must be included in the Quality Plan. The details must include how the method incorporates the requirements of (a) and (b) above.
Temper	The addition of water, and mixing of concrete (or mortar), to bring it initially to the required consistence. See also 'Retemper'.
Test result	The result from a single test specimen or sample.
Test value	The value calculated from single test results to represent the Sub-Lot (in accordance with relevant clauses of this Technical Specification). For example, single cylinder compressive strength results are averaged (after application of correction factors) to derive a test value.
Tiebar	A deformed reinforcing bar intended to hold joints closed whilst allowing hinge movement. See also 'Stitch bar'.
Tining	A surface texture applied to the plastic concrete in accordance with Clause 15.
Total fine aggregates	The sum of the fine aggregates as proposed and/or supplied in accordance with Clause 5.8 and excluding fines which are contained within the coarse aggregates.
Trafficked slab	A slab (bounded by longitudinal joints and/or edges) which lies either totally or in part within the trafficked carriageway, as defined by lane lines.
Transition Sub-Lot	A Sub-Lot that falls within a transition zone (as defined).
Transition zone	Hand vibrated concrete which is cast with otherwise machine-paved concrete, such as at transverse construction joints in machine-paved work. Refer to Clause 25.2.

Term	Definition
Transition point	The point at which vibration on a paving machine commences or ceases effective compaction. Examples include: a) transition zones b) boundary of a zone where a vibrator becomes faulty or irregular, and c) boundary of a zone where operation of paver becomes unsystematic and/or nonconforming. A periodic interruption to paving (due, for example, to irregular concrete supply) does not necessarily constitute a transition point.
Vebe test	A flow test on a vibrating table used as a measure of workability in stiff mixes.
Wet curing	Curing in which the concrete surface is maintained in a wet condition. For test specimens, this can be achieved by placing in a fog room / chamber with a relative humidity exceeding 98%.
Yielded cubic metre	As per the determination of mass per unit volume in accordance with AS 1012.5.

Table 3.1(b) – Definitions of Abbreviations

Abbreviation	Definition
ACRS	Australasian Certification Authority for Reinforcing and Structural Steels
ATIC	Australian Technical Infrastructure Committee
~~CMRS~~	~~Cementitious Materials Registration Scheme~~
CRCP	Continuously reinforced concrete pavement (base)
GGBFS	Ground granulated (iron) blast-furnace slag
IANZ	International Accreditation New Zealand
JRCP	Jointed reinforced concrete pavement (base), dowelled
LCS	Lean-mix concrete subbase
MBV	Methylene Blue Adsorption Value
NATA	National Association of Testing Authorities, Australia
PCP	Plain concrete pavement (base)
PCP-R	Discrete reinforced slabs within PCP (base)
SCM	Supplementary cementitious material
SFCP	Steel fibre reinforced concrete pavement (base)
SFCP-R	Discrete mesh-reinforced slabs of steel fibre reinforced concrete pavement (base)

Abbreviation	Definition
SFRC	Steel fibre reinforced concrete

Table 3.1(c) - Definitions of Symbols

Symbol	Definition
F_{28Min}	The specified minimum 28 day (cylinder) compressive strength in the trial mix
F_{28}	The actual 28 day (cylinder) compressive strength in the trial mix
F_{7}	The actual 7 day (cylinder) compressive strength in the trial mix
F_{f28Min}	The specified minimum 28 day flexural strength in the trial mix
F_{f7}, F_{f28}	The actual 7 day and 28 day flexural strengths in the trial mix
F_{ft28}	The actual 28 day indirect tensile strength in the trial mix
f_{cMin}	Specified minimum 28 day (cylinder) compressive strength in the Works
f_{c}	Actual 28 day (cylinder) compressive strength in the Works
f_{c7}	Actual 7 day (cylinder) compressive strength in the Works
f_{fMin}	Specified minimum 28 day flexural strength in the Works
f_{f}	The actual 28 day flexural strength in the Work
F_{sf}	Fibre factor for steel fibre reinforcement
K_{f}	Steel fibre bond coefficient
MT_{min}	Minimum mixing time determined in accordance with Clause 10.43 c)
S	Standard deviation
$\bar{\bar{X}}$	Process mean
S_{100}	Process standard deviation calculated on a rolling basis notionally using 100 values. Refer to Clause 10
S_{30}	Process standard deviation calculated on a rolling basis notionally using 30 values. Refer to Clause 10
S_{5}	Five-point rolling standard deviation
V_{f}	Steel fibre content (per cent volume) of a mix

Note: In relation to concrete strengths, the leading uppercase ‘F’ refers to results in the trial mix. The leading lowercase ‘f’ refers to results in the work.

4 Quality System Requirements

4.1 The Contractor must prepare and implement a Quality Plan for the work in accordance with the requirements of MRTS50 Specific Quality System Requirements. The Quality Plan must also ~~that~~ include~~s~~ the documentation in Table 4.1.
Hold Point 1 Record

It is anticipated that the initial submission of the Quality Plan will establish the structure for concrete pavement works for the remainder of the Contract. However, it is expected that ongoing updates to the Quality Plan will be required to reflect changes in the work methodology that are associated with progress of the works under the Contract.

In this sense, the Quality Plan is considered to be a 'living' document.

Table 4.1 – Quality plan

Clause	Description of document
3.1	If applicable, the method of defining a Sub-Lot which varies from the definition given in Clause 3.1.
5.23~~c)~~	Criteria for initiating changes in admixture type with changes in season and dosage rate charts for various temperature ranges.
5.~~40~~38	Joint sealant details, certification and method of installation.
9.39	Dowel support system and method of debonding.
9.49	Proposal to bend anchor stirrups.
10.41	Methodology for materials handling, batching and mixing.
10.45	Method of incorporation of admixtures in the mix.
10.56	Procedure for monitoring of identification certificate for compliance with batching requirements.
10.71	Details of the Contractor's representative who is nominated to monitor retempering.
10.73	Procedure for monitoring of concrete supply for conformity with retempering provisions.
10.75	Procedure to determine maximum forming time.
11.1	Name, qualification(s) and experience of the Paving Supervisor and details of concrete paving crew training for other personnel.
12.4	Details of the equipment and methods to be used for placing, spreading and finishing the concrete.

Clause	Description of document
12.8	Details of the equipment and methods to be used for placing, spreading and finishing slipform paving, including operating parameters for each proposed slipform paving configuration.
12.11	Details of system to provide indication of malfunction of individual vibrator.
12.21	Equipment and methods for placing, spreading and finishing concrete for fixed-form paving.
12.38	Method of traceability of loads of concrete placed.
14.1	Details of meteorological data to be collected, and measures to restrict evaporation and to limit incidence of plastic shrinkage cracking.
15.3	Details of the procedures and equipment proposed to complete the surface texture.
16.6	Supplier's recommended procedures for storage and agitation of curing compounds under varying weather conditions.
16.18	Procedures for Class 3 curing.
17.2	Procedures and equipment proposed for the protection of concrete from low air temperatures.
17.7	Procedures and equipment proposed to protect the concrete from rain damage.
19.8	Procedures and equipment for joint sealing.
19.35	Procedure for temporary sealing.
22.3	Method of paving over anchor slabs.
24.1	Inspection schedule for cracking in base slabs.
27.11 ~~a)~~	Method of calculating adjusted thickness from survey.

HOLD POINT 1	
Process Held	Commencement of concrete production.
Submission Details	The Quality Plan must be provided to the ~~Principal~~ Administrator at least 10 working days prior to the commencement of work on site.

5 Materials

Aggregates – General

5.1 Coarse aggregate and fine aggregate must be supplied by a quarry registered and operated in accordance with the department's Quarry Registration System (QRS) requirements. The current Quarry Registration Certificate, including its Testing Frequency Schedule, must be submitted to the Administrator as part of the mix design submission. For a QRS registered quarry source that does not have a testing frequency schedule nominated on the Quarry Registration Certificate, the default level testing frequencies stated in the QRS apply.~~If a prequalification/registration scheme for pavement materials is applicable to the jurisdiction where the work is carried out, the supplier of the aggregates must be prequalified or registered (as applicable) under that scheme.~~

5.2 The Contractor must notify the Administrator within 3 business days of any change to the Quarry Registration Certificate, including its Testing Frequency Schedule.~~Aggregates for base concrete must consist of clean, durable materials sourced from natural gravel, crushed stone, air-cooled iron blast-furnace slag and sand. Basic oxygen and electric arc furnace steel slag aggregates are not acceptable.~~

5.3 For each quarry that will supply material(s) to be used in the Works, the Contractor must prepare a construction procedure for aggregate production in accordance with Clause 6 of MRTS50 *Specific Quality System Requirements* and detail the following for each nominated material~~Aggregates must be sourced from stockpiles at the batch plant or quarry and which are certified as conforming. Stockpiles must comply with the following~~:

a) area (e.g. face number, bench number and reduced level) of the quarry from which the material in the lot will be won~~Stockpiles must be formed on clear, even, well-drained, firm ground or constructed floor, and construct them separated from each other in such a way as to prevent cross-contamination and segregation.~~

b) production process and method of winning the materials~~The maximum Lot size is 4000 tonnes.~~

c) procedures for stockpile management and traceability as part of lot control and, as applicable, stockpile sub-lot control, and~~The materials must be stockpiled such that:~~

~~i. each stockpile represents only one Lot, or~~

~~the stockpile is formed into incremental Lots, certified for conformity and signposted in sections throughout its continuous placement.~~

d) quality control procedures~~Stockpiles must be clearly and uniquely by signposting which indicates the Lot identification, type and quantity of material~~.

The aggregate production procedure must be submitted to the Administrator at least seven days prior to the commencement of aggregate production for the Works.
Record

Combined aggregates

5.4 The specified particle size distributions are based on materials of equal particle densities in a saturated surface dry condition. Where particle densities differ by more than 20%, the specified combined particle size distribution must be adjusted accordingly.

5.5 The ~~Principal~~ Administrator may approve an alternative combined aggregate particle size distribution where:

a) the variations are limited to the fractions retained on the 300 µm sieve and above, and

b) an alternative procedure for assessment has been submitted and accepted by the ~~Principal~~Administrator.

5.6 The aggregate particle size distribution must be provided with the nominated mix submission.

5.7 The particle size distribution of combined aggregates, determined in accordance with AS 1141.11.1, must conform to Table 5.7.

Table 5.7 – Combined aggregate particle size distribution

Sieve (mm/mm)	Percent passing by mass
19.00	95–100
13.20	75–90
9.50	55–75
6.70	45–62[(1)]

Sieve (mm/mm)	Percent passing by mass
4.75	38–50
2.36	30–42
1.18	22–34
600 µm	16–30
300 µm	5–15
150 µm	0–7
75 µm(2)	0–4(3)
2 µm(3)	0–1.0(3)

Notes:

(1) If specified in the contract document~~s, the values in brackets are for reporting only and do not constitute acceptance criteria~~.

(2) Determine in accordance with AS 1141.12 (calculated washed blend).

(3) Assess acceptance in accordance with Clause 5.~~2~~8.

Fine aggregate

5.8 Fine aggregate must conform to MRTS70 *Concrete* requirements for fine aggregate in Special Class concrete and the additional requirements in~~AS 2758.1, except as qualified in~~ Table 5.8. Minimum testing frequencies for fine aggregate, including for properties specified in MRTS70 *Concrete*, must conform to Appendix C.

Table 5.8 – Fine aggregate property requirements (additional to MRTS70 Concrete requirements)

Property	Test: individual or total fine(1)	Test Method	Requirements
Material passing~~finer than~~ 75 µm sieve	Total fine	AS 1141.11.1 or AS 1141.12	Refer to Figure 5.8
Material finer than 2 µm	Total fine	AS 1141.13	Refer to Figure 5.8
Methylene Blue Adsorption Value (MBV)	Individual(2)	AS 1141.66~~ or TfNSW T659~~	Refer to Figure 5.8
Deleterious Fines Index (DFI)~~MBV75 value~~(3)	Individual(2)	Not applicable	Refer to Figure 5.8

Property	Test: individual or total fine[1]	Test Method	Requirements
~~Bulk density (compacted)~~	~~Individual~~	~~AS 1141.4 Clause 7.2~~	~~Minimum 1,200 kg/m³~~
~~Water absorption~~	~~Individual~~	~~AS 1141.5~~	~~Maximum 5%~~
~~Aggregate soundness~~	~~Individual~~	~~AS 1141.24~~	~~Maximum 6.0% weighted average loss~~
~~Organic impurities[4]~~	~~Total fine~~	~~AS 1141.34 and AS 1289.4.1.1~~	~~Pass / Fail to AS 1141.34 and maximum 0.5% to AS 1289.4.1.1~~
~~Sugar content~~	~~Total fine~~	~~AS 1141.35~~	~~Less than 1 part in 10,000~~
~~Acid insoluble residue[7]~~	~~Total fine~~	~~Tex-612-J~~	~~Minimum 60%[7]~~
~~Micro-Deval loss[7]~~	~~Total fine~~	~~ASTM D7428[8]~~	~~Maximum 15% maximum[7]~~
Flow cone time[4][5]	Total fine	TfNSW T279 (TS 02799.54)[5][6]	Maximum 27 seconds
Glass content and requirements[6]	Total fine (glass content) Individual (other requirements)	Refer to ~~ATS 3050~~MRTS36 *Recycled Glass Aggregate*	Maximum 15% by mass of total fine aggregate content. Other requirements refer to MRTS36 *Recycled Glass Aggregate*[7]

Notes:

[1] Total fine ~~(TF)~~: Calculate the theoretical mixed result based on individual ~~(Ind)~~ component results with proportioning as per the nominated mix, or test the mixed total fine aggregate blend. Do not include the contribution from the coarse aggregates.

[2] Test all individual fine aggregates. If all individual components confirm, no further assessment is required. If any component fails, test the combined fine aggregates. Do not include the contribution from the coarse aggregates~~Determined by washing~~.

[3] DFI is the product of the MBV and the percent~~MBV75 is the product of the MBV and the~~ passing 75 µm value.

[4] ~~Test initially under AS 1141. If the presence of organic impurities is indicated, test under AS 1289.~~

[5] Flow Cone testing is not mandatory if the manufactured fine aggregate content is less than 20% by mass of the total fine aggregate.

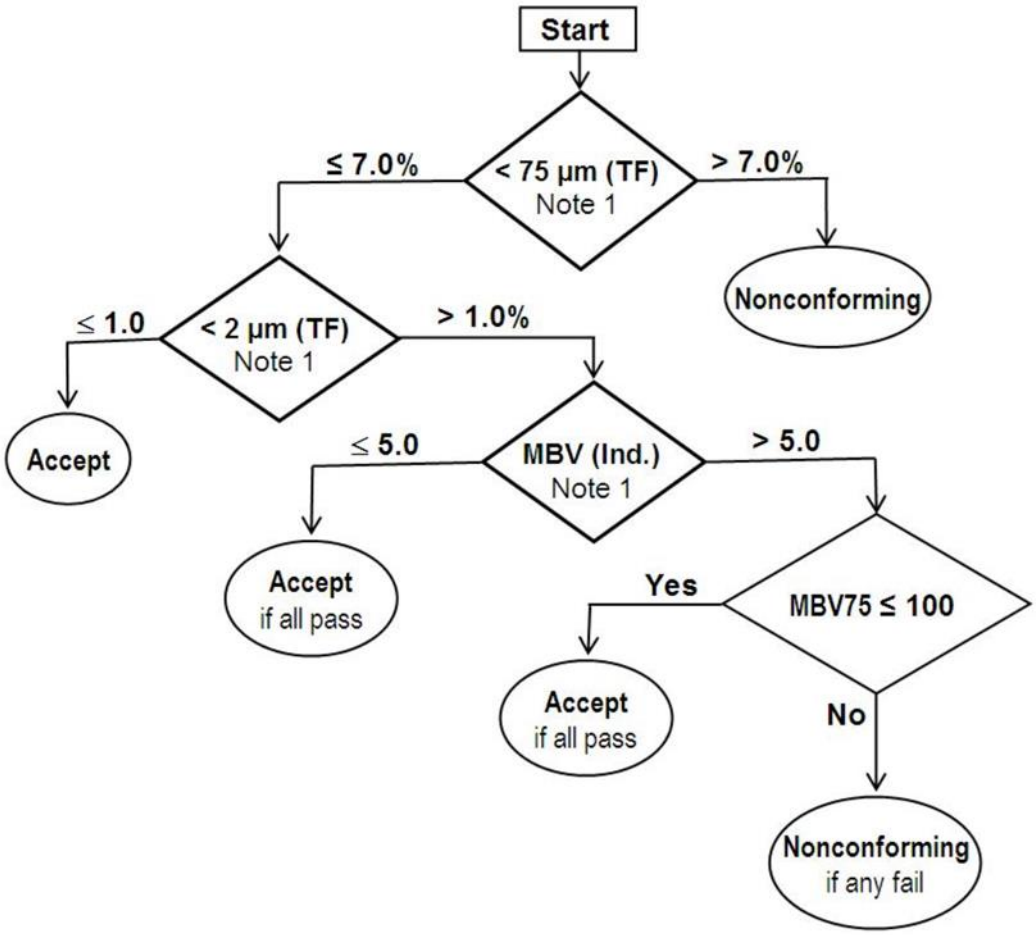
[5] Flow Cone test results need not be NATA endorsed.

(6) Recycled crushed glass may be used as a partial replacement of fine aggregate~~As a proportion of the total fine aggregate component~~.

~~(7) Test all individual fine aggregates. If all individual components conform, no further assessment is required. If any component fails, test the combined fine aggregates. Do not include the contribution from the coarse aggregates.~~

~~(8) Where NATA or IANZ registration is unavailable, provide test results endorsed by an ISO 9001 certified laboratory whose Quality Management System is certified by a Conformity Assessment Body or by JASANZ.~~

Figure 5.8 – Fine aggregate testing



Notes:

(1) Testing must be in accordance with Table 5.8.
The contribution from the coarse aggregates must be excluded.

(2) TF: Total Fine: Total fine aggregate.
Ind: Individual fine aggregates.

(3) MBV75 has the same meaning as DFI.

The use of high proportions of manufactured fine aggregate may adversely affect water demand and cause workability and finishing complications.

Coarse aggregate

5.9 Coarse aggregate must conform to ~~AS 2758.1, except as qualified in~~MRTS70 *Concrete* requirements for coarse aggregate in Special Class concrete and the additional requirements in Table 5.9. Minimum testing frequencies for coarse aggregate, including for properties specified in MRTS70 *Concrete*, must conform to Appendix C.

Table 5.9 – Coarse aggregate property requirements (additional to MRTS70 Concrete requirements)

Property	Test: individual or total coarse (1)	Test Method	Requirements
~~Bulk density (compacted)~~	~~Individual~~	~~AS 1141.4 Clause 7.2~~	~~Minimum 1,200 kg/m³~~
~~Particle density~~	~~Individual~~	~~AS 1141.6, SSD(8) method~~	~~Minimum 2,100 kg/m³~~
~~Water absorption~~	~~Individual~~	~~AS 1141.6.1 or AS 1141.6.2~~	~~Maximum 2.5%~~
~~Material finer than 75 µm~~	~~Total coarse~~	~~AS 1141.11.1(7) or AS 1141.12~~	~~Maximum 1.0%~~
For material retained on a ~~>~~ 9.50 mm sieve: Particle shape, 2:1 and 3:1 ratios	Individual	AS 1141.14	Maximum 25% (2:1 ratio) and maximum 10% (3:1 ratio)
~~For material < 9.50 mm: The ratio AGD/ALD(3) for all fractions 2 mm to 9 mm(4)~~	~~Individual~~	~~AS 1141.20.1~~	~~Maximum 2.25~~
Flakiness index	Individual	AS 1141.15	Maximum 25%
~~Wet strength~~	~~Individual(6)~~	~~TfNSW T215~~	~~Minimum 80 kN~~
~~Wet/dry variation~~	~~Individual(6)~~	~~TfNSW T215~~	~~Maximum 35%~~
~~Weak particles~~	~~Individual~~	~~AS 1141.32~~	~~Maximum 0.3%~~
~~Light particles~~	~~Individual~~	~~AS 1141.31~~	~~Maximum 1.0%~~
~~Fractured faces~~Crushed particles (2 or more)(~~21~~)	Individual	~~TfNSW T239~~AS 1141.18	Minimum 80%
~~Alkali reactivity~~	~~Individual(6)~~	~~AS 1141.60.1~~	~~Refer to Clause 5.11~~

Property	Test: individual or total coarse (1)	Test Method	Requirements
Foreign materials content	Individual(5)	TfNSW T276	Maximum 0.1%(5)

Notes:

(1) Not required for material from a blasted quarry faceTotal coarse (TC): Calculate the theoretical mixed result based on individual (Ind) component results with proportioning as per the nominated mix, or test the mixed total coarse aggregate blend.

(2) Test Method TfNSW T239 Clauses 6(a) to 6(c) and 7(b) to 7(d)(ii) may be ignored. Not required for material from a blasted quarry face.

(3) Ratio of Average Greatest Dimension to Average Least Dimension.

(4) In accordance with Test Method AS 1141.20.1, carry out the test only where the number of aggregate particles in the group is ≥ 15% of the minimum 100 particle sample used to determine ALD.

(5) Required only for a recycled aggregate component. The 0.1% limit is relative to the mass of the individual recycled aggregate component.

(6) Only testing a single nominal size from each rock source is required.

(7) Determined by washing.

(8) SSD: saturated surface dry.

Alkali-aggregate reactivity

5.10 Clause 5.11 does not apply if the Principal has previously approved the aggregate for use in a concrete mix and/or approved a concrete mix design utilising supplementary cementitious materials with the aggregate.

5.11 The Contractor must carry out testing each aggregate from each proposed individual supply source for potential alkali-aggregate reactivity in accordance with the Accelerated Mortar Bar Test Method AS 1141.60.1, within 18 months prior to the commencement of paving. From the classification obtained by the testing, taking into account the proportion of each aggregate in the mix, the Contractor must take the action specified in Table 5.11.

Table 5.11 – Action for aggregate reactivity classification

Aggregate reactivity classification in accordance with AS 1141.60.1	**Action required**
Non-reactive	None
Slowly reactive	Limit total alkali content in the mix to 2.1 kg/m³(1). or use an approved concrete mix design containing supplementary cementitious materials.

~~Aggregate reactivity classification in accordance with AS 1141.60.1~~	~~Action required~~
~~Reactive~~	~~Use a different aggregate and repeat the test, or Re-test using blended cement containing supplementary cementitious materials and re-assess the alkali aggregate reactivity potential using AS 1141.60.2. Any aggregates classified as 'reactive' by AS 1141.60.2 must not be used.~~

~~Note:~~

~~(1) Total alkali content is the available alkali content of cement and other sources expressed as Na_2O equivalent and calculated as the sum of Na_2O and 0.658 K_2O.~~

Cementitious materials

~~5.12~~5.10 Cementitious materials must be Transport and Main Roads registered products in the *Supplier Registration Scheme: Bridges and Other Structures*. In addition, cementitious materials must be supplied only by departmental registered suppliers.

~~5.13~~5.11 Cement must be either:

a) Type SL (shrinkage limited) cement, or

b) Type GP cement that complies with the shrinkage limit for Type SL cement in AS 3972 and ATIC-SPEC SP43.

Type GB cement is acceptable where the mix meets the requirements of this Technical Specification, including minimum cementitious content, allowable blend proportions and supplementary cementitious material requirements.

~~5.14~~5.12 Supplementary cementitious material (SCM) must be fly ash and/or ground granulated iron blast furnace slag (GGBFS).

For minimum cementitious content and blend requirements in the concrete mix, refer to Clauses 7.3 and 7.4 of this Technical Specification.

~~5.15~~5.13 Each delivery of cement and SCM must be accompanied by a delivery document providing traceability by detailing:

a) marking information as required by AS 3972, AS 3582.1 or AS 3582.2 (as relevant), and

b) ATIC registration number. **Record**

~~5.16~~5.14 If requested by the ~~Principal~~Administrator, within 5 working days after the start of the Works, the Contractor must deliver to the ~~Principal~~ Administrator a minimum 5 kilogram representative grab sample (labelled for traceability) of each cement and SCM.

~~5.17~~5.15 Documentary evidence of material compliance (such as process control monitoring and/or lot release test results, as detailed in ATIC-SPEC SP43) must be provided at least monthly to the ~~Principal~~Administrator. **Record**

~~5.18~~5.16 Bulk cementitious materials must only be stored in watertight silos.

~~5.19~~5.17 Bagged cementitious materials must be stored above ground in dry, weatherproof sheds, and be protected from dampness which may be acquired from contact with floors or walls. Bags must be stacked so as to allow counting, inspection and identification of each consignment.

~~5.20~~5.18 As far as practicable, cement must be used in order of receipt.

~~5.21~~5.19 Cementitious materials containing lumps, signs of moisture absorption or other contamination must not be used.

~~5.22~~5.20 Cement must:

a) comply with ATIC-SPEC SP43 and AS 3972, and

b) if more than 3 months old (from date of manufacture), be retested for conformance.

~~5.23~~5.21 Fly ash must:

a) be fine grade

b) comply with ATIC-SPEC SP43 and AS 3582.1, and

c) comply with Table 5.2~~2~~1 (calculated using the 30 most recent successive test results).

Table 5.2~~2~~1 – Fly ash uniformity requirements

Property	Test Method	Formula	Limit
Carbon content (LoI)	AS/NZS 2350.2	$LoI_{average}$ + 3SD	≤ 4%
Fineness	AS/NZS 2350.8	$Fineness_{average}$ + 3SD	≤ 100%
		$Fineness_{average}$ − 3SD	≥ 75%
		CoV	≤ 3%

Where:

$LoI_{average}$ = mean of loss on ignition test results.

$Fineness_{average}$ = mean of fineness test results.

SD = standard deviation expressed as a decimal.

CoV = Coefficient of Variation = SD ÷ $Fineness_{average}$ × 100%.

~~5.24~~5.22 Ground granulated iron blast-furnace slag must:

a) comply with ATIC-SPEC SP43 and AS 3582.2, and

b) conform to the following (calculated conformity with AS/NZS 2350.8 using the 30 most recent successive test results):

$(Fineness_{average} - 3SD) \leq Fineness_{sample} \leq (Fineness_{average} + 3SD)$

Where:

$Fineness_{sample}$ = individual fineness test result.

$Fineness_{average}$ = mean of fineness test results.

SD = standard deviation expressed as a decimal.

Admixtures

~~5.25~~5.23 Chemical admixtures and their use must conform to AS 1478.1 and AS 1379, but they must not contain calcium chloride. The following conditions also apply:

a) For combinations of 2 or more admixtures, their compatibility with each other must be certified in writing by their manufacturers. Provide certification with the nominated mix submission [refer to Hold Point 1].

b) For mixes with less than 50 kg/m³ fly ash, the total alkali contribution (measured as Na_2O equivalent in accordance with AS 1478.1) from all admixtures used in any mix must not exceed 0.20 kg/m³.

c) The Quality Plan must include details of the criteria for initiating changes in admixture type with changes in season. If the same admixture is proposed for use across all seasons, dosage rate charts for various temperature ranges must be provided. Additional testing in the mix design process is not required if admixture dose rate changes are based solely on ambient temperature.

d) Superplasticisers and high range water reducers Type HWRRe may be used in non-pavement applications, such as anchors and subgrade beams.

~~5.26~~5.24 Air entraining agents:

a) must be used in slipform paving mixes, and

b) may be used in fixed-form (hand placed) paving mixes or in non-pavement concrete mixes such as anchors and subgrade beams, but are not mandatory.

Curing compounds

General

~~5.27~~5.25 Curing compounds must conform to AS 3799~~, subject to the qualifications in~~ and Table 5.2~~6~~5.

Curing compounds registered to MRTS70 *Concrete* may not conform to all the requirements specified here. It is necessary to check conformance of the proposed curing compound even if it is a registered product to MRTS70 *Concrete*.

Table 5.2~~6~~5 – Curing compound requirements

Curing Compound Type	Conform to AS 3799 class	Carbon Number	Limitations
Hydrocarbon resin (HCR)	Class B with minimum 30% NV resin content(2,7)	C5 only	Do not use where a bitumen seal or asphalt will be placed(8)
Water-borne hydrocarbon resin (WHCR)	Class B with minimum 30% NV resin content(2,7)	C5 only	Do not use where a bitumen seal or asphalt will be placed(8)

Curing Compound Type	Conform to AS 3799 class	Carbon Number	Limitations
Styrene butadiene resin (SBR)	Class B[7]	Not applicable	Do not use where a bitumen seal or asphalt will be placed[8]
Blended bitumen and waterborne hydrocarbon resin (B HCR)	Class B with minimum 40% bitumen[6]	C5 only (hydrocarbon resin component)	To be compatible with the prime that will be applied later
Wax emulsion (WE)	Class A with minimum 30% NV content[1, 3, 4]	Not applicable	Do not use on the top surface. Use only for debonding of joints. Comply with ~~ATS 3520~~MRTS39 *Lean-mix Concrete Subbase*

Notes:

[1] When tested for stability in accordance with TfNSW T862, the rate of separation in 7 days must not exceed 4%.

[2] Ensure that a minimum of 30% comprises resin as defined in AS/NZS 2310 (independent of non-resin fillers).

[3] Ensure that a minimum of 30% comprises wax (independent of non-wax fillers).

[4] The softening point of the non-volatile material must be not less than 45°C when tested in accordance with AS 2341.18.

[5] Do not use on the top surface of the Base. Use only for debonding of joints.

[6] Bitumen must constitute at least 40% of the total mass as delivered and be Class C170 conforming to ~~AS 2008~~MRTS17 *Bitumen and Multigrade Bitumen*.

[7] For summer paving, use a Type 1-D compound incorporating a light-coloured fugitive dye.

[8] The ~~Principal~~ Administrator may consider alternative proposals where there will be a long delay before surfacing works, or where a specialised bonding treatment is proposed. The following conditions also apply:

a) where a fugitive dye is used, it must be is incorporated by the manufacturer, and

b) permanent dyes or pigments must not be used on the finished surface.

~~5.28~~5.26 For water retention testing, test results from a laboratory with NATA or IANZ accreditation must be provided. For all other testing, test results endorsed by an ~~AS/NZS ISO 9001~~AS ISO/IEC 17025 certified laboratory whose Quality Management System is certified by a Conformity Assessment Body or by JASANZ must be provided.

~~5.29~~5.27 For each nominated curing compound, the Contractor must certify by written report that the compound conforms to this Technical Specification and submit relevant test results with the report.

~~5.30~~5.28 A sample must be available for acceptance testing which is covered by the certification. This reference sample may be used on more than one project.

~~5.31~~5.29 The curing compound must not adversely impact the adhesion of pavement markings, raised pavement markers and audio tactile line markings as detailed in MRTS45 *Road Surface Delineation*~~Attention is drawn to the requirements of ATS 4110 regarding the adhesion of line marking~~.

Reference sample

~~5.32~~5.30 The reference sample must be tested for the following properties:

a) non-volatile content

b) the efficiency index

c) density

d) drying time

e) viscosity, and

f) the infrared spectrum as determined on the material as supplied and in accordance with TfNSW T1005 (TS 02811.05) - liquid method.

~~5.33~~5.31 The testing must be in accordance with AS 3799 and verify that the results conform to Table 5.2~~6~~5 and AS 3799.

~~5.34~~5.32 The Contactor must provide written certification (accompanied by the test results) that the reference sample conforms to this Technical Specification.

Initial delivery

~~5.35~~5.33 From the first delivery to the project, a random sample must be tested for the following properties:

a) non-volatile content

b) density

c) drying time

d) viscosity, and

e) the infrared spectrum, as determined on the material as supplied and in accordance with TfNSW T1005 (TS 02811.05) – liquid method.

~~5.36~~5.34 The testing must be in accordance with AS 3799 and verify that the results conform to Table 5.2~~6~~5 and AS 3799. The sample must be assessed for consistency with the Reference Sample in accordance with AS 3799.

~~5.37~~5.35 The Contactor must, provide written certification (accompanied by the test results) that the delivered batch has the same formulation as that of the reference sample.

Subsequent deliveries

~~5.38~~5.36 For all subsequent deliveries, the Contactor must provide written certification that each delivered batch has the same formulation as that of the initial delivery. The certification must be made on the basis of the manufacturer's Certificate of Analysis for uniformity of the following properties, with testing in accordance with AS 3799:

a) non-volatile content

b) density, and

c) viscosity.

Joint sealant

~~5.39~~5.37 Joint sealant must be silicone sealant for casting in situ, conforming to the requirements of Table 5.~~40~~38.

~~5.40~~5.38 The Contractor must submit the following to the ~~Principal~~Administrator:

a) Certification that the proposed sealant conforms to this Technical Specification

b) all relevant test results which have been NATA accredited (where specified) or endorsed by an ~~AS/NZS ISO 9001~~AS ISO/IEC 17025 certified laboratory whose Quality Management System is certified by a Conformity Assessment Body or by JASANZ (except that JASANZ certification is not required for Test Methods TfNSW T1192 (TS 02816.01) and T1193 (TS 02816.02)), and

c) full technical description of the products, (as part of the Quality Plan), including the method of installation recommended by the manufacturer.

Table 5.~~40~~38 – Silicone joint sealants requirements (refer to Clause 5.37)

Property	Test Method	Requirement
Specific gravity	ASTM-D792 (Method A)	1.1–1.55
Durometer hardness	ASTM-C661 (Standard Curing)	Maximum 25 at + 29ºC Maximum 30 at + 23ºC
Extrusion rate	ASTM-C603	90–250 g/minute
Tack free time	ASTM-C679	Tack free at 5 hours
Accelerated weathering	ASTM-C793	No surface crazing, hardening, chalking or bond loss at 5,000 hours
Adhesion to concrete	ASTM-C794	Minimum 35 N average peel strength
Accelerated ageing	TfNSW T1193~~2~~ (TS 02816.02)	Condition of specimen after one aging cycle
Adhesion to concrete	TfNSW T1192~~3~~ (TS 02816.01)	Conditioning as per TfNSW T1193 (TS 02816.02) Extension to 70%, compression to 50% After 500 cycles, not more than 10% failure over the cross-sectional area
Colour		Grey, compatible with pavement concrete

Steel reinforcement

~~5.41~~5.39 The steel reinforcement supplier must be certified by the Australasian Certification Authority for Reinforcing and Structural Steels (ACRS) for the supply of steel reinforcement.

~~5.42~~5.40 The reinforcement fabricator must be certified by ACRS for fabricating steel reinforcement and must have in place a quality management system conforming to AS/NZS ISO 9001 as a means of ensuring that the product conforms to this Technical Specification.

~~5.43~~5.41 Steel reinforcement must conform to ~~AS/NZS 4671~~MRTS71 *Reinforcing Steel*. Reinforcement must be readily identified as to its grade and origin.

~~5.44~~5.42 When galvanised steel reinforcement is specified, the reinforcing steel must be hot dip galvanised in accordance with AS/NZS 4680.

Water

~~5.45~~5.43 Water used in the production of concrete must be free from materials harmful to concrete and reinforcement and be neither salty nor brackish. The water must conform to AS 1379 Clause 2.~~7~~4 and Table 2.2, Limits for Impurities in Mixing Water, with the addition of the following:

a) chloride ion: maximum 500 ~~parts per million~~mg/L determined by AS 1478.1 Appendix C, and

b) sulphate ion: maximum 400 ~~parts per million~~mg/L determined by AS 1289.4.2.1.

~~5.46~~5.44 Mixing water which is drawn solely from a reticulated drinking water supply is deemed to conform.

~~5.47~~5.45 If the mixing water contains a component from a source other than a reticulated drinking water supply, ~~the Contractor must test all sources used and ensure that~~ the combined ~~mixing~~ water must conform~~s~~ to the requirements of Clause 5.4~~5~~3.

~~5.48~~5.46 The limits on soluble salt content for the total concrete mix are detailed in Clause 7.~~15~~14.

Preformed joint filler

~~5.49~~5.47 Preformed joint filler must conform to ATS 3505 *Preformed Joint Fillers for Concrete Road Pavements and Structures*.

6 Design

General

6.1 The Works must be constructed in accordance with the Drawings.

6.2 In plain concrete pavement (PCP), steel reinforcement is only used in special slabs, in anchors and in joints (as tiebars and dowels). Typically, longitudinal joints are tied and transverse joints are not dowelled.

6.3 In jointed reinforced concrete pavement (JRCP), steel reinforcement is used in all slabs, in anchors and in joints (as tiebars and dowels). Typically, longitudinal joints are tied and transverse joints are dowelled.

6.4 In steel-fibre reinforced concrete pavement (SFCP), mesh reinforcement is only used in special slabs, in anchors and in joints (as tiebars and dowels). All slabs contain steel fibre reinforcement, longitudinal joints are typically tied, and transverse joints are not dowelled. Refer to Clause 32 for additional SFCP requirements.

6.5 The ~~Principal~~ Administrator may alter the base thickness and levels by up to 30 mm before the commencement of each section of work.

Survey at the top of the underlying layer

6.6 The base invert level is the level at the top of the subbase, including the thickness of any debonding treatment and is determined in accordance with Table 6.6.

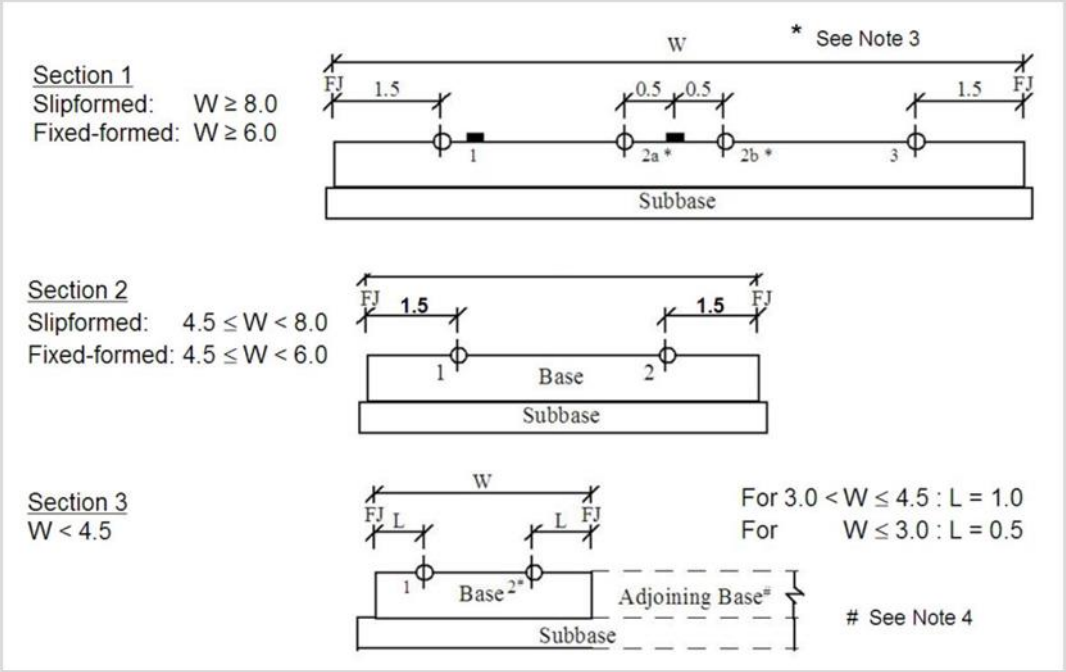
Table 6.6 – Underlying surface levels

Subbase	Survey Requirements
Lean-mix concrete subbase (LCS) where the base and subbase are constructed under the same contract:	In accordance with ~~ATS 3520~~MRTS39 *Lean-mix Concrete Subbase*.
LCS which was constructed by others:	By survey jointly between the Contractor and the ~~Principal~~Administrator, in accordance with the requirements for survey included in the Contract documents.
Subbases other than LCS:	In a manner consistent with criteria contained in ~~ATS 3520~~MRTS39 *Lean-mix Concrete Subbase*.

6.7 If the Contractor elects to undertake additional survey for the subbase and asphalt interlayer (where applicable), the survey does not need to be repeated on the base.

6.8 Levels of the underlying surface must be taken using a flat based staff of base area between 300 mm² and 4000 mm², ~~T~~at a spacing of 10.0 m longitudinally and at the transverse offsets shown in Figure 6.8, with a tolerance of 0.5 m. levels obtained must be reported to the nearest millimetre.

Figure 6.8 – Survey locations (not to scale)



Notes:

(1) All dimensions are in metres (m).

(2) Induced longitudinal joints are ignored for the purpose of locating survey points and so are not marked.

(3) In Section 1, survey either at point 2a or 2b.

(4) In Section 3, delete survey point 2 adjoining previously placed base.

(5) Unless otherwise specified or agreed, in locations where the distance between a formed edge and the adjacent lane line is variable (tapered), the survey point must be altered to a location which is offset by 0.5 m from that lane line.

Key:

FJ Formed joint or edge

W Paving width between formed joints or edges

■ Lane lines

φ Survey points

Survey report prior to placing base

6.9 Prior to base paving, a Survey Report conforming to the *TMR Surveying Standards* and highlighting all locations where the actual level is higher than the Contract level must be submitted to the ~~Principal~~Administrator. The survey must be carried in accordance with the survey requirements included in the Contract documents.

6.10 A Hold Point will apply to base paving if any high levels exist within the schedule.

Hold Point 2 Record

HOLD POINT 2	
Process Held	Paving of base if high underlying surface levels exist.
Submission Details	A schedule of underlying surface levels and relevant nonconformity report must be submitted to the ~~Principal~~ Administrator prior to placing the base.

Thickness of surface debonding treatment

6.11 For the purpose of determining survey levels, the initial curing compound is deemed to have nil thickness.

6.12 Where the surface debonding treatment comprises additional application(s) of curing compound without aggregate, the treatment is deemed to have nil thickness for the purpose of determining survey levels.

6.13 Where the surface debonding treatment over LCS comprises a sprayed bituminous seal, the thickness of the treatment is taken as the Average Least Dimension (ALD) of the cover aggregate, determined in accordance with AS 1141.20.~~1~~3. This thickness must be added to the levels determined at the top of the LCS. The resultant levels are regarded as the bottom level of the base for the purpose of determining its thickness.

6.14 Where the subbase is other than LCS, the bottom level of the base must be determined by survey using a flat based staff of base area between 300 mm² and 4000 mm² on the surface over which base will be paved.

Redesign of pavement levels

6.15 For low underlying surface levels, redesign to lower levels will not be allowed.

6.16 In the case of nonconforming levels which are high, the Contractor may locally redesign the pavement levels in accordance with the following criteria and submit the redesign to the ~~Principal~~ Administrator for approval.

6.17 The approved contract surface levels must be reviewed in accordance with the following criteria:

a) the rate of level change on any longitudinal profile string, calculated relative to the approved contract design, must not be greater than 0.1% (1.0 mm per metre)

b) the revised crossfall (or superelevation) at any location must not vary from the approved value by more than ± 0.3% (when expressed as actual values; hence a specified crossfall of 2.0% may be varied within the range 2.0% ± 0.3%), and

c) the revised design must transition to abutting structures and pavements.

6.18 Additionally, the revised design must be such that:

a) water will not pond on the carriageway

b) the drainage design is not compromised in aspects including depth and rate of flow over the pavement, flow direction and capacity (both on the pavement and within the drainage network), and

c) the risks and associated consequences (in terms of drainage) are not increased at locations such as superelevation transitions when considered in terms of aspects such as the likely construction deviations (within the specified level tolerances) in the finished base.

6.19 Where the base and subbase are both constructed by the Contractor, there is no entitlement to additional payment for redesign due to nonconformity of the underlying surface levels or the base finished surface levels.

7 Design of concrete mixes

General

7.1 The concrete mix must be designed in accordance with this Technical Specification, taking into consideration the anticipated conditions that will be prevailing on site so that, under those conditions, the concrete in the constructed base meets all the requirements of this Technical Specification.

Mix particle size distribution

7.2 The particle size distribution must be as specified in Clause 5.

Cementitious content

7.3 The minimum mass of cementitious material must be as detailed in Table 7.3.

Table 7.3 – Minimum Cementitious Material Content by Mix Type

Mix Type	Minimum Mass (kg/m³)
PCP, JRCP, CRCP	300
SFCP	350

The Contractor may need to adopt a higher minimum mass than specified to ensure the mix meets minimum strength requirements and is suitable for their specific construction procedures.

7.4 Cementitious material must be a blend conforming to MRTS70 *Concrete* for Special Class concrete.~~For carbonation resistance, in addition to complying with Table 7.3, the minimum proportion of cement, SL_{min}, is determined as follows:~~

~~$SL_{min} \geq 100 - 0.55\,[FA + 0.5 \times GGBFS]$~~

~~Where:~~

~~SL_{min} = minimum Type SL cement (% by mass).~~

~~FA = mass of fly ash (kg/m³).~~

~~$GGBFS$ = mass of GGBFS (kg/m³).~~

~~7.5 If specified in the Contract documents, or if the control of Alkali-Aggregate Reactivity is required, the proportions of supplementary cementitious materials in batched concrete must comply with Table 7.5~~

~~Table 7.5 – Allowable proportion of SCM in binary and ternary blended cement~~

~~SCM~~	~~AAR Class~~	~~Limits[1, 2]~~	
		~~Minimum (%)~~	~~Maximum (%)~~
~~Fly ash~~	~~Non-reactive~~	~~15 – (0.5 × *GGBFS%*)~~	~~40 – (0.5 × *GGBFS%*)~~
	~~Slowly reactive/reactive~~	~~20 – (0.5 × *GGBFS%*)~~	
~~GGBFS~~	~~Non-reactive~~	~~10 – (2.0 × *FA%*)~~	~~65 – (2.0 × *FA%*)~~
	~~Slowly reactive/reactive~~	~~40 – (2.0 × *FA%*)~~	

~~Where:~~

~~FA% = Percentage of fly ash by mass of total cementitious material.~~

~~GGBFS% = Percentage of GGBFS by mass of total cementitious material.~~

~~Notes:~~

~~(1) It is acceptable to use mixes without supplementary cementitious materials. However, where they are used, these limits apply. For example, if fly ash is used with non-reactive aggregates, proportions between 1% and 14% are not acceptable.~~

~~(2) By mass, relative to total cementitious material.~~

As specified in Clause 5.12, supplementary cementitious material must be fly ash and/or ground granulated iron blast furnace slag (GGBFS). Therefore, blends to MRTS70 *Concrete* containing amorphous silica are not permitted.

Strength

~~7.6~~7.5 Concrete compressive and flexural strength must comply with the requirements shown in Table 7.6, together with qualifying requirements for moulding and testing.

~~7.7~~7.6 For CRCP mixes, the flexural strength of the trial mix must not exceed 6.5 MPa at 28 days.

Table 7.6 – Concrete strength requirements (refer to Clause 7.5)

Description	Compressive Strength	Flexural Strength(1)
~~Non-SCM mixes(2)~~		
~~Trial mix~~	~~45.0 MPa (F_{28Min})~~	~~5.0 MPa (F_{f28Min})~~
~~In the Works~~	~~40.0 MPa (fc_{Min})~~	~~4.8 MPa (f_{fMin})(3)~~
~~SCM mixes(2)~~		
Trial mix	40.0 MPa (F_{28Min})	4.8 MPa (F_{f28Min})
In the Works	35.0 MPa (fc_{Min})	4.~~8~~5 MPa (~~F~~f_{f28Min})(2)
Test specimen size	Cylinder 100 mm diameter	Beam 100 × 100 × 350 mm
Test methods	Preparation: AS 1012.8.1(43) Testing: AS 1012.9	Preparation: AS 1012.8.2(43) Testing: AS 1012.11

Notes:

(1) Applicable to base pavement mixes only. Not applicable to non-pavement mixes such as anchors and kerbs.

~~(2) SCM Mixes: Mixes containing supplementary cementitious material(s).~~

(32) Specified only for process control, not specified for Sub-Lot acceptance. For SFCP, refer to Clause 32.

(43) As amended by TfNSW T304 (TS 02800.05) for moulding.

Indirect tensile testing is not used for initial assessment of conformity. It is required for future reference (should there be any future doubt regarding the flexural strength results).

Consistence

~~7.8~~7.7 The consistence of the concrete must be determined by measuring the slump in accordance with AS 1012.3. ~~Method~~ 1.

~~7.9~~7.8 The nominated slump for each concrete mix must best suit the equipment and methods to be used, within the ranges as follows:

a) for fixed-form (manual) paving: 50–70 mm

b) for slipform paving (other than transition zones): 15–50 mm

c) for paving in transition zones: 15–70 mm.

~~7.10~~7.9 This slump must be within ± 5 mm from the slump value obtained from laboratory tests on the trial mix. (refer to Clause 8.1~~7~~1).

~~7.11~~7.10 The slump adopted must allow the production of a dense, non-segregated base without excessive bleeding. Bleed water must not form in sufficient quantity to flow over the slab edge.

~~7.12~~7.11 For slipform concrete mixes, the Vebe reading of the laboratory mix design testing in accordance with AS 1012.3.3 must be tested and reported.

The Vebe test is a flow test on a vibrating table. It is used to provide a measure of workability in stiff mixes.

Shrinkage

~~7.13~~7.12 Unless specified otherwise in the Contract documents, testing in accordance with Clause 7.1~~4~~3 only applies to the trial mix and is not required for production.

~~7.14~~7.13 The shrinkage of the concrete specimen must comply with Table 7.1~~4~~3. Conformity is required at only one age: hence if the shrinkage does not meet the specified limit at 21 days, but meets the specified limit at 56 days, the mix is accepted as conforming.

Table 7.143 – Maximum shrinkage strain

Mix Type	Maximum Shrinkage Strain (microstrain, με)[1]	
	Drying Period: 21 Days	Drying Period: 56 Days
GGBFS mixes[2]	580	680
Other mixes	~~450~~500	~~580~~650

Notes:

[1] To be tested only in the trial mixes.

[2] For the purpose of this Technical Specification, a GGBFS mix is defined as having a minimum of 40% GGBFS (by mass).

Other concrete attributes

~~7.15~~7.14 The concrete must comply with the requirements specified in Table 7.1~~5~~4.

Table 7.1~~5~~4 – Other concrete attributes

Attribute	Test Method	Requirement
Compaction	Refer to Clause 25	Minimum relative compaction 98.0%[1]
Chloride ion content	Refer to Clause 7.1~~7~~6	Maximum 0.8 kg per m³ of concrete
Sulphate ion content	Refer to Clause 7.1~~7~~6	Maximum 5% relative to cementitious binder mass[2]
Air content of fresh concrete[~~3~~3]	AS 1012.4.2, with compaction by internal vibration[~~2~~4]	5.0 ± 2.0%
Bleeding[5]	AS 1012.6, with compaction by internal vibration	Maximum 3%
~~Coefficient of Thermal Expansion (CTE)[6]~~	~~AASHTO T336~~	~~Report only[6]~~

Notes:

(1) Not applicable to the trial mix.

(2) Calculate the sulphate ion content relative to the cement mass (i.e. excluding SCM such as fly ash and slag).

(3) For mixes that contain an Air entraining agent (refer to Clause 5.254), test for air content in accordance with Clause 10.78.

(4) Use the same vibration pattern and durations as for cylinders in accordance with Test Method TfNSW T304 (TS 02800.05).

(5) To be tested only in the trial mix.

(6) ~~Test at least one slipform mix and one fixed-form mix. This value is for research purposes only and is not an acceptance criterion (refer to Clause 8.12 regarding delayed submission of results).~~

~~7.16~~7.15 Refer to Clause 5.453 for limitations on mixing water.

~~7.17~~7.16 The chloride and sulphate ion content of concrete constituents or harden concrete must be determined in accordance with either Clause 7.187 or Clause 7.198. Testing is required by only one method.

~~7.18~~7.17 Testing of concrete constituents for chloride and sulphate ion contents must be carried out as follows:

a) Determine the chloride content of the mix by testing in accordance with:

   i. AS 1012.20.1 for aggregates, and

   ii. AS 1478.1 Appendix C for water and admixtures dissolved in water, and calculating the total chloride content and percentage in the mix.

b) Determine the sulphate content of the mix by testing in accordance with:

   i. AS 1012.20.1 for aggregates

   ii. AS 1289.4.2.1 for water and admixtures dissolved in water, and

   iii. AS 2350.2 for cementitious materials, and calculating the total sulphate content and percentage in the mix.

c) For water, test samples taken from the source proposed for the Works. If the mixing water is drawn solely from a reticulated drinking water supply, test values provided by the supply authority may be used.

d) For admixtures, the chloride and sulphate contents may be taken as the values certified in writing by the manufacturer.

~~7.19~~7.18 Testing of hardened concrete for chloride and sulphate ion contents must be carried out as follows:

a) Determine the chloride and sulphate content of the hardened concrete in accordance with AS 1012.20.1.

b) To determine the chloride ion content, use a representative sample of at least 20 grams of crushed and ground concrete, with the titrating solution being from 0.01 N to 0.02 N. Use the Volhard method, calibrated using a concrete of known chloride content, for the test.

8 Nominated concrete mixes

Submission of nominated mixes

8.1 ~~Subject to Clause 8.9, p~~Prior to commencing production of each base concrete mix, the Contractor must: **Witness Point 1** **Record** **Hold Point 3**

a) conduct trial mixes to demonstrate that the proposed mix designs conform to this Technical Specification

b) certify that each nominated mix and its constituents meet the requirements of this Technical Specification

c) submit NATA or IANZ endorsed test results for all relevant tests (except that Vebe need not be NATA or IANZ endorsed)

d) submit a copy of a verification checklist covering items listed below, and

e) specify the nominated slump for each mix within a tolerance of ± 5 mm from the trial mix value.

WITNESS POINT 1	
Process	Trial mix.
Notification Period	At least 2 working days before mixing (include location of the mixing).

HOLD POINT 3	
Process Held	Production of each concrete mix.
Submission Details	At least 5 working days before production, the documentation required under Clause 8 must be submitted to the Administrator.

8.2 Where a higher slump mix is proposed under Clause 7.~~9~~8 for use in transition zones, it may be considered to be covered by the slipform trial mix.

8.3 Trial mixing must conform strictly with the proposals under Clause 10 for batching and mixing, including the dilution and incorporation of admixtures, and the sequence of addition of materials.

8.4 The date of testing of both the trial mix and the aggregates must be within 18 months prior to the commencement of paving. If sufficient production mix results are available from within this period, the ~~Principal~~ Administrator may reduce the scope of the trial mix or waive it.

8.5 To determine the compressive strengths F_7 and F_{28} for each trial batch, a minimum of 3 specimens at age 7 days and a minimum of 3 specimens at age 28 days must be tested. Specimens must conform to Clause 7.~~7~~5, with compaction by internal electric vibration. F_7 and F_{28} are the average of all individual results not more than 2.0 MPa from the median value.

8.6 The cylinders must be inspected, capped and crushed in accordance with AS 1012.9. Their unit mass is determined in accordance with AS 1012.12.2, as amended by Clause 25.10.

8.7 To determine the flexural strength for each trial batch, a minimum of 3 specimens at age 7 days and a minimum of 3 specimens at age 28 days must be tested. Specimens must conform to Clauses 7.~~6~~5 and 7.6, with compaction by either internal electric or table vibration. The flexural strengths F_{f28} and F_{f7} are the average of all individual results not more than 0.5 MPa from the median value.

8.8 To determine the indirect tensile strength (AS 1012.10) for each trial batch of base, a minimum of 3 specimens at age 28 days must be tested. Notwithstanding the requirement of AS 1012.8.1 Clause 5.2(b), specimens must be 100 mm diameter cylinders which conform to the requirements for compressive strength specimens under Clause 7.~~6~~5, with compaction by internal electric vibration. The indirect tensile strength F_{t28} is the average of all individual results not more than 0.5 MPa from the median value. The indirect tensile strength will not be used for conformity purposes.

~~8.9 If the Principal maintains a list of registered conforming mixes, the Contractor may propose to use a registered mix, subject to the Principal being satisfied that the proposed registered mix is suitable for the project.~~

~~HOLD POINT 3~~	
~~Process Held~~	~~Production of each concrete mix.~~
~~Submission Details~~	~~At least 5 working days before production, the documentation required under Clause 8.1 and/or Clause 8.9 must be submitted to the Principal.~~

Details required for each nominated mix

Constituent materials

~~8.10~~8.9 The following details of the constituent materials must be provided to the ~~Principal~~Administrator:

a) Cement: type, supplier, product name, ATIC registration number and source.

b) SCM: type, supplier, product name, ATIC registration number and source (for each).

c) Water: source, and test results (if not from a reticulated drinking water supply).

d) Admixtures: proprietary source, type, name and dosage recommended by manufacturer and certification of compatibility if more than one admixture is used.

e) Aggregates: source, geological type, moisture condition on which mix design is

based (oven dry, saturated surface dry or nominated moisture content) and Quarry Registration Certificate (including its Testing Frequency Schedule).

f) Relevant test results for all constituents.

g) Test results for chloride and sulphate content in accordance with Clause 7.154.

~~h) If applicable, test results for alkali-reactive materials in accordance with Clause 7.18.~~

Mix design

~~8.11~~8.10 The following details of the mix deign must be provided to the ~~Principal~~Administrator:

a) Constituent quantities, including cementitious material content, per yielded cubic metre of concrete.

b) Nominated particle size distribution of aggregates, including fine, coarse and combined particle size distribution.

c) Nominated slump.

Test results for a laboratory trial batch (or batches)

~~8.12~~8.11 For each nominated mix, a slump which conforms to Clause 7.~~9~~8 must be determined and conformity demonstrated (where required) for:

a) Cementitious content per yielded cubic metre of concrete.

b) Compressive strength at age 7 days (F_7).

c) Compressive strength at age 28 days (F_{28}).

d) Flexural strength at age 7 days (F_{f7}).

e) Flexural strength at age 28 days (F_{f28}).

f) Indirect tensile strength at age 28 days (F_{t28}).

g) Slump.

h) Drying shrinkage.

i) Vebe reading, only for slipform concrete mixes.

j) Air content, if AEA is used.

k) Bleeding.

l) Age correction factor (AF) in accordance with Clause ~~10.22~~26.17. Derivation of AF is optional but, where adopted, it must be notified as part of the nominated mix submission. For ages beyond 28 days, the results must be reported progressively as they become available.

~~m) Coefficient of Thermal Expansion (if specified in the Contract documents). Results may be submitted up to 3 months after the laboratory trial mix compressive strength at age 7 days (F_7) (information only).~~

~~8.13~~8.12 All test specimens must be prepared using test methods in accordance with Clause ~~6~~7.

~~8.14~~8.13 Where it is impractical to prepare all specimens from a single batch, 2 batches of the laboratory trial mix must be prepared and the test specimens moulded in accordance with Table 8.1~~4~~3.

Table 8.1~~4~~3 – Specimen grouping

Batch Number	Specimen Grouping from Items Above
1	a) to g) inclusive
2	h) to k) inclusive, and c)(1)

Note:
(1) Repeat item c) to demonstrate batch consistency.

~~8.15~~8.14 The unit mass for all specimens tested under items b), c), d), e) and f) must be reported using test methods specified in Clause 10.~~9~~27 and Clause ~~24~~25.10.

~~8.16~~8.15 Test results must certify that the specimens were prepared specifically in accordance with this Technical Specification and using vibration as stipulated above.

Variations to authorised nominated mixes

~~8.17~~8.16 The authorised nominated mix may be varied without submitting a new nominated mix, unless the proposed variations from the current authorised nominated mix exceed the following amounts:

a) Cement and other cementitious material: 10 kg/m³ (subject to compliance with Clause 7.3).

b) Other constituent materials except admixtures and water: 5% by mass.

c) Admixture dosages: in accordance with Clause 5.243.

d) Water: unspecified.

~~8.18~~8.17 The ~~Principal~~ Administrator must be notified of such variations to an authorised mix before commencing production with the varied quantities.

~~8.19~~8.18 If it is intended to vary the quantities of the constituents in excess of the above amounts, or to change the type of admixture or the source of supply of any constituent, a new nominated mix must be submitted in accordance with Clause 8.1

~~8.20~~8.19 Tolerances on the particle size distribution of aggregates are specified in Clause 10.3.

9 Placing steel reinforcement

General

9.1 For CRCP, reinforcement must be placed as shown on the Drawings. Longitudinal steel must be placed on top of transverse steel and must provide a mass steel ratio within the range 0.65% to 0.70%, calculated in accordance with TfNSW Drawing DS2012/001190 (unless an alternative drawing is included in the Contract documents).

9.2 For other bases, including special slabs (refer to Clause 21), reinforcement must be placed as shown on the Drawings~~,~~. Reinforced PCP slabs are designated as PCP-R. Unless shown otherwise on the Drawings, steel mesh reinforcement must be placed as follows:

a) within 80 mm ± 20 mm of the finished top surface of the base slab, and

b) clear of all joints and edges by 80 mm ± 20 mm.

9.3 Reinforcement must:

a) be formed to the dimensions and shapes shown on the Drawings

b) be bent to an internal bend ~~radius~~ diameter in accordance with ~~Table~~ Clause 9.50

c) not be bent or straightened in a manner that will damage the material

d) not be used with kinks or bends not shown on the Drawings, and

e) not be heated for the purposes of bending.

9.4 Steel reinforcement placed in the Works must be free from loose or thick rust, grease, tar, paint, oil, mud, mortar or any other coating; however, it must not be in a smooth polished condition. Its surface condition must not impair its bond to the concrete or its performance in the concrete member.

9.5 Reinforcement must be 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.

Chair support

9.6 Reinforcement must be supported at the required positions using concrete, plastic or wire chairs. The chairs must be sufficiently wide at their base to avoid overturning. Timber or pieces of aggregate must not be used to support reinforcement. A support chair which is likely to impede compaction of the enveloping concrete must not be used. Any enclosed perimeter of the bar chair side elevation must have at least 25% voids, with a minimum gap in the chair below the reinforcement of 1.5 times the maximum nominal size aggregate in the concrete mix.

9.7 The chairs must be placed at spacings such that, during placing and compaction of the concrete, the permanent deflection or displacement of the reinforcement is no more than 2 mm from its required position.

9.8 The mass of steel reinforcement supported by any one chair must not exceed 10 kg. Chairs must be capable of supporting 200 kg mass without permanent distortion in excess of 2 mm.

9.9 The ends of bars forming a lapped splice must be securely wired together at a minimum of 2 locations.

9.10 For reinforcing fabric, splices must be measured as the overlap between the outermost wire of each sheet of fabric transverse to the direction of splice. This overlap must not be less than the pitch of the transverse wires plus 25 mm.

9.11 In CRCP, the support chairs must be placed under the transverse steel using a systematic pattern such that the spacing between any 2 adjacent chairs does not exceed 0.90 m in both the longitudinal and transverse directions. **Hold Point 4 Record**

HOLD POINT 4	
Process Held	Placement of concrete around steel reinforcement.
Submission Details	Certificate of conformity, signed by the Contractor, for installation of steel reinforcement and embedments.

Tiebars

9.12 The minimum length of a tiebar is 1.0 m. The minimum length of drill-ties is 0.75 m.

9.13 The method of insertion of tiebars must ensure:

a) no disturbance to the finished concrete surface

b) full reinstatement of the structural integrity of the affected slab

c) for fixed-form paving, vibration of all tiebars at their final positions by either internal vibration or by vibrating screed board, and

d) anchorage strength of at least 85% of the bar's yield strength.

9.14 At longitudinal tied joints, tiebars must be placed:

a) not less than 300 mm from a transverse untied joint (contraction or isolation joint)

b) not less than 200 mm from a transverse tied joint

c) at spacings as shown on the Drawings, with a tolerance of ± 20% for the spacing of individual bars, subject to the provision of the specified number of tiebars per slab, and

d) within the central third of the slab depth, but with a minimum vertical clearance of 30 mm from any crack inducer or sawcut. This clearance also applies to any bar or mesh which is required to function as a tiebar.

9.15 At transverse tied joints of jointed bases, tiebars must be placed not less than 300 mm from a longitudinal joint or slab edge.

9.16 Testing for tiebar anchorage (pull out), location and concrete compaction, must be conducted in accordance with Clauses 9.17 to 9.33.

Pull-out testing

9.17 For tiebars which have been inserted (in lieu of pre-placement) into a formed slab edge (either slipformed or fixed-formed), anchorage strength must be tested. Pull-out testing is not required in fixed-form paving if the tiebars are pre-placed and are subjected to internal vibration.

9.18 Testing must be undertaken within 30 days of paving.

9.19 Tiebars must be capable of withstanding a tensile pull-out stress equal to 85% of their yield stress. Testing must be terminated at the 85% level.

9.20 Pull-out testing must be undertaken at the following minimum frequency for each inserter:

a) one test per 20 m of joint until 4 consecutive conformities are achieved; and thereafter.

b) at a rate of 1 per 50 m of joint until a further 4 consecutive conformities have been achieved; and thereafter.

c) at a rate of 1 per 100 m of joint.

9.21 The frequency of pull-out testing is independent of transverse construction joints. The pull-out testing commences 5 m from the start of base paving under the Contract. If tiebars are inserted on both sides of a paving run, each side must be tested at the specified frequency.

9.22 A minimum of 5 bars must be tested in any paving trial.

9.23 If a nonconformity is encountered at any stage of the test, consecutive bars must be tested alternately at each side of the failed bar until 4 consecutive tests are performed without failure. Testing then reverts to the frequency in Clause 9.20 a).

9.24 Nonconforming bars must be replaced by using a suitable epoxy or polyester setting system to develop anchorage strength of at least 85% of the yield strength of the bar. Bar replacement must not disturb the concrete surface. The replaced bars must be tested at a minimum frequency of 1 in 2.

Locations and compaction of inserted tiebars

9.25 For tiebars which have been inserted (instead of pre-placement) at induced joints:

a) location conformity (plan position and depth) must be assessed in accordance with Clause 9.26 using a metal detector; and

b) cores must be taken in accordance with Clause 9.27 to ensure that the method of placement provides full compaction of concrete around and above the bars.

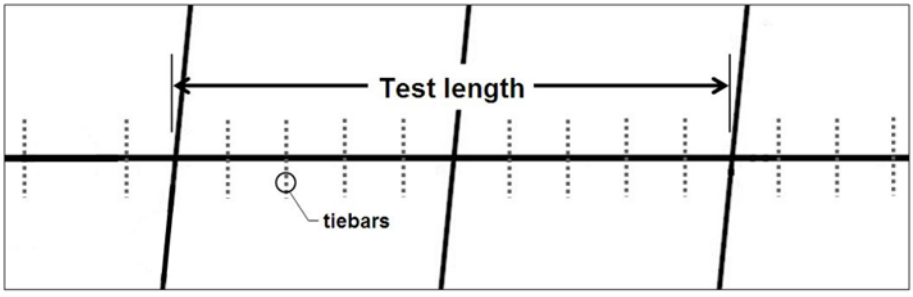
9.26 Locations must be assessed as follows:

a) for the paving trial, the location of every bar must be assessed; and thereafter

b) for each Sub-Lot, the location of every bar within 2 consecutive slabs must be assessed as shown in Figure 9.26 twice, until 10 consecutive conformities are achieved; and thereafter

c) for every second Sub-Lot, the location of every bar must be assessed within 2 consecutive slabs. If a nonconformity is detected, the frequency reverts to the frequency in Clause 9.26 b).

Figure 9.26 – Tiebar test length



9.27 Compaction must be assessed as follows:

a) for the paving trial: one core per 40 m of joint, or part thereof; and thereafter

b) one core per 100 m of joint until 5 consecutive conformities are obtained, and thereafter

c) one core per 200 m of joint.

9.28 If a nonconformity is detected at any stage, a Hold Point applies in accordance with Clause 25.40 and the testing frequency reverts to the frequency in Clause 9.27 b).

9.29 Where 2 or more inserters are used, the frequencies in Clause 9.27 apply to each inserter.

9.30 Coring must be carried out within 2 days of paving.

9.31 Cores must be located to intersect tiebars but must be offset from the longitudinal joint by 350 mm ± 50 mm and must not be less than 1.5 m from transverse contraction joints nor 3.0 m from transverse construction joints.

9.32 All cores must be inspected at the time of extraction. If there is any indication of visual non-homogeneity, corrective action must be implemented within 2 hours of extraction.

9.33 Each core must be tested for within-core variability in accordance with Clause 25.36.

Concrete cover below sawn joints

9.34 For tiebars which are located below sawn joints, the vertical cover to the bottom of sawcut must be assessed as follows:

a) for the paving trial, one test per 15 m of joint, or part thereof, and thereafter

b) one test per 30 m of joint until 15 consecutive conformities are achieved, and thereafter

c) one test per 50 m of joint.

9.35 If a nonconformity is encountered at any stage of testing, consecutive bars must be tested alternately at each side of the failed bar until 10 consecutive tests are performed without failure. Testing then reverts to the frequency specified in Clause 9.34 a).

9.36 Cores must not be taken for this purpose. A metal detector may be used to assess the depth below the finished surface in conjunction with physical measurement (at the same location) of the depth of sawcut.

9.37 This testing requirement also applies to any steel bar and mesh which is required to function as a tiebar.

9.38 At each location of nonconformity, a drilled stitch bar must be provided in accordance with TfNSW Drawings DS2013/001838 (unless an alternative drawing is specified in the Contract documents).

Dowels

9.39 Dowels must be installed ahead of paving and must:

a) comply with AS/NZS 3679.1 and be galvanised in accordance with AS/NZS 4680

b) be straight and free of irregularities, including burrs and protrusions, which could hinder their movement in accordance with this Technical Specification

c) be coated at one end with a tough, durable debonding agent of thickness 0.75 mm ± 0.25 mm over a minimum length of 275 mm. At formed joints, the debonding must be within the second-placed slab

d) when tested in accordance with Test Method ~~AGBT-T725~~TfNSW T366 (TS 02800.41), have an average bond stress of not more than 0.15 MPa

e) at expansion joints, have the debonded end capped to provide a clearance for movement equal to the width of the joint plus 15 mm (± 5 mm)

f) unless shown otherwise on the Drawings, be placed at mid-depth ± 20 mm, parallel to the pavement surface and normal to the line of the joint with tolerances as given below

g) be supported so that no part of the assembly, except for the dowel, crosses the joint. Details of the proposed dowel support system and the method of debonding must be include in the Quality Plan

h) be 450 mm long and be aligned parallel with the line joining the centroids of the adjacent slabs, unless shown otherwise on the Drawings

i) be perpendicular to, with centres along the line of the intended joint, within a tolerance of ± 25 mm, and

j) be placed not less than 150 mm from a longitudinal joint or slab corner.

9.40 Prior to placing concrete, the alignment tolerance of individual dowels at any location as measured in the dowel assembly is ± 2 mm.

9.41 The alignment tolerance of dowel location in the finished slab is ± 2 mm.

Testing general

9.42 The locations of steel reinforcement and dowels within the finished pavement must be confirmed using a metal detector.

9.43 Cores must not be taken for this purpose, except as required under Clause 9.25 or unless approved by the ~~Principal~~Administrator.

Protective coatings

9.44 Unless specified otherwise in the Contract documents, protective coated reinforcement must not be used.

Bending of steel reinforcement

9.45 Steel reinforcement must be bent in accordance with Clause 17.2.3.1 of AS 3600.

9.46 The bar must be bent without impact or damage to the bar either by cold bending around pins or by applying uniform heat not exceeding 450°C to, and beyond, the portion to be bent. Heated bars must not be cooled by quenching.

9.47 Reinforcement already bent and straightened or bent in reverse must not be bent again within 20 bar diameters of the previous bend.

9.48 Reinforcement partially embedded in concrete may be field bent, provided that the bending conforms to the above requirements and the bond of the embedded portion is not impaired as a result of bending.

9.49 The Quality Plan must include details of any proposal to bend anchor stirrups to facilitate slipform paving.

9.50 The nominal internal diameter of a reinforcement bend or hook is taken as the external diameter of the pin around which the reinforcement is bent. The diameter of the pin must be not less than the value determined from Table 9.50.

Table 9.50 – Internal diameter of bends and hooks

Type of Bar	Minimum Internal Diameter of Bend[(1)]
(a) Normal bends	
Fitments: bar grade 250 and wire grade 500	3db
Fitments: bar grade 500	4db

Type of Bar	Minimum Internal Diameter of Bend[1]
Mesh and bars other than in (b) and (c) below	5db
(b) Bends designed to be straightened or re-bent subsequently	
db ≤ 16 mm	4db
16 mm > db < 28 mm	5db
~~D~~db ≥~~3~~ 28 mm	6db
(c) Bends in reinforcement epoxy coated or galvanised either before or after bending	
db ~~£~~≤ 16 mm	5db
d~~D~~b ≥~~3~~ 20 mm	8db

Note:

[1] db is the nominal diameter of a bar or wire.

Welding

9.51 All welding must conform to the requirements of ~~ATS 5310~~MRTS71 *Reinforcing Steel*. For Grade 500 bars, the welding procedure must conform to the bar manufacturer's recommendations for control of heat input. For welded splices, bars may only be welded by an electrical method. The welded splice must comply with the tensile and bend tests specified for the parent metal.

Lapped splices

9.52 The minimum length of lapped splices must be in accordance with Clause 13.2 of AS 3600, unless shown otherwise on the Drawings.

9.53 Lapped bars splices not shown on the Drawings must have lengths not less than the values listed in Table 9.5~~2~~3. The ends of bars forming a lapped splice must be welded or securely wired together at a minimum of 2 locations.

Table 9.523 – Splice lengths

Bar Type	Bar Diameter (mm)	Splice Length (mm)
Deformed	12	360
	16	525
	20	600
	24	900
	28	1050
	32 and 36	1200
Plain (fitment)	db < 13	50 db[(1)], or 300, whichever is greater

Note:
[(1)] db is the nominal diameter of a bar or wire.

9.54 Splices in reinforcing fabric must conform to AS 3600 such that the 2 outermost transverse wires of one sheet overlap the 2 outermost transverse wires of the lapping sheet. The orientation of the sheets must be such that they mechanically engage each other (i.e. the bottom sheet has transverse wires uppermost and the top sheet has them underneath).

Mechanical splices

9.55 Mechanical splices must be of the type specified or an approved equivalent and used only at the locations shown on the Drawings. The splices must be installed in accordance with the manufacturer's recommendations.

9.56 When tested in tension or compression, mechanical bar splices must develop at least the nominal ultimate tensile or compressive strength of the smaller of the bars being tested.

Storage

9.57 Steel reinforcement must be supported above the surface of the ground and protected from damage and deterioration due to exposure.

10 Production and transport of concrete

General

10.1 The production and transport of concrete must:

a) prevent segregation or loss of materials

b) supply a homogeneous product, and

c) result in concrete workability, at the time of incorporation, which is compatible with the capacity of the paving equipment to achieve the specified compaction and a surface finish requiring only minimal manual finishing.

10.2 For slipform paving, the mixing, agitation and transport equipment must have an operational capacity which allows continuous paving at the target paving speed. In no case must the capacity be less than that required to maintain continuous paving with adequate allowance for mixer efficiency and control testing.

Production mixes

10.3 For producing a concrete mix, the authorised nominated mix must be targeted. Table 10.~~3~~6 shows the allowable tolerances on individual batches.

10.4 The mean content of each cementitious material within a Sub-Lot must be not less than that of the authorised nominated mix (after compliant variations in accordance with Clause 8.1~~7~~6).

10.5 The Contractor must maintain and monitor a Batching Record which records the actual masses of each ingredient in every batch, together with departures beyond the allowable tolerances. Do not incorporate nonconforming batches or loads into the Works.

10.6 The combined aggregate particle size distribution must be determined by the following methods:

Test Method A – by calculation:

Determine a separate particle size distribution in accordance with AS 1141.11.1 for each constituent aggregate and calculate the combined particle size distribution from the nominated mix proportions.

Test Method B – by wet-sieving:

Determine the combined particle size distribution by wet-sieving in accordance with TfNSW T329 (TS 02800.26) of the production mix for the fractions coarser than the 1.18 mm sieve.

For the fraction passing the 1.18 mm sieve, adopt the most recent result obtained using Method A.

Table 10.~~36~~ – Production tolerances (refer to Clause 10.3)

Description	Tolerance (% by mass)
Aggregate Particle Size Distribution:	
19.00 mm	± 2
13.20 mm	± 5
9.50 mm	± 5
4.75 mm	± 3
1.18 mm	± 5
0.600 mm	± 5
0.300 mm	± 5
0.150 mm	± 2
0.075 mm	± 0.5
~~Each Cementitious~~Other Materials:	~~± 2.0(1)~~
Cement	± 2.0(1)
SCM	± 4.0(1)
Admixtures	unspecified
Water(2)	± 15.0

Notes:

(1) Subject to compliance of the mean for the Lot, as specified above.

(2) The total batched water must be monitored relative to the authorised nominated mix and the water contained in the aggregates measured at least once per day. This value may be used for the full day of batching.

10.7 For the purpose of this clause, concrete which is mixed in a mobile mixer is deemed to be of a different mix to that which is mixed in a wet-batch plant.

10.8 Clauses 10.16 to 10.39 do not apply to SFRC, which is covered in Clause 32.

7 day compressive strength

10.9 7 day compressive strength testing must be undertaken at the same frequency as specified for 28 day compressive strength testing in accordance with Clause 26.

10.10 Whenever the 7 day compressive strength requirements are not met, the results must be submitted to the ~~Principal~~ Administrator with an assessment report and an assignable cause within 2 working days of testing.

10.11 The 7 day compressive strength requirements will be met if the 5 point rolling mean compressive strength is not less than the following lower warning limit (LWL):

$$LWL = \frac{F_7}{F_{28}} \times f_{cMin} + S_{30} \text{ MPa}$$

where:

F_7 is the 7 day compressive strength of the nominated mix.

F_{28} is the 28 day compressive strength of the nominated mix.

f_{cMin} is as specified in Clause 7.~~6~~5.

S_{30} is the standard deviation.

10.12 When production results become available for f_c and f_{c7}, the factor F_7/F_{28} must be replaced by f_{c7}/f_c. This must be done initially on receipt of 30 test values, and thereafter, at the contractor's discretion, but no less frequently than with each group of 30 new values.

10.13 Prior to 30 test values becoming available, a value of $f_{cMin}/10$ must be adopted for S_{30}. Thereafter, S_{30} must be calculated as the rolling standard deviation for 7 day compressive strength of not fewer than 30 test values.

10.14 The target value must not be less than $2S_{30}$ above the lower warning limit.

Frequency of moulding of flexural test specimens

10.15 Clauses 10.16 to 10.20 do not apply to SFRC, which is covered in Clause 32.

10.16 Flexural strength requirements apply to base pavement mixes, including shoulders. They do not apply to non-pavement mixes for applications such as anchors and kerbs.

10.17 28 day specimens must be prepared at the minimum frequencies given in Table 10.20. Specimens for 7 day testing are required only from the paving trial.

10.18 Specimens must be prepared in accordance with Table 7.6.

10.19 Flexural test specimens must be prepared in sets of three (3 for each of 7 day and 28 day testing). All specimens within a set must be prepared from the same sample of concrete. Flexural strength test specimens must be prepared from batches of concrete from which cylinders are prepared for 28 day compressive strength under Clause 7.~~6~~5.

10.20 In the paving trial, the 7 day and 28 day flexural strength test specimen sets must be prepared from the same batch.

Table 10.20 – Test frequency of flexural strength specimens (refer to Clause 10.17)

	Minimum Frequency (Sets)	
	7 day Testing	**28 day Testing**
Paving Trial	As per Clause 12	
and thereafter		
From the first 3 Sub-Lots using that mix	Nil	1 per Sub-Lot
and thereafter		
For daily outputs ≤ 200 m³	Nil	1
For daily outputs > 200 m³	Nil	1 per 400 m³

Flexural strength test specimens

10.21 Clauses 10.22 to 10.28 do not apply to SFRC, which is covered in Clause 32.

10.22 The flexural strength (f_f) of the concrete represented by a set of specimens prepared from one sample is the mean of individual results not more than 0.5 MPa from the median value.

10.23 Sampling must be in accordance with AS 1012.1. For agitator delivered concrete, sampling must take place at the point of discharge after retempering.

10.24 Test specimens for determining the flexural strength of concrete must be standard beams of nominal size 100 mm × 100 mm × 350 mm conforming to Clause 7.~~6~~5.

10.25 All specimens within a set must be prepared from the same sample of concrete, with compaction by internal or table vibration.

10.26 Specimens must be prepared in accordance with Table ~~R83.7~~7.6 and inspected, conditioned and tested in accordance with AS 1012.11.

10.27 The unit mass of all 28 day flexural strength test specimens at age not less than 7 days must be determined in accordance with AS 1012.12.2, amended as follows:

a) Mass testing must be in the saturated-surface-dry condition and without dressing of voids (refer to Test Method TfNSW T368 (TS 02800.43)).

b) The unit mass for a set of beams is the average of results not more than 20 kg/m³ from the median value. The average is rounded to the nearest 10 kg/m³.

10.28 The unit mass results for flexural strength test specimens must be reported regularly to the ~~Principal~~Administrator, but the results must not be used in the calculation of the representative cylinder unit mass (RCUM).

Assessment of 28 day flexural strength

10.29 Clauses 10.30 to 10.34 do not apply to SFRC, which is covered in Clause 32.

10.30 A statistical check of the flexural strength of each nominated pavement mix must be made using consecutive 28 day test results.

10.31 Should any specimen be tested more than 28 days after preparation, the equivalent 28 day flexural strength is the flexural strength divided by the AF applicable to the age of the specimen at the time of test (refer to Clause 26.1~~8~~6).

10.32 The 5 point rolling mean for flexural strength and standard deviation for each group must be calculated.

10.33 The results must be assessed in accordance with Table 10.3~~9~~3. If the rolling mean flexural strength falls below f_{fMin} or the rolling standard deviation exceeds 0.5 MPa, action must be taken in accordance with Table 10.33.

Table 10.33 – Rolling mean flexural strength

Rolling Mean Flexural Strength	Required Action
0.95 f_{fMin} less than or equal to 28 day rolling mean flexural strength less than f_{fMin}	Promptly implement corrective action to ensure conformity as specified.
28 day rolling mean flexural strength less than 0.95 f_{fMin}	Observe the Hold Point specified.
28 day rolling coefficient of variation greater than 11.0%	Promptly implement corrective action to ensure conformity as specified.

10.34 The test results must be submitted to the ~~Principal~~ Administrator within 2 working days of testing.

Process control charts

10.35 Process control charts must be developed in accordance with AS 3940 and AS 3942 for the parameters listed in Table 10.39 ~~T~~for each authorised nominated mix in use (excluding non-pavement mixes such as those for anchors and kerbs).

10.36 Analysis must generally be in accordance with AS 3942 Clause 5, except that the decision rules shown in the Table 10.39 must be followed for the identification of assignable causes that require corrective action.

10.37 Corrective action under the Quality Management System must be taken if:

a) tests are not carried out at the required frequency, or

b) results are not recorded and/or reported within the specified time.

10.38 A Hold Point applies to the use of the relevant authorised nominated mix if:
Hold Point 5 Record

a) the rolling mean 7 day compressive strength falls below the specified minimum

b) the rolling mean 28 day flexural strength falls below the specified minimum, or

c) corrective action is not promptly implemented.

HOLD POINT 5 (Where specified in Clause 10.38)	
Process Held	Use of the concrete mix in the pavement base.
Submission Details	The following must be submitted to the ~~Principal~~ Administrator prior to the use of the mix: a) Results for compressive and flexural strength, relative compaction and thickness for the same Sub-Lot. b) Proposal for corrective action to achieve conformity.

10.39 Following release of the Hold Point, the 7 day compressive and flexural strength must be monitored the results submitted to the ~~Principal~~ Administrator with an assessment report within 2 working days of testing.

Table 10.39 – Control charts (refer to Clauses 10.35 and 10.36)

Parameter	Control Chart Requirements		Decision Rules[2]
	Chart Types and Controls	**Specifications and Criteria**	
7 day compressive strength	a) Mean chart, showing:	As per AS 3942 Clause 4.3.2	
	– target value	Refer to Note 5	
	– LWL	As per Clause 10.~~9~~11	
	– 5-point rolling mean	As per Clause 10.~~9~~11	A
28 day flexural strength[8]	a) Mean chart, showing:	As per AS 3942 Clause 4.3.2	
	– target value	Refer to Note 5	
	– LWL	As per AS 3942 Clause 4.3.2 and Note 7	
	– specified limits	As per Clause 10.30 to 10.34	
	– 5-point rolling mean	As per Clause 10.30 to 10.34	B
	b) Coefficient of variation (CoV) chart, showing:		
	– Upper warning limit (UWL)	9.0%	
	– specified limit	As per Clause 10.30 to 10.34	
	– 5-point rolling CoV	As per Clause 10.30 to 10.34	B
Cylinder unit mass	a) Mean chart, showing:	As per AS 3942 Clause 4.3.2	
	– LWL	LWL = RCUM in paving trial, less 30 kg/m³	
	– RCUM for paving trial(s)		A
	b) Standard deviation chart, showing:	As per AS 3942 Clause 4.3.4	
	– 10-point rolling standard deviation		
	– process standard deviation S100	UWL = 15 kg/m³[4]	E
Fraction passing 75 µm sieve[6]	a) Sample chart, showing:	Based on calculated combined grading for all possible stockpile combinations	
	– specified upper limit	Upper control limit = 7.0% (Clause ~~2.4~~5.7)	D
	– individual results		C

Notes:

(1) UCL:upper control limit
UWL: upper warning limit
LCL: lower control limit
LWL: lower warning limit
(2) Key to decision rules:
A: Any value below LWL
B: In accordance with Clause 10.353
C: Five consecutive increasing values
D: Any value above the UCL
E: Any value above the UWL
(3) The individual values to be charted are those calculated to represent the Sub-Lot after averaging of pair / group test results in accordance with the relevant clause of this Technical Specification.
(4) The process mean and standard deviation (S_{100}) must be calculated using 100 values (i.e. k = 100). Prior to 100 values becoming available, all available values must be used.
(5) At the start of production of an authorised nominated mix, base the target value on the results of the trial mixes. When 25 test values are available, the target value may be revised at the Contractor's discretion and conditional on the results having been conforming. A further revision may be conducted when 100 test values are available. At all times, the target value must be at least 3 standard deviations above the minimum specified value.
(6) The specified upper limit applies to all authorised nominated mixes but control charting of this parameter is only required where manufactured or unwashed natural sand is used.
(7) The LWL for 28 day flexural strength must be at least one process standard deviation above the minimum specified limit.
(8) This parameter is not applicable to SFRC.

Mixing, transport, consistence and air content

10.40 The handling, storing and batching of materials and the mixing, transport and consistence of concrete, including any retempering, must conform to AS 1379 Sections 3 and 4 and Appendix A, all as modified by the following requirements:

a) Aggregates which have become intermixed or contaminated with foreign matter must not be used.

b) Cementitious materials must be weighed separately from each other.

c) For volumetric batching of water, a measuring device calibrated in one litre increments to an accuracy of ± 2% of the value shown on the indicating device must be used.

d) For liquid admixtures, the metering equipment must measure the volume, or mass, of liquid to an accuracy of ± 5% of the value shown on the indicating device.

e) In addition to the terms defined in Clause 3:

i. For central batch mixers discharging into tipper trucks, a 'load' may comprise more than one 'batch'.

ii. For mobile mixers, a 'batch' is deemed to be the same as a 'load'. A load must not comprise more than a single batch. After the completion of batching, the entire batch of concrete from the mixer must be discharged before any further charging takes place, with the exception of conforming retempering.

iii. For continuous mixers, a 'batch' is deemed to be a 'load' which has been produced in a single discrete operation.

10.41 The Quality Plan must include details of the proposed methods of handling, storage and batching of materials, and the method of charging the mixer, including the proposed sequence of addition of ingredients. The method and sequence of charging must be consistent with the recommendations of the suppliers of mix additives.

Mixing time

10.42 The minimum mixing time MT_{min} must be determined as defined in Clause 10.43 c).

10.43 The term 'mixing time' is applicable to batch mixers only. It comprises only that mixing carried out at the specified mixing rate (ie, excluding agitation) and is measured as follows:

a) For stationary batch mixers, mixing time is measured from the time at least 90% of the total water content and all other the ingredients are in the mixing drum, until mixing ceases, or after specified revolutions. Up to 10% of the total water may be added beyond the defined mixing time on the following conditions:

i. for split-drum mixers, a minimum of 30 secs of mixing must be provided after the final addition of water, and

ii. for twin-shaft mixers, a minimum of 15 secs of mixing must be provided after the final addition of water.

b) For mobile mixers, mixing time is measured from the time all the ingredients, including the total added water content, are in the mixing drum, until mixing ceases, or after specified revolutions.

For mobile mixers, refer to Clause 10.71 for retempering provisions.

c) The minimum mixing time MT_{min} must be determined from mixer uniformity testing in accordance with ~~Annexure~~ Appendix B and the following:

i. for twin-shaft mixers, the mixing time after charging must not be less than 30 seconds plus 5 seconds for each cubic metre (or part thereof)

ii. for all other stationary batch mixers, the mixing time after charging must not be less than 54 seconds plus 6 seconds for each cubic metre (or part thereof), and

iii. for mobile batch mixers, the mixing time must not be less than that shown on the mixer identification plate (as required and defined by AS 1379), or 3.0 minutes, whichever is the greater.

The full period of mixing must be provided at either the testing station or the point of placement. All other mixing and agitation for the purpose of assessing the actual mixing time for a specific batch must be ignored.

For mobile mixers which do not have a mixer identification plate, the minimum mixing time is 3.5 minutes.

For SFRC, Clause 32 also applies.

d) The maximum mixing time is 5 minutes for split-drum and twin-shaft mixers, or 10 minutes otherwise.

Mixer uniformity testing

10.44 Testing for conformity of mixers must be undertaken in accordance with ~~Annexure~~ Appendix B. **Hold Point 6** **Record**

HOLD POINT 6	
Process Held	Production of concrete for paving (including paving trial).
Submission Details	Results demonstrating conformity of mixer uniformity, except for C_oV_C and C_oV_{MUV}, which are assessed at a date no greater than 8 days after the uniformity assessment.

Admixture addition

10.45 The Quality Plan must include details of how admixtures will be incorporated in the mix in accordance with the requirements of this Technical Specification.

10.46 This clause does not cover the addition of water, which is covered under Clause 10.71.

Incorporation during initial batching

10.47 Prior to their introduction to other materials, admixtures must be separately and thoroughly diluted in the mixing water by one of the following methods:

a) addition into the water weigh-hopper, or

b) direct introduction into the water feed line during water batching.

10.48 They must be incorporated in accordance with the manufacturer's instructions, and by a method which ensures that no adverse interaction occurs.

Addition of admixtures to a mobile mixer after completion of batching

10.49 Immediately after addition, the mixing mechanism must be operated at the designated mixing speed for not less than 30 revolutions or for such additional time as may be necessary to re-establish uniformity of the mix, except that if assurance is not available that the batch was initially mixed for 55 revolutions, the adjusted batch must be re- mixed for a minimum of 55 revolutions.

10.50 Incorporate admixtures in accordance with the manufacturer's written recommendations.

Batch delivery docket

10.51 An identification certificate (delivery docket) which is pre-numbered and issued sequentially in accordance with the order of batching must be provided with each batch of concrete. This certificate must record the details required to establish the time of Completion of Batching and the total allowable quantity of water in the batch.

10.52 Depending on the mixer and transport types, this may require the recording of times for charging, and/or mixer discharge and/or slump adjustment.

10.53 Any addition of water which occurs after the Completion of Batching must be in accordance with Clause 10.71.

10.54 Any addition of admixture which occurs after the Completion of Batching must be in accordance with this Clause 10.

10.55 No other materials are allowed to be added to a mixed batch before its complete discharge. Concrete remnants from previous loads must not be incorporated into the Works.

10.56 The Quality Plan must include details of how the identification certificate will be monitored for compliance with the batching requirements of this Technical Specification.

Consistence (Slump)

10.57 Consistence of concrete must be tested by the slump test in accordance with AS 1012.3.1, within 40 minutes of the Completion of Batching.

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

10.59 Sampling must be undertaken as follows:

a) For concrete delivered by tipper trucks, obtain a composite test sample in accordance with AS 1012.1 Clause 7.3. Take the sample before discharge from the truck using a shovel or scoop. Exclude the top 100 mm of concrete.

b) For concrete delivered by agitators, obtain an individual sample in accordance with AS 1012.1 Clause 7.2.2.

10.60 The slump must be within the following limits from the nominated slump:

a) slip-formed concrete: ± 10 mm

b) fixed-formed concrete: ± 15 mm.

10.61 For any sample, if the measured slump is not within the specified limits, one repeat test from another portion of the same sample must be immediately carried out. If the result from the repeat test falls within the specified limits, the concrete represented by the sample is accepted as conforming.

10.62 If the result from the repeat test falls outside the specified limits, the following applies:

a) For concrete delivered by tipper trucks, the concrete is deemed to be nonconforming.

b) For concrete delivered by agitators, the batch may be re-mixed and re-tested within a limit of 40 minutes from the Completion of Batching. If desired, it may be retempered in accordance with the conditions stated in Clause 10.71.

10.63 Concrete which is nonconforming in relation to consistence must not be incorporated into the Works.

Minimum frequency of routine testing - Tipper delivery

10.64 For initial daily slumping, every load before discharge must be tested until there is 8 consecutive conforming loads. The standard deviation (SD) of these 8 loads must be calculated as follows:

a) If the SD is less than or equal to 8.0 mm, proceed with process slumping in accordance with Clause 10.65.

b) If the SD is greater than 8.0 mm, continue slumping every load until any 8 consecutive loads have a SD less than or equal to 8.0 mm.

10.65 For process slumping:

a) Every fourth load must be tested

b) Every load must be intermediate visually checked load before discharge~~, and~~

c) Any load which appears, in the opinion of either party, to be nonconforming must be tested for slump, and

d) If a nonconforming slump is measured, slump tests must be carried out on all loads thereafter (before discharge) until the SD of 6 consecutive loads is less than or equal to 8 mm, at which time testing may revert to each fourth load.

10.66 Visual assessment for process slumping must only be carried out by the testing staff, and only at the testing station. Visual checks must be recorded as, for example, V30 and V40 for Visual 30 mm and 40 mm respectively.

10.67 Additionally, slump testing must be carried out on every load from which samples are taken for other tests on the concrete or its constituents.

Minimum frequency of routine testing - Mobile mixer delivery

10.68 For initial daily slumping, every load must be tested before discharge until there are 4 consecutive conforming batches. Thereafter, every alternate batch for slump is tested.

10.69 Additional slump tests must be carried out as required in accordance with the provisions for retempering in Clause 10.71.

Retempering

10.70 Concrete which is delivered by other than a mobile batch mixer must not have water or any other ingredient added to the mixed batch.

10.71 Concrete which is delivered by mobile batch mixer may be retempered in accordance with the following conditions:

a) Retempering is allowed only within 40 minutes of the Completion of Batching.

b) Retemper only in the presence of the Contractor's representative who has been previously nominated to the ~~Principal~~ Administrator for this purpose.

c) Retemper only at the batch plant, the testing station, or the point of placement.

d) Immediately after retempering, re-mix the batch at the designated mixing speed for not fewer than 30 revolutions or for such additional time as may be necessary to re-establish uniformity of the mix.

e) Record the quantity of added water on the identification certificate for that batch. If water is added after the commencement of discharge, record the estimated remaining quantity of concrete at that time.

f) Immediately after condition (d) has been satisfied, test the slump for conformity.

g) Mould test cylinders for compressive strength from the retempered mix, in accordance with this Technical Specification. These cylinders are additional to the routine testing requirements.

10.72 Nonconforming concrete must not be used in the Works.

10.73 The Quality Plan must include details of how concrete supply will be monitored for conformity with these retempering provisions.

Forming time

10.74 The maximum Forming Time for each authorised nominated mix must be determined with consideration of the prevailing weather conditions and concrete temperature.

10.75 The Quality Plan must include details of the procedure to determine the maximum forming time.

10.76 The actual forming time must be monitored and recorded for any load exceeding:

a) 90 minutes for air temperatures less than 30°C, or

b) 60 minutes for air temperatures greater than or equal to 30°C.

10.77 Conformity of such a load is conditional on the conformity for compaction and compressive strength of cores from that specific load.

Air content of concrete

10.78 For mixes that contain an air-entraining agent, the air content must be tested in accordance with AS 1012.4.2 for conformity with Clause 7.1~~5~~4.

10.79 Daily testing at the following minimum frequency must be carried out:

a) one per load until 3 consecutive conforming results are obtained, and thereafter

b) one per 50 m³ until 4 consecutive conforming results are obtained, and thereafter

c) one per 200 m³ for the remainder of the day.

10.80 Testing under Clause 10.79 b) and c) must be on loads of concrete from which cylinders are moulded for 28 day compressive strength under Clause 26.1.

10.81 For any sample, if the measured air content is not within the limits specified, one repeat test from another portion of the same sample must be immediately carried out. The concrete represented by the sample is accepted as conforming if the value obtained from the repeat test falls within the specified limits.

10.82 The frequency reverts to that specified under Clause 10.79 a) if a nonconforming result is obtained at any stage of testing.

10.83 Air entrained concrete with an air content higher than the specified range is nonconforming and must not be used in the Works, except that concrete batched for base may be used in anchors and subgrade beams subject to conformity with the relevant requirements.

10.84 Air entrained concrete with an air content of less than the specified range is nonconforming. However, such concrete may be used in the Works on condition of the conformity of the compressive strength of cylinders from that specific load which have been obtained and tested in accordance with this Technical Specification. This testing is in addition to routine random sampling, unless that particular load has been chosen in the random selection process.

Transport of mixes for fixed-form paving

10.85 Agitator vehicles must be used to deliver concrete which will be placed manually except that material transfer placers (MTP) and tipper trucks may be used where slump and haul lengths are such that segregation does not occur and compaction and finishing of the mix is not compromised.

11 Concreting personnel

General

11.1 The Quality Plan must include the name of the Paving Supervisor with details of their qualification(s) and experience in concrete paving.

Paving Supervisor

11.2 The Paving Supervisor must:

a) hold a TfNSW Concrete Paving Crew Grey Card

b) have suitable qualification(s) in concrete paving, and

c) be present during all stages of the paving operations until implementation of the curing regime.

11.3 For the purpose of Clause 11.2, paving operations include the following activities:

a) establishment of stringlines

b) fixed form placement

c) placing and fixing reinforcement, tiebars and dowels

d) receiving and placing concrete

e) operation of slipform pavers or vibrating screeds, and

f) compaction, finishing, texturing, curing, debonding and early age protection of concrete.

Paving Crew

11.4 In addition to the Paving Supervisor, at least half of the remaining crew involved in concrete paving operations must hold a TfNSW Concrete Paving Crew Grey Card.

The TfNSW Concrete Paving Crew Grey Card course is delivered by the Australian Society for Concrete Pavements (ASCP). It is available as a scheduled course, or it can be organised on a project-specific basis by contacting ASCP.

11.5 At least 10 working days prior to the first concrete paving, the names of the personnel who will be involved in concrete paving operations; which of these persons hold a TfNSW Concrete Paving Crew Grey Card; and corresponding evidence of this must be submitted to the ~~Principal~~Administrator.

11.6 At least 4 working hours prior to concrete paving, a statement stating that at least half of the personnel who will be involved in concrete paving operations hold a TfNSW Concrete Paving Crew Grey Card must be submitted to the ~~Principal~~Administrator. **Hold Point 7** **Record**

HOLD POINT 7	
Process Held	First concrete base in the Works, including paving trial.
Submission Details	Details of the paving crew must be submitted to the ~~Principal~~ Administrator in accordance with Clauses 11.5 and 11.6.

12 Paving concrete

General

12.1 Paving of CRCP must precede paving of adjacent jointed base unless they are separated by an isolation joint. Where practicable, paving of travel lanes must precede paving of adjacent shoulder lanes.

12.2 Where practicable, paving must be carried by slipform method using equipment in accordance with this Technical Specification.

12.3 The slipform and fixed-form paving operations must be programmed to optimise the ride quality and construction standards of the finished pavement in accordance with this Technical Specification.

12.4 The Quality Plan must include details of the equipment and methods to be used for placing, spreading and finishing the concrete base.

12.5 For each of the proposed slipform paving configurations, the following parameters must be nominated:

a) maximum paving speed (instantaneous, not average)

b) target (optimum) paving speed

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

d) gross operating mass per metre of paving width.

12.6 For fixed-form paving, the following parameters must be nominated:

a) the size and number of vibrators, and

b) the pattern and spacing of vibrator insertions.

12.7 For transition zones, the following information must be provided:

a) the proposed technique for paving at transverse construction joints, including both slipform and fixed form operations, at both the start and finish of paving runs

b) 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

f) the proposals to ensure suitable workability for manual placement of the mix within the transition zone, and

g) the equipment type and its method of use to provide surface vibration.

Slipform (mechanical) paving

12.8 The Quality Plan must include details of the equipment and methods to be used for placing, spreading and finishing the concrete base, including the parameters nominated in Clause 12.37 for each of the proposed slipform paving configurations.

12.9 The slipform paver must be a self-propelled machine and must include the following features:

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

b) means of spreading the mix uniformly and regulating the flow of mix to the vibrators and conforming plate without segregation of the components

c) internal vibrators capable of compacting the full depth of the concrete to produce a dense and homogeneous slab with a smooth uniform finish requiring a minimum of hand finishing, and

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

12.10 The paver must be regularly inspected and serviced so that it is maintained at all times in full operating condition consistent with the manufacturer's specifications. Key items such as vibrators and sensors must be monitored throughout the paving process.

12.11 The Quality Plan must include details of a system which can provide an indication of any malfunction of each individual vibrator.

12.12 The supporting surface for the tracks of the paver, curing machine and any other equipment in the paving and curing trains must be maintained in a smooth and firm condition.

12.13 The delivery, spreading and paving activities must be planned and coordinated to optimise the continuous and uniform progress of the paver and to minimise discontinuities in the work.

12.14 Details of any interruptions to the progress of the paver, including the reason, location, and duration must be recorded.

12.15 A transverse construction joint must be formed in accordance with Clause 19 if an interruption to paving occurs which is likely to result in a loss of integrity of the concrete mass.

12.16 Should subsequent testing at the location of an interruption indicate the presence of non-uniform or nonconforming concrete, the affected section must be removed and replaced with conforming concrete in accordance with Clause 30.

12.17 The mechanical paver must spread, compact, screed and finish the freshly placed concrete so as to produce a dense and homogeneous slab with a smooth uniform finish requiring a minimum of hand finishing.

12.18 The edge produced must maintain its shape and must not sag or tear. If excessive bleed water occurs, such that it flows over the slab edge, paving must cease until the consistence of the mix is adjusted to prevent such flow or until the mix is redesigned.

12.19 At locations where the paver is unable to fully compact and finish the concrete (such as, but not confined to, transition Sub-Lots), supplementary fixed-form paving methods in accordance with Clause 12.2~~2~~1 to Clause 12.32 must be used.

12.20 Gaps under side-forms must be limited such that the specified systematic vibration and compaction can be achieved throughout the slab with only minimal mortar losses and such that the requirements of Clause 19 are met.

Fixed-form (manual) paving

12.21 The Quality Plan must include:

a) details of the equipment, including the size and number of vibrators, and

b) procedures for placing, spreading and finishing the concrete, including the pattern and spacing of vibrator insertions.

12.22 The formwork must:

a) be designed and constructed so that it is braced in a substantial and unyielding manner

b) debonded so that it can be removed without damaging the concrete

c) such that the screeding surface will be within the tolerances of the specified levels of the finished base surface, and

d) only have limited gaps such that the specified systematic vibration and compaction can be achieved throughout the slab with only minimal mortar losses and such that the requirements of Clause 19.49 are met.

12.23 The concrete must be deposited and spread uniformly and without segregation within the formwork by means other than vibration.

12.24 The concrete must be compacted using internal vibrators. Suitable vibrator operating parameters must be established and documented for the specific site conditions using systematic spacing and durations to achieve a homogeneous slab with uniform and thorough compaction.

12.25 Prior to the demonstration of such conformity, one of the 3 methods listed in Table 12.~~31~~26 must be adopted and operating parameters which are no less thorough than the guidelines provided must be used.

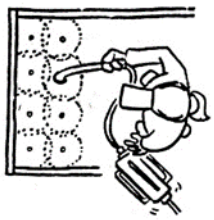
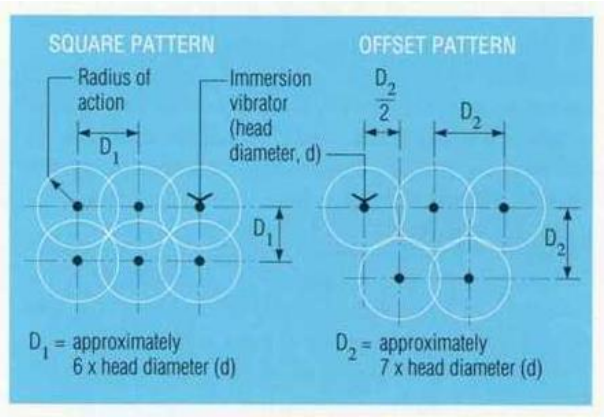
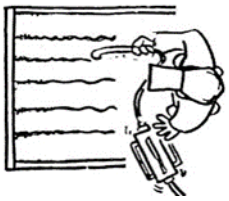
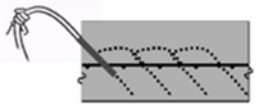
12.26 Internal vibrators used must be used with the following operating parameters:

a) a minimum diameter of 50 mm

b) operating at a frequency of between 8,000 and 12,000 vibrations / minute (130–200 Hz), and

c) systematic procedures using one of the methods shown in Column 1 of Table 12.26.

Table 12.26 – Internal vibration methods (refer to Clauses 12.25 and 12.26)

Method	Diagram	Guideline Parameters[1]
1. Dip method		a) the spacing D1 is not greater than 300 mm, and D2 is not greater than 350 mm b) insertion durations are 10 seconds minimum, and c) withdrawal speed does not exceed 1.5 m/minute.  Source: C&CAA T43 (1995) 'Concrete Practice on Building Sites'. SAA Handbook HB67–1995, jointly as Cement & Concrete Association publication.
2. Drag method		a) vibrator paths at spacings not greater than 350 mm, and b) travel speed not exceeding 1.5 m/minute.
3. Modified Drag method (for reinforced pavement)	 (Section view)	a) vibrator paths at spacings not greater than 350 mm b) insertion spacings not greater than 350 mm c) nett horizontal travel speed not greater than 1.5 m/minute, and d) withdrawal speed not greater than 1.5 m/minute.

Note:

(1) The vibration intensity required to achieve compaction conformity will vary according to factors such as the workability of the concrete and the characteristics of the compaction equipment. The guideline parameters are specified as minimum levels only, and higher compaction levels may be required to produce conforming results.

12.27 The number of standby vibrators must be not less than one fourth of the number in use, with a minimum of one.

12.28 Following internal vibration, the slab must be compacted and finished by at least 2 passes of a hand-guided vibratory screed with the following operating parameters:

a) traverse the full width of the slab on each pass

b) the screed's length must be compatible with the width of the slab under construction

c) constructed of tubular steel trusses or rigid metal and/or timber, and

d) operating at a frequency of between 3,000 and 6,000 vibrations / minute (50 – 100 Hz) and a minimum amplitude of 0.3 mm.

12.29 A suitable head of concrete must be maintained in front of the screed over its whole length for uniform transmission of vibration into the slab, to produce a dense and homogeneous slab with a surface finish that requires minimum hand finishing.

12.30 At least 2 passes of the screed must be provided after any significant disturbance of the concrete surface, such as by walking on the mix.

12.31 Power trowelling must not be used on the surface.

12.32 A transverse construction joint must be formed in accordance with Clause 19 if an interruption to paving occurs which is likely to result in a loss of integrity in the concrete mass. If subsequent testing at the location of an interruption indicates the presence of non-uniform or nonconforming concrete, the affected section must be removed and replaced with conforming concrete in accordance with Clause 30.

Placing and paving operations

12.33 The subbase at the time of base paving must be clean and free of loose or foreign

matter, including sealing aggregate, and must not hold ponded water.

12.34 Where the subbase is lean-mix concrete (LCS), it must be treated with debonding agent in accordance with ~~ATS 3520~~MRTS39 *Lean-mix Concrete Subbase*.

12.35 Where the subbase is asphalt, its surface at the time of base paving must be in a condition which minimises the absorption of mortar and water from the base concrete.

12.36 Where the subbase is other than LCS or asphalt, it must be sealed with a sprayed bituminous or bitumen emulsion seal.

12.37 Concrete must be placed, paved and finished so as to:

a) prevent segregation or loss of materials

b) prevent premature stiffening

c) produce a uniform dense and homogeneous product throughout the pavement

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

e) provide the specified thickness and surface finish.

12.38 The Contractor must maintain records showing the location of each load of concrete in the finished work in accordance with MRTS50 Specific Quality System Requirements~~the provisions for traceability included in the Contract documents~~. The method of traceability must be sufficiently accurate to enable subsequent identification of specific loads for examination and/or testing. Details of the method of traceability must be included in the Quality Plan.

13 Temperature

Concrete temperature

13.1 The concrete temperature at the point of ~~placement~~ discharge must be measured and recorded in accordance with ASTM C1064M.

13.2 Concrete must not be placed in the Works if its temperature at the point of discharge from transport vehicles is less than 10°C or more than 32°C, except that when the diurnal air temperature changes are greater than or equal to 20°C, the upper limit of

temperature of concrete to be placed in the Works is 30°C.

~~13.3 If specified in the Contract documents, the concrete temperature at the point of discharge must be measured and recorded in accordance with ASTM C1064M.~~

Air temperature

~~13.4~~13.3 The air temperature outdoors in the shade at the paving site, but remote from artificial influences such as machinery exhaust outlets, must be measured and recorded.

~~13.5~~13.4 The air temperature must be monitored at intervals not exceeding 30 minutes. Concrete batching must stop when the air temperature reaches 32°C and is rising.

~~13.6~~13.5 Concrete must not be placed in the Works when the air temperature is below 5°C or above 35°C.

Placing and finishing concrete during hot weather may require the Contractor to implement additional precautions to control workability, setting times, strength and unplanned cracking. This is particularly important if the air temperature at the point of placement is likely to exceed 35°C, or exceed 30°C for a prolonged period during placing and finishing operations, and/or when strong dry winds are present.

Where adverse conditions are likely to occur during paving, the Contractor should develop and implement a thermal control plan in their Construction Procedures. The plan should define maximum allowed concrete temperatures at discharge, maximum allowed temperature differential between the top and bottom of the slab during early hydration, and temperature monitoring procedures during the first 72 hours after placement.

Precautions may include, but not be limited to:

a) Mix design to minimise heat of hydration

b) Program paving to occur during more favourable conditions, and cease paving during adverse conditions

c) 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.

d) 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.

The Administrator may agree to the Contractor continuing to batch up to an air temperature of 35°C where appropriate precautions have been implemented (as per the Contractor's Construction Procedures) and demonstrated to be effective on prior lots, including the paving trial.

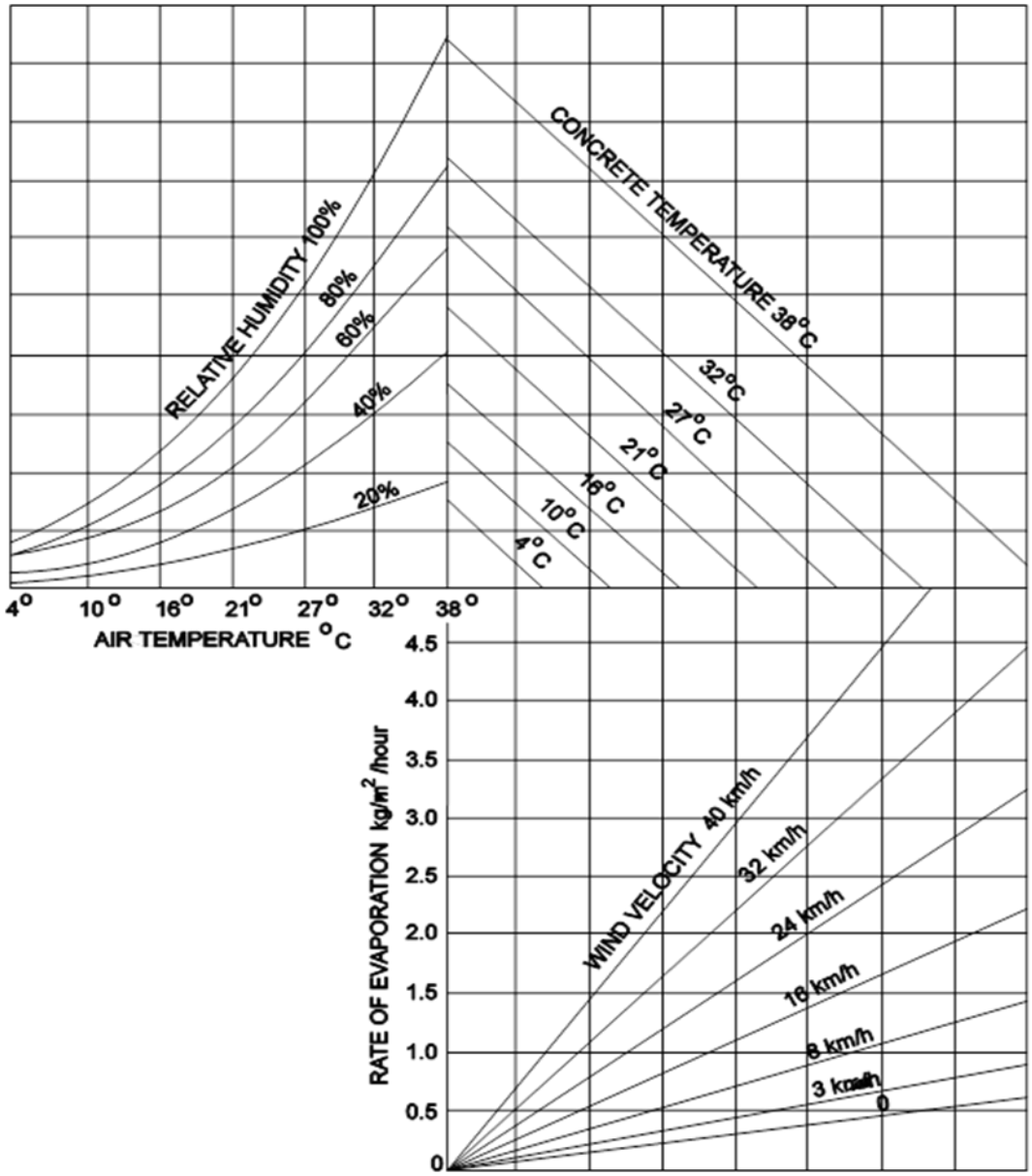
14 Prevention of moisture loss

14.1 The Quality Plan must include details of what meteorological or other data will be collected, how such data will be used and what measures will be taken to restrict the evaporation of water from the concrete surface and to limit the incidence of plastic shrinkage cracking.

14.2 If an evaporation retarder is used to restrict the evaporation of water, it must be applied as a fine uniform spray. Any subsequent finishing operations must be carried out in such manner that does not incorporate the evaporation retarder into the surface mortar. The plastic concrete must be regularly inspected to monitor the effectiveness of the adopted procedures.

14.3 The evaporation rate must be determined using Figure 14.3.

Figure 14.3 – Evaporation from Concrete Freshly Placed on Site



Note:

The graph shows the effects of air temperature, humidity, concrete temperature and wind velocity together on the rate of evaporation of water from freshly placed and unprotected concrete. An example follows:

With 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 will be 1.6 kg/m²/h. To determine the evaporation rate from the graph, enter the graph at the air temperature (in this case 27°C), and 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). Move vertically down to the respective wind velocity curve (in this case interpolating for 26 km/h) and then horizontally to the left to intersect the scale for the rate of evaporation.

Source: Gelber S (1984) '*Predict evaporation rate and reduce plastic shrinkage crack*', Concrete International (ACI), 5(4):19–22.

15 Texturing of surface

General

15.1 Unless specified otherwise in the Contract documents, the surface must be textured by both hessian drag and tining, except that:

a) tining is not required beneath bituminous or asphalt surfacing, unless specified otherwise in the Contract documents, and

b) light brooming may be applied in lieu of hessian drag.

15.2 For SFCP, refer to ~~to~~ Clause 32.

15.3 The Quality Plan must include details of the procedures and equipment proposed to complete the surface texture.

15.4 The Average Texture Depth must comply with Table 15.4.

Table 15.4 – Specified Average Texture Depths

Type	Description	Average Texture Depth[1]	Test Method[2]
1	Hessian drag[32] with no tining or grooving[43]	0.40 mm ± 0.05 mm[43]	~~AGAM-T013 or~~ TfNSW T192 (TS 02795.50)
		or alternatively, 0.55 mm ± 0.05 mm[43]	~~AGPT-T~~ATM 250 ~~or TFNSW T240~~
2	Transverse tining[54, 65]	0.60 mm ± 0.10 mm	~~AGAM-T013 or~~ TfNSW T192 (TS 02795.50)
		or alternatively, 0.9 mm (−0.30, +0.20)	~~AGPT-T~~ATM 250 ~~or TFNSW T240~~
3	Longitudinal tining[54, 65]	0.65 mm ± 0.15 mm	~~AGAM-T013 or~~ TfNSW T192 (TS 02795.50)
		or alternatively, 0.80 mm ± 0.20 mm	~~AGPT-T~~ATM 250 ~~or TFNSW T240~~
4	Diamond grinding[54, 65]	Minimum 0.65 mm	~~AGAM-T013 or~~ TfNSW T192 (TS 02795.50)

Notes:

(1) Note that these are average depths over the area of test and are not actual depths. This is the same measure as that calculated as 'Texture Depth (TD)' under Test Method ~~AGPT-T250 or TFNSW T240~~ATM 250.

~~(2) Texture testing is exempt from the requirement in for NATA or IANZ registration.~~

(~~3~~2) An acceptable alternative to hessian drag is light brooming which is done to resemble hessian drag. It may be longitudinal or transverse, unless otherwise specified in the Contract documents.

(~~4~~3) Testing of Type 1 texture is required only where tining and/or grooving is not specified.

(~~5~~4) The specified values for tining are for total texture, including the contribution from the hessian drag or brooming (where it has been specified).

(~~6~~5) When testing to ~~AGAM-T013 or~~ TfNSW T192 (TS 02795.50) for tining, grinding and/or grooving, test orthogonal to the direction of texturing and for a minimum length of 7 m.

15.5 The surface texturing process must be adjusted to account for the prevailing weather conditions and mix design to limit surface ravelling and to produce a uniform finish without rounding of the paved edges.

15.6 Areas with less than the specified texture depth must be treated with either saw-grooving in accordance with Clause 15 or diamond grinding in accordance with Clause 31.

Hessian drag and brooming (initial texturing)

15.7 A hessian drag or broom must be used to produce initial texturing. To produce the specified texture, the length of the drag or broom type must be adjusted and maintained or replaced when required.

Tining

15.8 As soon as possible after paving or initial texturing (where specified), additional texture must be applied to the surface of the freshly placed concrete ~~in accordance with the Contract documents and~~ by means of a mechanical device for tining plastic concrete.

15.9 For paving widths less than 4.5 m, a manual tining comb is permitted for transverse tining.

15.10 The texturing equipment must have rectangular shaped tines of flat spring steel, approximately 0.6 mm thick, 3 mm wide and minimum free length of 200 mm.

15.11 The following applies to Transverse Tining:

a) Space the tines at random spacing of between 10 mm and 21 mm, with mean spacing between 13 mm and 14 mm. A typical random pattern is shown below:

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

b) The width of the texturing comb must be at least 750 mm.

c) Texture at 900 to the direction of linemarking.

d) For paving widths exceeding 4.5 m, carry out texturing by means of a machine spanning the concrete slab. Make provision for downward adjustment to compensate for tine wear.

15.12 The following applies to Longitudinal Tining:

a) Space the steel tines at uniform spacing of 15 mm with tolerance on individual spacings of ± 3 mm. The direction of movement of the tines in the plastic concrete must be in the direction of paving and parallel with the linemarking.

b) Carry out tining with a machine which spans the concrete slab. Make provision for vertical adjustment to compensate for tine wear.

Texture testing

15.13 The texture must be tested in accordance with either Clause 15.14 or 15.15.

15.14 The Sand Patch Test Method must be undertaken in accordance with the following:

a) Prepare the surface for testing by removing concrete burrs which will soon likely to abrade under early trafficking. Prepare an area at least 330 mm in diameter to minimise impedance to the 300 mm straightedge.

b) The target condition is for the top surfaces of the landings to be free of burrs while still retaining a coating of mortar.

c) Use a circular carborundum stone with minimum diameter of 50 mm and minimum thickness of 20 mm to grind the test area by hand in circular motion, as follows:

i. For concrete which is deemed (under Clause 17.14) to have reached at least 20 MPa compressive strength, each part of the target area must receive between 15 and 20 passes. Apply constant down force of approximately 20 kg.

ii. For concrete of less than 20 MPa compressive strength, stop grinding when the target condition has been achieved uniformly over the test area.

d) The test area must be swept prior to the test to completely remove all loose material.

15.15 The Laser Test Method must be undertaken in accordance with ~~AGAM-T013 or~~ TfNSW T192 (TS 02795.50). For tining, grinding and/or grooving, testing must be orthogonal to the direction of texturing and for a minimum length of 7 m.

Sawcut grooves

15.16 Sawcut grooves must:

a) be 3 mm wide and 3 mm deep

b) be at random spacing pattern

c) have spacing neither less than 10 mm nor more than 18 mm

d) have mean spacing between 12 mm and 15 mm, and

e) be aligned parallel with the tining unless otherwise specified in the Contract documents.

15.17 Grooving residue must be controlled and removed from the pavement and must not be allowed to flow into the drainage system or across lanes which are in public use.

16 Curing

General

16.1 The base must be cured by the application of a sprayed curing compound.

16.2 In confined spaces (such as tunnels) where the use of curing compounds is deemed undesirable, the base must be cured for a minimum of 7 days using water or blanket techniques in accordance with Clause 16.23.

16.3 All other structural concrete (including kerbs and gutters) must be cured either by application of a compound or by a method included in Clause 16.23.

16.4 The compound must be applied in accordance with the following conditions:

a) to form a continuous and unbroken film with 2 uniform applications as follows:

i. the first within 15 minutes of the surface reaching the low-sheen bleed water condition, and

ii. the second between 10 minutes and 30 minutes later or as recommended by the manufacturer.

b) On fixed-formed surfaces, spray the first application within 30 minutes of stripping and the second between 10 minutes and 30 minutes after the first. At the time of the first application, the concrete must be in a damp condition.

16.5 Fully operational spraying equipment is a pre-condition for paving to proceed.

Materials and equipment

16.6 The Quality Plan must include details of the method and application rate for applying the curing compound, including the supplier's recommended procedures for storage and agitation of compounds under varying weather conditions in order to maintain uniformity.

16.7 When sprayed, the compound must have a uniform consistency and must be conforming in all regards.

16.8 The curing compound must be applied in a fine spray in accordance with Table 16.8.

Table 16.8 – Curing compound application

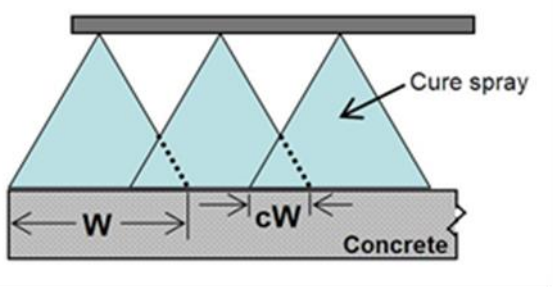
Class	Method of Application	Permitted Paving Widths
1	Hand lance, with either single or multiple nozzles:	Up to 3.5 m
2	Hand lance or spray bar fitted with a minimum of 3 nozzles spaced to give a uniform cover over a minimum width of 1.0 m in a single pass:	3.5 to 4.5 m

Class	Method of Application	Permitted Paving Widths
3	Mechanical sprayer fitted with a spray bar with multiple nozzles spaced to give a uniform cover for the full paving width in a single pass:	Slipformed paving widths greater than 4.5 m

16.9 Protective hoods must be fitted to Class 3 spray bars and lances to reduce the drift of curing compounds to workers and roadside areas and to minimise the effects of wind on the variability in application rate.

16.10 The spray nozzles must be set to provide an overlap factor (by width measurement) as shown in Figure 16.10. This factor must be determined through field trials in accordance with Clause 16.18 c).

Figure 16.10 – Curing spray overlap



Where:

W = theoretical coverage

c = overlap factor (decimal)

16.11 For fan nozzles, each nozzle must be rotated sufficiently about a vertical axis to prevent interference between adjacent fans.

Application rate

16.12 For Class 3 applications, the minimum rate in each pass must comply with Table 16.12.

Table 16.12 – Minimum application rate

Surface Texture	Minimum Application Rate
On tined texture:	The higher of 0.30 L/m², or 50% more than the rate stated on the test certificate.
On surfaces with only hessian-drag or light broom texture:	The higher of 0.25 L/m² or 25% more than the rate stated on the test certificate.

16.13 For Class 1 and Class 2 applications, the rate in each pass must be the higher of 0.30 L/m² or 50% more than the rate stated on the test certificate, regardless of the texture type. These areas include the faces of formed joints and sections of slipformed edges which were supported by temporary forms at the time of initial spraying.

16.14 The curing membrane must be maintained intact in a continuous and unbroken membrane for 7 days or until an in situ concrete strength of 25 MPa is achieved, whichever occurs first. The insitu strength must be assessed (if required) by methods as stated in Clause 26.

16.15 Any damage to the curing membrane must be rectified by hand spraying the affected area.

16.16 Additionally, for a minimum distance of 7 m adjoining the commencement of each paving run, a re-spray with a single application must be applied any hardened concrete of age less than 7 days that has been trafficked by persons during placement at the construction joint (and notwithstanding that membrane damage may not be readily apparent).

16.17 The Contractor bears the cost of any respraying and of making good any damage to the curing membrane.

16.18 For Class 3 curing, the Quality Plan must include the procedures that are proposed for demonstration of the following:

a) uniformity of bulk output from each nozzle, including edge sprays (litres per minute per nozzle)

b) the variables and methods to be used to measure and calibrate a uniform output across the full spray width and edges (litres/m²)

c) field trials that are proposed in order to develop operating parameters such as nozzle height, spray pressure and the spray overlap factor 'c' (as shown in Figure 16.10) and to demonstrate uniform and conforming coverage, including edges. These parameters must be determined and provided to the ~~Principal~~ Administrator prior to a Paving Trial that requires Class 3 curing

d) during the Paving Trial, the operating parameters developed under c) must be verified.

16.19 In the absence of an alternative method approved by the ~~Principal~~Administrator, the curing compound application rate must be checked as follows:

a) by calculating the average application rate from the total measured quantity of compound applied within the area specified in Table 16.19, or

b) by testing the local amount of curing compound as measured on test mats placed on the pavement at random locations, using 3 felt mats per test, each approximately 0.25 m² in area and placed within an area of 50 m² on the surface to be treated.

Table 16.19 – Testing procedure for application rate

Class of Curing	Test Procedures	Frequency[(1)]
1 and 2	Clause 16.19 a)	Each paving area of between 500 m² and1000 m²[(1)]
3	Clause 16.19 a) and b)	Each paving area of between 1000 m² and 1500 m²[(1)] a) in the Paving Trial; and thereafter b) one in every sixth Sub-Lot until 3 consecutive conformities are obtained, then c) one every fifty (50) Sub-Lots. Testing frequency reverts to b) if a nonconformity is encountered.

Note:

[(1)] This area may be varied for each test to suit individual circumstances such as the timing of refilling the curing tank, conditional on the application procedure being homogeneous within each nominated test Sub-Lot.

16.20 The application within a test section is deemed to be conforming if:

a) the application on the surface is visually uniform and homogeneous

b) the losses (by wind or other causes) are insignificant, and

c) all test results obtained in accordance with Table 16.19 are conforming.

16.21 For any section at which the application is nonconforming, it must be resprayed within 6 hours of initial spraying at an application rate not less than twice the deficiency in the original application.

Curing of other structural concrete

16.22 All structural concrete members, including anchors, kerbs and channels (gutters), must be cured for a minimum of 7 days from placing of concrete.

16.23 Curing compounds in accordance with Clause 16.1 or wet curing must be used. Plastic covers may be used provided that they form a continuous barrier against loss of moisture and are fully secured around all edges to maintain a moist environment over the full mass of concrete, as evidenced by the presence of moisture on the underside of the covers.

17 Protection of work

Temperature

17.1 If the temperature at the Site is forecast by the Bureau of Meteorology to fall below 10°C within 24 hours of paving, the surface temperatures must be measured and recorded for the first 24 hours after paving, at 2 or more locations within each day's paving, using purpose-made surface thermometers.

17.2 The Quality Plan must include details of the procedures and equipment proposed for the protection of concrete from low air temperatures.

17.3 Failure to maintain the temperature of the concrete at or above 5°C for the first 24 hours after paving constitutes a nonconformity.

17.4 Subbase protective covers may be used.

Rain

17.5 Concrete must not be placed in the Works during rain or when rain appears imminent.

17.6 The Works must be protected from rain damage. Protective equipment must be kept on site ready for use by experienced personnel at short notice.

17.7 The Quality Plan must include details of the procedures and equipment proposed to protect the concrete from rain damage.

17.8 Concrete is nonconforming if:

a) during transport in tippers, it is exposed to rain creating puddles on the surface of the concrete

b) after discharge on the ground, it is exposed to rain creating puddles which will be mixed into the uncompacted concrete during spreading or paving, or

c) after paving, it is exposed to rain such that water is incorporated into the surface mortar during finishing operations.

17.9 If a paved surface has been exposed to rain, it must be assessed in accordance with the finished surface acceptance criteria.

Anchor slabs

17.10 Regardless of the temperature, the base above anchors must be thermally protected for a minimum period of 24 hours after placement. The covers must include vertical edges and must extend at least 5 m onto adjoining base slab which was cast at the same time. The covers must be adequately covered around all edges to prevent air flowing under them.

Trafficking of base

17.11 Trafficking of the base, including foot traffic, must be monitored and minimised to avoid damage to the curing compound.

17.12 The base must not be accessed by non-essential trafficked until an in situ compressive strength of 20 MPa has been reached.

17.13 Essential traffic must be controlled as follows:

a) Only concrete saws and coring machines may have access before 20 MPa compressive strength is reached, subject to a 0.5 tonne limit on any item.

b) Once 20 MPa compressive strength is reached and all joints have been permanently sealed, other vehicles may access the pavement, subject to compliance with the limits in Table 17.13.

Table 17.13 – Load limits

Vehicle Type	Load Limit
Wheeled Vehicles:	Single: 5.0 T Tandem: 8.0 T total Triaxle: 9.0 T total
Tracked Vehicles	15 T/m² pressure over the track area, with the concrete protected from surface damage.

c) Higher axle loadings, limited in accordance with the regulations issued pursuant to the applicable legislation for control of road vehicles, may be applied after 25 MPa compressive strength has been reached and all joints have been permanently sealed.

d) Steel implements such as grader blades and loader buckets must not impact joints or edges of the base.

e) Compaction of granular verge material against the edge of base is not allowed until 20 MPa compressive strength is reached and all joints have been permanently sealed, including the vertical faces.

17.14 For trafficking purposes, the cast in place concrete compressive strength must be assessed using cylinders which have been prepared for the purpose of Clause 26.1, with curing and testing to TfNSW T367 (TS 02800.42).

17.15 Alternatively, trafficking strength may be assessed from cores taken for the purposes of Clause 25.~~10~~7, subject to the following:

a) The cores must 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) must be not less than 24 hours nor more than 36 hours and must conclude within 3 hours prior to compressive strength testing

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

c) Additional cores must not be taken for this purpose without the prior approval of the ~~Principal~~Administrator

d) The requirements of Clause 26.1~~5~~4 apply, except that strength assessment may be based on a single core per Sub-Lot

e) Assessment of any particular Sub-Lot must be based on not fewer than 3 core results of equal or lesser age (in days) compared with the Sub-Lot under assessment, and

f) Upon determination of an acceptable in situ strength of any Sub-Lot, all concrete placed prior to that Sub-Lot using the same concrete mix may be assumed to have achieved an equivalent trafficking strength.

17.16 A Hold Point applies to trafficking of the base at both the 20 MPa and the 25 MPa compressive strength levels. **Hold Point 8** **Hold Point 9** **Record**

HOLD POINT 8	
Process Held	Trafficking of vehicles in accordance with Clause 17.13 b) and e).
Submission Details	Insitu concrete compressive strength test results showing the base having reached 20 MPa compressive strength must be submitted to the ~~Principal~~ Administrator prior to trafficking of the base.

HOLD POINT 9	
Process Held	Trafficking of vehicles in accordance with Clause 17.13 c).
Submission Details	Insitu strength test results showing the base concrete having reached 25 MPa compressive strength and confirmation that all joints have been permanently sealed must be submitted to the ~~Principal~~ Administator prior to trafficking of the base.

17.17 Any damage to the base must be repaired in a way which produces a dense, homogeneous subbase with the specified surface finish.

18 Concrete paving trials

General

18.1 Prior to full scale concrete pavement base paving, a trial section must be constructed using the authorised nominated concrete mix, equipment and methods. **Witness Point 2**

WITNESS POINT 2	
Process	Construction of a paving trial; and/or Construction of the concrete base on any section of work.
Notification Period	At least 5 working days prior to the trial and/or construction commencing.

18.2 The trial sections must be constructed in a continuous operation without intermediate construction joints. A separate trial is required for each paver. Table 18.2 details the requirements for construction and testing of paving trials.

Table 18.2 – Concrete Paving Trial Construction and Testing Requirements

Property and Testing Requirements		Paving type	
		Fixed-form	**Slipform**
Length of paving trial	Minimum	15 m	50 m
	Maximum	50 m	100 m
Minimum concrete volume of trial		20 m³	-
Cylinders: Minimum testing for UCS(1) and MUV(1). As per Clause 25, except test MUV at age between 2 and 3 days.	7 days(2)	4 loads	6 loads
	28 days(2)	4 loads	6 loads
Flexure beams(2): Minimum testing for strength and MUV(1)	7 days(2)	3 loads	4 loads
	28 days(2)	3 loads	4 loads
Fresh concrete: wet-sieving test to Clause 10.6 ~~b)~~	At 10%, 50% and 90% of discharge	3 loads	3 loads
Cores: Minimum testing for relative compaction. As per Clause 25, except: a) extract cores at age between 2 and 3 days, and b) determine MUV within 2 days of extraction.	Transition sub-Lots	not applicable	2 per Sub-Lot
	Standard Sub-Lots	4(3)	3(3)
	At inserted tiebars at induced joints	NA	Refer to Clause 9.25
	At inserted tiebars in formed joints	2(4)	2(5)
Photographs of cores through inserted tiebars (Clauses 9.17 and 9.34)(6) a) Inspect and photograph within one day of coring, b) Photograph resolution must be adequate to show entrapped voids around and above the tiebars.		All(4)	All
Metal detector survey for tiebar location (plan location and depth) in accordance with Clauses 9.25 and 9.34.		not applicable	All

Notes:

(1) MUV: mass per unit volume (or 'unit mass').

(2) UCS: ultimate compressive strength

(3) Refer to Clause 10.19 for conditions on moulding from the same sample or batch (as applicable).

(4) These cores are additional to those taken at tiebars within the same Sub-Lot.

(5) Testing is not required in fixed-form paving if the tiebars are pre-placed and are subjected to internal vibration.

(6) Inserted tiebars at formed joints are treated in Clause 9. Coring is required only in the paving trial, for advance assessment ahead of 30 day pull-out testing.

(7) Locate cores to intersect a tiebar but offset them from the longitudinal joint by 250 mm ± 100 mm and not closer than 1.5 m to a transverse contraction joint nor 3.0 m to a transverse construction joint.

(8) Inspect and photograph all cores for compaction within one day of coring as advance warning ahead of compaction testing.

18.3 If the trial is conducted at a paving width of less than 70% of the maximum width proposed, the ~~Principal~~ Administrator may require a new trial section prior to full-width paving. **Hold Point 10**

HOLD POINT 10	
Process Held	Base paving subject to the trial.
Submission Details	Checklists and test results (as listed in Table 18.4) must be submitted to the ~~Principal~~ Administrator at least 5 working days prior to the commencement of paving.

18.4 The Contractor must provide a written report to the ~~Principal~~ Administrator which includes:

a) the 7 day test results

b) a comparison of all results from the paving trial with those from the laboratory trial mix

c) a table which shows, as a minimum, the information contained in Table 18.4 together with an assessment of the consistency between the mixes in the laboratory trial and the paving trial, and

d) comments on any notable inconsistencies and any consequential risks.

Table 18.4 – Paving trial analysis

Row	Item	Result	
A	Location	(a)	(b) Length (m):
B	Mix details	Date:	Date:
		Mix No:	Trial No:
		Mix type: (tick one) ☐ Fixed-form ☐ Slipform	Mix variations(c):

Row	Item	Result	
C	Air content (%)		Min: Max: Mean:
D	Admixture content	AEA: WRA: Other:	AEA[d]: WRA[d]: Other[d]:
E	Slump (mm) Water content[e]		
F	Compressive strength 7D	(1)	(3)
G	Compressive strength 28D	(1)	(3)
H	Flexural strength 7D	(1)	(3)
I	Flexural strength 28D	(1)	(3)
J	Unit mass – cylinders	Mean[1]:	Min[1]: Max[1]: Mean:
K	Unit mass – beams	Mean[1]:	Min[1]: Max[1]: Mean:
L	Core length (mm)[f]	NA	(g)
M	Cores[h]: Unit mass (and relative compaction)	NA	Transition Sub-Lots Other Sub-Lots
N	Curing application rates	NA	Min[i]: Max[i]: Mean[j]:

Alphanumeric notes:

[a] Name of laboratory and suburb.

[b] Location of the trial (c'way, Ch, etc.).

[c] List any variations to the authorised mix except for admixtures and water.

[d] Provide the ranges (max and min).

[e] In accordance with Clause 10.

[f] Excluding any debonding material.

[g] Provide all results.

[h] Record all individual results; e.g. 2360 (99.5%), 2340 (98.5%).

[i] For Class 3, report min and max values for each test.

[j] For all Classes.

Numerical notes:

[1] Record the reported result (not individual specimens).

[2] Record individual specimen results.

[3] Provide all results for cylinder pairs or beam sets, as applicable.

18.5 The Paving Trial test results must be submitted to the ~~Principal~~ Administrator at times specified Table 18.5.

Table 18.5 – Paving trial submissions

Item	Timing of Submission	Clause Reference
Surface profile	Hold Point submission	28
Tiebar location and cover	Hold Point submission	9.25 and 9.34
Texture depth	Hold Point submission	15
Curing application Row N	Hold Point submission	16
Table 18.4 Rows A to E	Hold Point submission	Table 18.4
Class 3 curing calibration results	Hold Point submission	16
Photographs of cores at inserted tiebars	within 4 days of the Trial	Table 18.4
Table 18.4 Rows J, K, L, M	within 5 days of the Trial	Table 18.4
Table 18.4 Row F, H	within 9 days of the Trial	Table 18.4
Assessment of paving mix	with the 7 day test results	
Table 18.4 Rows G, I	within 30 days of the Trial	
Tiebar pull-out testing	within 30 days of the Trial	9.17

Acceptance of trial section

18.6 The trial section will be accepted as part of the Works if it conforms to this Technical Specification.

18.7 If the relative compaction of the trial section is less than 98.0%, it must be removed, a new trial section prepared and the evaluation detailed in this Clause repeated. In the event of other nonconformity in the trial section, the ~~Principal~~ Administrator may require a new trial section, which must be treated as if it was the first trial section.

18.8 The ~~Principal~~ Administrator may direct that a new trial section be prepared and evaluated at any stage of the Works if:

a) significant changes are made to the equipment, mix design, materials, plant or rate of paving

b) recurring nonconformities of the concrete base occur, or

c) Non-conformance Reports are not submitted in accordance with the Quality Management System.

19 Joints and Edges

General

19.1 Detritus from sawcutting operations must be removed in accordance with ~~the environmental management requirements specified in the Contract documents~~MRTS51 *Environmental Management*.

19.2 Refer to the Contract documents for any project-specific details of treatments required on existing pavements and/or kerbs abutting new Works.

19.3 The pavement must not be sawcut for any purposes other than those shown on the Drawings. Traffic presence detector loops must not be sawcut unless specifically approved by the ~~Principal~~Administrator.

19.4 Where scabbling is required, the coarse aggregate must be exposed over a large proportion of the scabbled face (avoiding the arrisses as shown on the Drawings) to achieve a rough surface with indentations 4-6 mm deep. Scabbled joints within the base must always be subsequently debonded. Joints in anchors must not be debonded.

Joint cleaning and sealants

19.5 Sealants must be handled and installed in accordance with the manufacturer's written recommendations, including:

a) earliest concrete age at the time of installation

b) minimum temperature of air and concrete at installation

c) requirements for priming of the joint face

d) tooling requirements, and

e) minimum trafficking age.

19.6 The dimensions of the cured sealants must be tested in accordance with the Drawings and in accordance this Clause 19.

19.7 Where an asphalt surfacing is to be placed over the base, a silicone sealant which has been approved by the manufacturer for that application must be used.

19.8 The Quality Plan must include details of the procedures and equipment proposed to complete joint sealing.

19.9 Joints and sealants must be tested at random locations at the minimum frequency specified in Table 19.9.

Table 19.9 – Joint and sealant testing

Test type	Joint type		
	Transverse contraction	**Other untied joints(1)**	**Tied sealed joints(2)**
Joint face cleanliness(3,4)	Test at 2 locations per joint, and a) At 3 joints per Sub-Lot commencing with the paving trial, until 3 consecutive conforming Sub-Lots are obtained, and thereafter b) At one joint in every alternate Sub-Lot. c) If any joint fails, re-clean all joints within the Sub-Lot and revert to test frequency (a).	Include all joint types in the calculation of jointing output, and in the selection of testing location. Test at one location per joint per Sub-Lot, and a) At every Sub-Lot commencing with the paving trial, until 3 consecutive conforming Sub-Lots are obtained, and thereafter b) At every third Sub-Lot. If any test fails, re-clean all joints within the Sub-Lot and revert to test frequency (a).	Test at one location per joint per Sub-Lot, and a) At every Sub-Lot commencing with the paving trial, until 3 consecutive conforming Lots are obtained, and thereafter b) At every third Sub-Lot. If any test fails, re-clean all joints within the Sub-Lot and revert to test frequency (a).

Test type	Joint type		
	Transverse contraction	**Other untied joints[1]**	**Tied sealed joints[2]**
Sealant dimensions[4] - depth[5] - width[6] - recess	Test at one location per joint, and a) Three tests per Sub-Lot commencing with the paving trial, until 6 consecutive conforming samples are obtained, and thereafter b) One test per Sub-Lot. Testing frequency reverts to (a) if a nonconformity is encountered.	Include all joint types in the calculation of jointing output, and in the selection of testing location. Test: a) Two locations per 30 m of joint type until 6 consecutive conforming samples are obtained, and thereafter b) One test per 30 m. Testing frequency reverts to (a) if a nonconformity is encountered.	a) Two tests per 50 m of joint until 6 consecutive conforming samples are obtained, and thereafter b) One test per 50 m. Testing frequency reverts to (a) if a nonconformity is encountered.
Sealant field adhesion[4,7]	a) One test per Sub-Lot commencing with the paving trial, until 3 consecutive conforming samples are obtained, and thereafter b) One test every fifth Sub-Lot. Testing frequency reverts to (a) if a nonconformity is encountered.	Include all joint types in the calculation of jointing output, and in the selection of testing location. a) One test per Sub-Lot commencing with the paving trial, until 3 consecutive conforming samples are obtained, and thereafter b) One test every third Sub-Lot. Testing frequency reverts to (a) if a nonconformity is encountered.	a) One test per Sub-Lot commencing with the paving trial, until 3 consecutive conforming samples are obtained, and thereafter b) One test every third Sub-Lot. Testing frequency reverts to (a) if a nonconformity is encountered.

Notes:

[1] Examples include isolation and expansion joints, but exclude transverse contraction joints.

[2] For example, tied longitudinal sawn joints.

[3] Test for cleanliness in accordance with TfNSW T379 (TS 02800.53). An acceptable result is obtained when Grade 1 (None) visual rating category is achieved.

[4] Ignore transition areas in the selection of Sub-Lots for testing.

(5) Check the depth (or thickness) by removal of a continuous section of cured sealant of length not less than 30 mm. Dissect the sample transversely at 2 random cross-sections and measure the meniscus depth to the nearest millimetre. The sample conforms if both test sections conform to the Drawings.

(6) Test at the time of installing the permanent sealant.

(7) Test for adhesion in accordance with TfNSW T380 (TS 02800.54).

19.10 The backer rod and sealant at all test locations must be reinstated to the specified sealant dimensions and field adhesion. **Witness Point 3** **Record**

WITNESS POINT 3	
Process	Testing of joints and silicone sealants.
Notification Period	At least 2 working days before testing (include location of the test).

Transverse construction joints

19.11 Transverse construction joints must:

a) be provided at discontinuities in the placement of concrete determined by the paving operations

b) be continuous over the paved width without steps or offsets in any axis so that the line of the joint does not deviate by more than 20 mm from a 3 m straightedge

c) be constructed at 90°± 6° to the longitudinal joint, with a butt (Flat) joint face which is orthogonal (± 6°) to the finished top surface of the base

d) in jointed bases, have tiebars installed as detailed on the Drawings and in accordance with Clause 9 (except for dowelled construction joints, if and where applicable). Where the ties are installed by drilling and fixing in hardened concrete, a suitable epoxy mortar must be used giving anchorage strength of at least 85% of the yield strength of the bar

e) if initially nonconforming or damaged, be reinstated or repaired prior to the placement of adjoining concrete. The repair material must not be placed integrally with the adjoining concrete

f) have the face of the joint debonded to prevent intimate microtexture bond, and

g) conform in all regards to the requirements of Clause 12.22.

19.12 Intimate bond at the microtexture level can induce spalling at arrises and must be avoided. For this reason, debonding of the joint face is specified, including joints between new and existing concrete pavements.

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

19.14 The first-placed face must be resprayed with curing compound not more than 10 days prior to placing the abutting concrete. All aspects of the treatment must be in accordance with Clause 16, except that the compound must be a wax emulsion conforming to ~~ATS 3520~~MRTS39 *Lean-mix Concrete Subbase* and a single application must be used at a rate 25% higher than the rate stated on the test certificate for curing efficiency, subject to a minimum value of 0.20 L/m². The coating must be intact and effective at the time of subsequent concrete placement.

19.15 Reinforcement must not be sprayed with wax or bitumen compounds.

Transverse contraction joints

19.16 Transverse contraction joints must be provided in jointed pavements as shown on the Drawings. Contraction joints are not used in CRCP.

19.17 Transverse contraction joints must:

a) be initiated by sawcutting, unless the Drawings allow the use of crack inducing inserts outside trafficked areas

b) be continuous across the full pavement width, without steps or offsets in any axis, so that along the line of the joint, it does not deviate by more than 10 mm from a 3 m straightedge

c) be skewed at 1 in 10, unless specified otherwise on the Drawings, or reduced locally to accommodate construction joints and slab anchors

d) be sawn, where a deflection angle is specified, such that the sawing on any alignment does not extend beyond the intended limit as defined by intersecting joints (typically longitudinal)

e) be sealed in accordance with this Technical Specification

f) have trafficking controlled in accordance with Clause 17.13, and

g) be maintained at all times free of incompressible and foreign materials and sealed for this purpose at all formed edges, including vertical faces, where any underlying induced crack must also be sealed.

19.18 Sawcutting must be used, unless shown otherwise on the Drawings.

Sawcutting

19.19 Transverse contraction joints are sawn, using either a two-cut operation (comprising an initial sawcut and a widening sawcut) or a single cut operation.

19.20 Sawcutting must be carried out in a timely manner so as to prevent cracking of the base concrete other than at the bottom of the sawcut.

19.21 The type of blade and equipment and the method of control must be best suited to the hardness of the concrete being sawn. Provide sufficient standby equipment at Site to ensure continuity of sawing must be provided

19.22 The surface of the transverse contraction joint must not exhibit more than 10 mm of vertical or horizontal edge ravelling. The cumulative length of ravelling with a dimension greater than 3 mm must not exceed 300 mm for any 3 m length of joint edge (that is, assess each side of the joint separately).

19.23 The vertical face at the edge of the slab must not show ravelling greater than 20 mm in any axis at the point of intersection with the sawn joint.

19.24 If a nonconformity occurs, corrective action must be implemented immediately in accordance with ~~ATS 1120~~MRTS50 *Specific Quality System Requirements*.

Cleaning

19.25 All debris from the sawcut must be cleaned soon after sawing and before the residue dries or hardens. A liquid or liquid / air oil-free jet combination must be used which:

a) does not damage the sawcut or arrisses

b) has sufficiently high pressure to ensure that the faces are dust-free when dry. Gravity fed liquid from tanks is not acceptable

c) does not leave any substance deleterious to the concrete or to the adhesion of the joint sealants to be used, and

d) removes all sawing residue in a way which prevents it from entering the joint.

19.26 The timing of cleaning and other variables, such as pressure, must be adjusted to suit the prevailing concrete characteristics.

19.27 Grit blasting must not be used.

Preliminary sealing

19.28 Within 2 hours of cleaning an initial sawcut, seal the joint against drying and contamination by installing a continuous closed-cell polyethylene backer rod with the top of the seal being neither higher than the concrete surface nor more than 5 mm below it.

19.29 Sealing must include the vertical faces of the slab at the ends of sawcuts.

19.30 Maintain the preliminary sealant in a sound and effective condition at the top of the joint until the joint is temporarily or permanently sealed. Replace within one day any backer rod which is damaged or removed prior to sealing.

19.31 In a two-cut operation, the preliminary seal must remain in position until the commencement of widening sawcut, when it must be pushed to the bottom of the initial sawcut in a way which is effective in preventing sawcut residue from entering the underlying joint.

19.32 In a single-cut operation, the preliminary seal must remain in position until permanent sealing.

Temporary sealing

19.33 In two-cut operations:

a) The preliminary seal must be effective in preventing sawcut residue from entering the underlying joint.

b) After widening, clean the sawcut in accordance with Clause 19.25. Within 2 hours of cleaning, seal the joint with a continuous closed-cell polyethylene backer rod of a suitable diameter to prevent the ingress of incompressible materials into the joint and to maintain moist conditions within the joint.

c) Sealing must include the vertical faces of the slab at the ends of sawcuts.

d) The top of the backer rod must be neither higher than the concrete surface nor more than 5 mm below it. The backer rod must pass over any longitudinal joint seal already in place.

19.34 Prior to diamond grinding and grooving, provide a temporary joint seal sufficiently robust to withstand the stresses applied during grinding.

19.35 The proposed procedure for temporary sealing must be included in the Quality Plan.

19.36 Maintain the temporary sealant in a sound and effective condition at the top of the joint until the joint is permanently sealed. Replace any temporary sealant which is damaged within one day.

Permanent sealing

19.37 Permanent sealant must be an in situ cast silicone sealant, stored and installed in accordance with the manufacturer's written instructions.

19.38 At slab edges and formed joints, permanent seal must extend down the vertical faces of joints and any underlying crack.

19.39 The permanent seal must be placed in the joint between 7 days and 14 days after initial sawing, unless diamond grinding or grooving is proposed, in which case place permanent seal within 14 days of the completion of that operation within each Sub-Lot, except as follows:

a) the permanent sealant must not be placed within 24 hours of the concrete surface having been wet, and

b) at the time of sealant installation, the joint faces must be clean and surface-dry. Assess the cleanliness in accordance with Clause 19.9.

19.40 Prior to introducing the silicone sealant into the groove, clean the joint in accordance with Clause 19.25 to remove all foreign or disturbed material, such as dust, from the joint and from the top of the backer rod.

19.41 Grit blasting must not be used.

19.42 A joint primer must be used if and when recommended by the sealant manufacturer.

19.43 A continuous closed-cell polyethylene backer rod must be installed at a depth which enables the silicone sealant to be inserted at the planned location to the correct shape. If the backer rod is damaged in any way, the full length of the joint must be replaced.

19.44 Unless otherwise stated in the manufacturer's recommendations, the sealant must be tooled to the specified shape before a surface skin forms.

19.45 Test adhesion of the sealants at an age of between 3 days and 5 days in accordance with Clause 19.9.

Isolation and expansion joints

19.46 Isolation and expansion joints must be provided within 25 mm of the positions shown on the Drawings. They must:

a) be continuous across the full width of the base without steps or offsets in any axis so that the line of the joint does not deviate by more than 20 mm from a 3 m straightedge

b) be constructed with the joint face square (± 5°) to the finished top surface of the base

c) be treated with joint filler conforming to ATS ~~5305~~3505~~, and~~

d) joint sealant must be installed in accordance with Clause 19.37, except that backer rod is only required where shown on the Drawings, and

e) be maintained at all times free of incompressible and foreign materials. At free edges, the permanent sealant must extend down the full vertical face of the joint. At other edges, the filler must be able to prevent the ingress of concrete and other foreign materials into the joint space during subsequent work.

19.47 Where the joint faces are constructed by methods other than sawing (such as formed joints), the joint cavity must be prepared (for permanent sealing) within the sealant area by one of the following methods:

a) by sawing - undertake all operations, including cleanliness and adhesion testing, in accordance with Clause 19 as if it were the second cut of a two-cut operation, or

~~b) undertake all operations, including cleanliness and adhesion testing, in accordance with Clauses 19.9 and 19.11 as if it were the second cut of a two-cut operation.~~

~~c)~~b) by wire brushing - clean the full face area using a mechanised rotary wire brush or similar abrasive contact equipment. Control all residue and arris spalling as if it were from sawcutting. Undertake all operations, including cleanliness and adhesion testing, in accordance with Clause 19.

~~d) clean the full face area using a mechanised rotary wire brush or similar abrasive contact equipment. Control all residue and arris spalling as if it were from sawcutting. Undertake all operations, including cleanliness and adhesion testing, in accordance with Clauses 19.9 and 19.11.~~

Longitudinal joints

General

19.48 Longitudinal joints must be provided within 25 mm of the positions shown on the Drawings.

19.49 Longitudinal joints must comply with the following:

a) Be continuous over their full length without steps or offsets in any axis so that the line of the joint does not deviate by more than 20 mm from a 3 m straightedge after due allowance for any planned curvature.

b) For tied joints, have tiebars installed in accordance with Clause 9.13.

c) For formed joints (both tied and untied):

i. have the face square (± 6°) to the finished top surface of the base, and corrugated, unless otherwise specified

ii. have the face of the joint debonded to prevent intimate microtexture bond

iii. if nonconforming or damaged, be reinstated or repaired prior to the placement of the adjoining slab. Do not place repair material integrally with the adjoining concrete, and

iv. the sealant faces be prepared in accordance with Clause 19.46.

d) ~~Please double check f~~For induced joints:

i. be formed by sawcutting in accordance with this Technical Specification

ii. exhibit at the surface not more than 10 mm width of vertical or horizontal edge ravelling. The cumulative length of ravelling with a dimension exceeding 3 mm must not exceed 300 mm in any 3.0 m length of joint edge (i.e. assess each side of the joint separately)

iii. control all residue and undertake all operations including cleanliness and adhesion testing in accordance with Clause~~s~~ 19~~.9 and 19.11~~, and

iv. permanently seal the full vertical face at the ends of sawcuts.

Condition of formed joints and debonding

19.50 Intimate bond at the microtexture level can induce spalling at arrisses and must be avoided. For this reason, debonding of the joint face is specified, including joints between new and existing concrete pavements.

19.51 The first-placed face must be dense and fully compacted and must be free of honeycombing and re-entrant angles. Where the face is nonconforming or the edge is damaged, reinstatement or repair must be carried out prior to the placement of adjoining concrete. The repair material must not be placed integrally with the adjoining concrete.

19.52 The first-placed face must be resprayed with curing compound not more than 10 days prior to placing the abutting concrete. All aspects of the treatment must be in accordance with the requirements for curing the concrete, except that the compound must be a wax emulsion conforming to ~~ATS 3520~~MRTS39 *Lean-mix Concrete Subbase* and a single application must be used at the specified rate plus an increase of 25%. The coating must be intact and effective at the time of subsequent concrete placement.

19.53 Steel tiebars must not be sprayed with wax or bitumen compounds.

Sawcutting

19.54 Sawcutting must proceed in a timely manner so as to prevent cracking of the base concrete other than at the bottom of the sawcut.

19.55 The type of blade and equipment and the method of control best suited to the hardness of the concrete being sawn must be used. Sufficient standby equipment must be provided on Site to maintain continuity of sawing.

Cleaning

19.56 Joints must be cleaned in accordance with Clause 19.25.

19.57 Grit blasting must not be used.

Temporary sealing

19.58 Within 2 hours of cleaning, the joint must be temporarily sealed against drying and contamination by installing a continuous closed-cell polyethylene backer rod.

19.59 Sealing must include the vertical faces of the slab at the ends of sawcuts in order to prevent ingress of materials from subsequent operations.

19.60 The top of the backer rod / seal must not be higher than the concrete surface or more than 5 mm below it.

19.61 The temporary sealant must be maintained in a sound and effective condition at the top of the joint until permanent sealing is installed. Any temporary seal which is damaged or removed prior to permanent sealing must be replaced within one day.

Permanent sealing

19.62 A permanent sealant must be installed as for transverse contraction joints except that, if the backer rod is damaged, only the damaged length needs to be replaced.

19.63 Residue from cleaning operations must be prevented from entering transverse joints.

19.64 At the time of sealant installation, the joint faces must be clean and dry. All operations, including cleanliness and adhesion testing, must be undertaken in accordance with Clause~~s~~ 19~~.9 and 19.11~~.

Widening of existing concrete base

19.65 Where the Works involves widening of existing concrete base, the existing edge must be treated as follows and in accordance with the Drawings and/or any other requirements in the Contract documents.

19.66 Correction work, such as sawcutting, to the existing face, must be undertaken where specified.

19.67 The vertical face of all transverse untied joints and underlying induced cracks must be sealed in accordance with Clause 19.62, to prevent ingress of mortar. Joints for sealing (regardless of their original method of construction) must be prepared in accordance with Clause 19.347.

19.68 Drilled tiebars must be fixed where specified and the existing face debonded in accordance with Clause 19.453.

Mismatched joints and re-entrant angles

19.69 Mismatched joints may only be constructed as shown on the Drawings. Untied joints must not form mismatched joints except at a junction with an isolation joint.

19.70 Re-entrant angles that exceed 190° must be reinforced with SL82 reinforcing fabric.

Outer edges

19.71 Outer edges must:

a) not deviate from the design position at any point by more than 25 mm

b) be continuous over the full length without steps or offsets in any axis so that the line of the edge does not deviate by more than 20 mm from a 3 m straightedge, after due allowance for any planned curvature, and

c) have face geometry conforming to Clause 19.49, but having corrugations and tiebars only if specified on the Drawings.

19.72 Each outer edge must be tested for alignment conformity at random locations and at a frequency not less than the following, commencing with trial paving and thereafter independent of the boundaries to sub- Lots:

a) one test per 10 m of edge, until 5 conforming results are recorded; and thereafter, and

b) one test per 50 m of edge.

19.73 The testing frequency reverts to Clause 19.72 a) if nonconformity is detected.

20 Kerb and channel

20.1 Kerbs and channels (ie gutters) must be constructed in accordance with the drawings, MRTS03 *Drainage Structures, Retaining Structures and Slope Protections*, the requirements of ATS 2245 that are specific to concrete base, and the following requirements:

a) Kerbs not constructed integrally with a concrete base may only be extruded if the drawings specifically allow extrusion.

b) Where the kerb and channel is to be constructed integrally with a concrete base, it must be constructed to the same requirements as specified for the base.

c) Unless specified otherwise, concrete for kerb and channel which is not constructed integrally with a concrete base must conform to either:

i. to this Technical Specification, or

ii. ~~AS 1379~~MRTS70 *Concrete* for normal class concrete with strength grade N32 and 20 mm aggregate.

d) Kerb longitudinal joints must conform to Clause 19.46 (including debonding of formed joints), but the rounding of the kerb or channel (gutter) lip must not be greater than 5 mm, even if a larger rounding is shown on the kerb drawings.

e) Untied joints must be sealed in accordance with the drawings.

f) At all kerb joints, the first placed joint face must be reinstated or repaired if initially nonconforming or damaged, prior to the placement of adjoining concrete. The repair material must not be placed integrally with the adjoining concrete.

g) All inlet pits must be separated from the adjoining base concrete by an isolation joint (without subgrade beam) in accordance with the drawings.

h) Kerb and channel must be cured in accordance with this Technical Specification.

21 Special slabs

Odd-shaped and mismatched slabs

21.1 Odd-shaped and mismatched slabs must:

a) be reinforced as shown on the Drawings

b) if not shown on the Drawings, be reinforced with SL82 reinforcing fabric, unless transverse construction joints are provided for the odd shape or mismatch, and

c) be marked by imprint into the surface of the slab edge with the letter 'R', except for anchor slabs which must be marked in accordance with Clause 21.4. The imprint must be 4 mm ± 1 mm below the surrounding concrete.

21.2 The imprinting may be omitted if the slab edge will be covered by asphalt surfacing.

Anchor slabs

21.3 Terminal anchor slabs must be constructed adjoining bridge approach slabs and at changes from rigid to flexible pavement.

21.4 Steel reinforcement to anchor slabs must be provided in accordance with the Drawings and their presence marked by imprinting the letter 'A' on the surface of the slab edge. The imprint must be placed above the anchor centreline and within 0.5 m of each end of the anchor at a relatively low trafficked area and 4 mm ± 1 mm below the surrounding concrete.

21.5 The imprinting may be omitted if the slab edge will be covered by asphalt surfacing.

22 Slab anchors

Slab anchors

22.1 Slab anchors must be constructed as shown on the Drawings. The slab anchors must be in accordance with the following (unless alternative details are specified in the Contract documents):

a) At jointed base:

i. provide Type 12 or 18 anchors at bridge approaches

ii. provide Type 6 or 12 anchors at flexible pavement transverse interfaces, and

iii. provide Type 12 anchors on steep grades at locations shown on the Drawings.

b) At CRCP base:

i. provide multiple Type 12 anchors at bridge approaches and flexible pavement transverse interfaces

ii. anchors may be provided at other CRCP slab transitions as shown on the Drawings, and

iii. do not provide anchors within continuous lengths of CRCP, regardless of the grade.

c) Cast the anchor at least 24 hours before the overlying base slab paving.

d) Trim the trench to neat lines, free of loose soil material, and compact the bottom to at least match the adjacent undisturbed material.

e) Concrete must either conform to this Technical Specification or be N32 concrete in accordance with MRTS70 *Concrete* ~~AS 1379 and must be normal class concrete with strength grade N32~~, with 20 mm aggregate, and slump between 40 mm and 80 mm at the point of placement.

f) Place and compact the concrete using internal vibration in accordance with Clause 12.21.

g) Anchor stirrups must be lapped (as defined) to the base reinforcement.

h) At the junction with an existing flexible pavement, make a straight sawcut to the full depth of any asphalt in the flexible pavement along the joint line. Excavation of the trench must then take place without disturbance or damage to existing flexible pavement. Make good any disturbance or damage to the flexible pavement.

22.2 Drainage of the interface between flexible and rigid pavements must be as shown on the Drawings.

22.3 The Quality Plan must include details of the method of paving over anchors without damaging the stirrup reinforcement.

23 Traffic islands and medians

23.1 Sand must not be used as backfill at any location directly abutting the concrete base.

23.2 Geotextile must be placed where shown on the Drawings to prevent the ingress of fines into joints.

23.3 A densely graded subbase material, with a 20 mm nominal size, must be placed under concrete cappings in traffic islands and medians. The material must conform to the requirements for Type 2.3 material in MRTS05 *Unbound Pavements*~~any additional requirements include in the Contract documents~~.

24 Conformity – Concrete cracking

24.1 The Quality Plan must include details of the inspection schedule for cracking in base slabs.

24.2 Cracking is categorised in accordance with Table 24.2. Where required, the Contractor must rectify nonconforming base in accordance with Table 24.2.

Table 24.2 – Base slab cracking

Classification of Crack	Description	Outcome
Jointed base		
Plastic shrinkage:	Discrete cracks of length less than 500 mm and of depth less than 50% of the base thickness which form during the plastic stage and which do not intersect a longitudinal edge or a formed joint (that is, not an induced joint).	Conforming only if the cumulative length < 1 m in any slab and: • PCP and SFCP slab – no other cracks. • PCP-R, SFCP-R and JRCP slabs – may contain drying shrinkage cracks. Otherwise, the slab is nonconforming.
Drying shrinkage cracks in mesh-reinforced slabs (PCP-R, SFCP-R and JRCP):	Cracks occurring in the central part of the slab, extending full depth and continuous between joints and/or edges. Restraint cracks over anchors are included in this category.	Accepted.

Classification of Crack	Description	Outcome
Unplanned structural cracks:	All other cracks, including drying shrinkage in unreinforced slabs.	Nonconforming: Remove and replace.
CRCP base		
Plastic shrinkage:	Discrete cracks of length less than 500 mm and of depth less than 50% of the base thickness which form during the plastic stage and which do not intersect a longitudinal edge or a formed joint (i.e. not an induced joint).	Plastic shrinkage cracks with a cumulative length of 1 m or less in any 5 m x 5 m square area of base must be filled with a suitable low viscosity penetrating epoxy resin, within 7 days of casting of the concrete. Otherwise, the slab is nonconforming. The epoxy resin must not extend laterally by more than 15 mm beyond the edge of the crack nor completely fill the tining.
Planned cracks forming induced longitudinal joint:	Induced longitudinal cracks.	Treated in accordance with Clause 19.49.
Planned cracks other than induced joints:	Full depth discrete transverse cracks over the full width between longitudinal formed joints or edges. These cracks do not require any treatment.	No treatment required.
Jointed base		
Restraint cracks over anchors:	Full-depth cracks of a nature that is consistent with restraint (against curling) from the underlying anchor.	Nonconforming.

24.3 Within 4 days of paving, all nonconforming cracking must be reported and a scaled crack map of all nonconforming cracking submitted to the ~~Principal~~Administrator.

25 Conformity – Concrete compaction

Sub-Lot delineation

25.1 The conformity of base for compaction is assessed on the basis of Sub-Lots, except for Transition Zones in slipform paving.

25.2 For the purpose of compaction testing, Transition Zones are treated as separate Sub-Lots in accordance with the following rules:

a) At each transverse construction joint in slipformed work, generate one discrete Transition Zone on each side of the joint, each for a length of 3 m or as otherwise nominated in Clause 12.

b) Where a Transition Point is remote from a transverse construction joint, the transition point is treated as if it were a joint (i.e. generate 2 transition Sub-Lots are generated as in Clause 25.2 a).

25.3 Conformity for within-core variability is assessed in accordance with Clause 25.36. Conformity for compaction will be assessed in accordance with Clauses 25.~~7~~4 to 25.~~6~~9.

Conformity for compaction – Fixed-form paving

25.4 For fixed-form paving, a Sub-Lot conforms to compaction if:

a) it has been internally vibrated by a planned and systematic procedure, followed by a minimum of 2 passes of a vibrating screed, all in accordance with Clause 12

b) vibration was undertaken in such a way as to limit lateral spreading of the mix

c) any disturbed areas (such as workers' footprints) in the compacted mix have been reinstated in accordance with Clause 12.~~22~~30, and

d) the relative compaction is at least 98.0%, determined in accordance with TfNSW T381 (TS 02800.55) as the percentage ratio of the core unit mass of the Sub-Lot to the RCUM for the Sub-Lot.

25.5 Sub-Lots which do not conform to Clause 25.4 a), b) and c) will not be assessed under Clause 25.4 d), and must be removed and replaced.

25.6 Sub-Lots which conform to ~~items~~ Clause 25.4 a), b) and c), but which do not conform to item Clause 25.4 d), must be assessed as follows:

a) If the relative compaction is between 97.0% and 98.0%, cores must be taken in accordance with Clause 26.9 and the Sub-Lot assessed in accordance with Clause 26.1~~5~~4 on the basis of the 28 day core compressive strength.

b) If the relative compaction is less than 97.0%, the Sub-Lot must be removed and replaced in accordance with Clause 30.

Conformity for compaction – Slipform paving

25.7 For slipform paving, a Sub-Lot conforms to compaction if:

a) it has been internally vibrated by a planned and systematic procedure in accordance with Clause 12~~.26~~

b) vibration was undertaken in such a way as to limit lateral spreading of the mix

c) the relative compaction is at least 98.0%, determined as the percentage ratio of the core unit mass of the Sub-Lot to the RCUM for the Sub-Lot (when calculated in accordance with Clause 25.10).

25.8 Sub-Lots which do not conform to Clause 25.7 a) and b) will not be assessed under Clause 25.7 c) and must be removed and replaced.

25.9 Sub-Lots which conform to Clause 25.7 a) and b), but which do not conform to Clause 25.7 c), must be assessed as follows:

a) If the relative compaction is between 97.0% and 98.0%, cores must be taken in accordance with Clause 26.9 and the Sub-Lot assessed in accordance with Clause 26.1~~5~~4 on the basis of the 28 day core compressive strength.

b) If the relative compaction is less than 97.0%, the Sub-Lot must be removed and replaced in accordance with Clause 30.

Moulding and testing of cylinders

25.10 The unit mass reference values for concrete compaction using standard prepared cylinders must be determined in accordance with the following:

a) Test cylinders must be those which are prepared for 28 day compressive strength testing. At age between 4 days and 7 days, determine the MUV for all 28 day cylinder specimens in accordance with AS 1012.12.2, amended in accordance with (b) and (c) hereunder.

b) Determine the MUV in accordance with Clause ~~2.2 of Annexure B~~33.3.

c) Round individual results to the nearest even number (in contrast to AS 1012.12.2 which requires rounding to the nearest 10 kg/m³). The unit mass for a pair of cylinders is the average of the 2 results unless they differ by more than 20 kg/m³, in which case the higher result represents the unit mass of the pair. Round the averaged result to the nearest 5 kg/m³.

25.11 For each authorised nominated mix, a statistical check to determine the RCUM must be made using the pair unit mass as defined in item (c) above.

25.12 For the paving trial, the RCUM is the mean of all 28 day pairs from that trial of the same concrete mix. The mean result is rounded to the nearest 5 kg/m³.

25.13 Thereafter, the RCUM for any Sub-Lot is taken as the mean of 5 consecutive pairs of 28 day cylinders of the concrete mix up to and including the Sub-Lot and the results from paving trial, where applicable. Where fewer than 5 pairs of an authorised nominated mix are available, the RCUM is taken as the mean of all available pairs from that mix. In each case, round the mean result to the nearest 5 kg/m³.

25.14 The unit mass of flexural strength test specimens or 7 day compressive strength test specimens is not used for calculations of the RCUM.

Core specimens

25.15 Specimens for determining the relative compaction of concrete must be cores of nominal diameter 75 mm to 100 mm, cut and extracted from the full depth of the concrete base, in accordance with AS 1012.14.

25.16 The cores must be secured as soon as practicable without causing damage to the cores or the pavement, but not later than 2 days after paving.

25.17 The locations of coring must be in accordance with Clause 25.~~3~~24 to Clause 25.28.

25.18 Within 2 hours of extraction, the cores must be placed in either a tank of lime saturated water or individual plastic bags that are sealed to prevent water loss and stored in the shade.

25.19 Cores must not be subject to temperatures:

a) in excess of the ambient temperature or 28°C, whichever is higher, and

b) less than 10°C.

25.20 All cores must be tested for unit mass in accordance with Clause 25.32 to Clause 25.35 and all results reported to the ~~Principal~~Administrator.

Frequency and location of coring for compaction

25.21 For slipformed concrete, the frequency of coring for compaction must be as follows:

a) take at least one core specimen from each Sub-Lot until 10 consecutive conforming Sub-Lots (that is, not less than 98.0% compaction) are obtained, and then

b) at least one core from each second Sub-Lot until 10 consecutive conforming Sub-Lots are obtained, and then

c) one core from each third Sub-Lot.

In each case, transition zones must be avoided and sampling Sub-Lots selected on the basis of time sequence.

If a nonconforming result occurs, the frequency of testing, commencing from the nonconforming Sub-Lot, reverts to that specified in Clause 25.21 a).

25.22 For manually paved base, 2 cores must be taken from each Sub-Lot. The core locations must be separated by at least one-third of the length of the Sub-Lot.

25.23 For transition zones, coring must commence from the trial section. The minimum frequency of coring is as follows:

a) 2 cores from each Sub-Lot until 3 consecutive conforming Sub-Lots (i.e. not less than 98.0% compaction) are obtained, and then

b) 2 cores from each third Sub-Lot, selected on the basis of time sequence, until 4 consecutive Sub-Lots conform, and then

c) one core from each fifth Sub-Lot, selected on the basis of time sequence, and

d) if a nonconforming result in Clause 25.23 b) or c) is obtained, the frequency of testing, starting from the nonconforming Sub-Lot, reverts to that specified in Clause 25.23 a).

Locations of coring for compaction

25.24 The locations of coring must be selected at random (AS 1289.1.4.2), but with grid lines established in accordance with the criteria shown for a dual-lane paving run in Figure 25.248. Consistent criteria must be applied for single-lane paving runs, such as shoulders and ramps.

25.25 A metal detector must be used to locate all bars and mesh reinforcement and locate core holes to maximise the chance of avoiding reinforcement.

25.26 Adjust the longitudinal location by the minimum extent necessary to:

a) exclude reinforcement and tiebars from the core, except as required under Clause 9.25 or as otherwise required by the Principal to assess process uniformity

b) in jointed pavements, maintain a longitudinal separation of 1.0 m minimum from any transverse untied joint.

25.27 In CRCP, adjust the locations in both directions by the minimum extent necessary to avoid reinforcement.

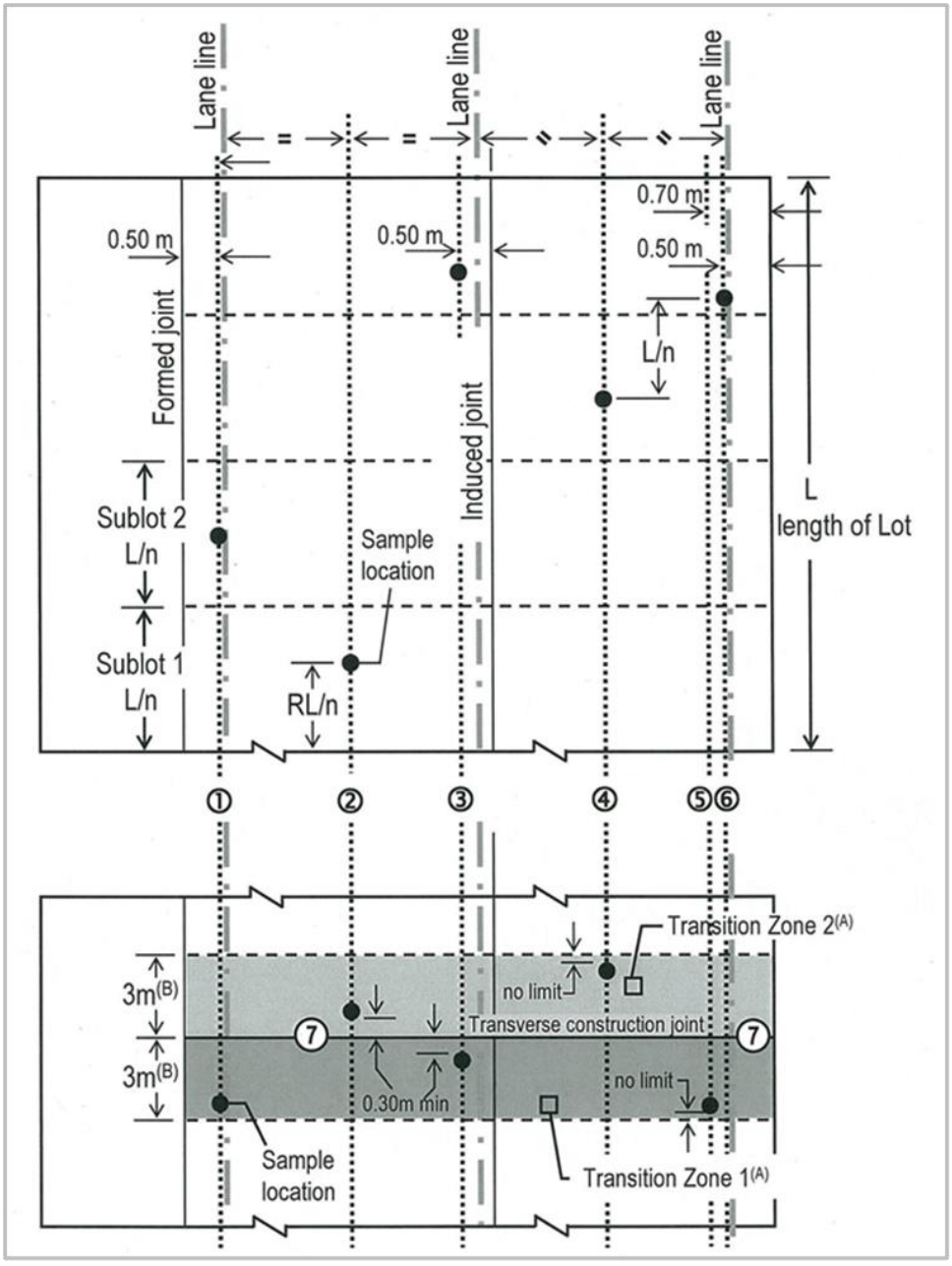
25.28 For small and/or odd-shaped slabs of all base types, coring at the following locations must be avoided:

a) within 0.50 m of an edge or a longitudinal joint

b) within 0.30 m of a transverse tied joint

c) within 1.5 m of a transverse untied joint.

Figure 25.248 – Sampling locations for a Dual-lane paving Sub-Lot (refer to Clause 25.24)



Notes:

(A) Transition Zones apply to slipform paving only.

(B) or as otherwise nominated in Clause 9.26.

Repair of core holes

25.29 All core holes taken in the base must be cleaned and restored with low-shrink cementitious concrete having a compressive strength of not less than that in the base. The authorised base mix may be used for this purpose.

25.30 The surface of the restored hole must be similar in colour to the surrounding surface. Prior to trafficking, the concrete in the core must be cured sufficiently to achieve an expected compressive strength of 10 MPa. The expected strength gain must be demonstrated by previous testing or by a technical data sheet.

25.31 The cost of restoring core holes will be borne by the Contractor, except in the case of additional cores ordered by the ~~Principal~~Administrator.

Core testing for unit mass

25.32 All cores must be tested for unit mass and the results reported to the ~~Principal~~Administrator. The full core must be tested, except that:

a) non-concrete materials such as bitumen must be removed

b) up to 15 mm of concrete may be removed from each end of the core where it can be demonstrated to constitute planned nonhomogeneity (such as surface texture), and

c) testing under Clause 25.36 requires the full core to be divided.

25.33 The unit mass of cores must be determined in accordance with Clause 33.~~3~~4.

25.34 Where 2 cores are available from a Sub-Lot, the unit mass of the Sub-Lot is the average of the test results unless they differ by more than 20 kg/m³, in which case the lower result applies. Round the average results to the nearest 5 kg/m³.

25.35 Where 3 or more cores are available from a Sub-Lot, the unit mass of the Sub-Lot is the mean of the test results. Round the mean to the nearest 5 kg/m³. However, if the lowest result differs from the mean by more than 30 kg/m³, the lowest result applies.

Within-core variability

25.36 Cores must be tested for variability as required by Clause 9.25 at a frequency as follows:

a) for cores taken over tiebars for location assessment: test all cores, and

b) for cores extracted for compaction assessment:

i. at a frequency of one in 5 commencing at the paving trial, until 5 consecutive conforming results are obtained; and thereafter

ii. at a minimum frequency of one in 10 unless a nonconformity occurs, in which case the frequency reverts to the frequency in Clause 25.36 b) i)

iii. select cores for variability testing on the basis of time sequence of paving, and

iv. if fewer than 5 cores are required in the paving trial, take an additional core for variability testing.

25.37 For cores which will be assessed for variability, voids must not be dressed prior to sawcutting. Testing for the unit mass of the full core is optional, but if testing is done, the report must include description of its void condition and conformity (or otherwise) with Test Method TfNSW T368 (TS 02800.43) regarding voids and steel.

25.38 Cores must be prepared and tested for variability as follows:

a) Divide the cores as follows:

i. Cores from CRCP, JRCP, PCP-R, SFCP-R and all tiebar cores:

saw each core horizontally along the line of the reinforcement.(-if the core contains no reinforcement, sawcut along the line of the reinforcement in the slab from which the core was taken). If the core contains bar or mesh, remove it by sawcutting each side of the steel to a maximum offset of 5 mm each side as measured orthogonal to the axis of the core. Label and retain the sawn slice until its matching cores are discarded.

ii. Cores from PCP, SFCP:

saw horizontally into 2 core cylinders of equal length, with a tolerance of 20 mm.

b) Determine the unit mass of each specimen in accordance with Clause 33.4 ~~B2.2 of Annexure B~~.

25.39 The difference in unit mass between the upper and lower parts of the core must be calculated. The variability must not be greater than 30 kg/m³, when calculated as the difference between the 2 results, using the measured unit mass values rounded to the nearest even number.

25.40 In the event of a nonconformity, action must be taken as follows:

a) For fixed-form paving, initiate corrective action before commencement of next day's paving.

b) For tiebar cores (refer to Clause 9.2~~5~~8), a Hold Point applies to slipform paving. **Hold Point 11 Record**

HOLD POINT 11	
Process Held	Slipform paving.
Submission Details	The following must be submitted to the ~~Principal~~ Administrator prior to the recommencement of slipform paving: a) All test results for compaction from the past 5 Sub-Lots and within-core variability from the past 5 tests. b) Proposal for corrective action to achieve conformity.

25.41 Following release of the Hold Point, the Contractor must continue to monitor the cores at the point of extraction and submit an assessment report to the ~~Principal~~ Administrator within 3 paving days of the resumption.

25.42 For slipform paving (excluding tiebar cores), any corrective action must be initiated before commencement of next day's paving.

26 Conformity – Concrete compressive strength

Cylinder strength testing

26.1 For each Sub-Lot of base, 2 pairs of cylinder test specimens must be prepared for compressive strength testing; one pair at 7 days and the other pair at 28 days. Refer to Clause 10.9 for 7 day compressive strength testing.

26.2 Sampling must conform to AS 1012.1.

26.3 The specimens must be prepared in accordance with Table 7.6.

26.4 The compressive strength of concrete must be determined using 28 day compressive strength test cylinders of 100 mm nominal diameter conforming to Clause 7.~~6~~5, with compaction by internal vibration in accordance with TfNSW T304 (TS 02800.05).

26.5 The following also apply:

a) Prepare all specimens of a set from the same sample of concrete.

b) For concrete delivered by mobile mixer, sampling must occur at the point of discharge or the point of testing, and after final retempering.

26.6 Inspect, cap and crush the concrete specimens in accordance with AS 1012.9. Their unit mass must be determined in accordance with Clause 33.43.

26.7 If the age of the test specimens is greater than 28 days at the time of compressive testing, the test results must be adjusted for age in accordance with Clause 26.186.

26.8 The compressive strength (f_c) of concrete represented by a pair of cylinders is the average of their test results, except that the higher result applies if the difference in the results exceeds 10% of the average. However, when the compressive strength test results of 10 consecutive pairs of cylinders become available and the mean of the difference in results for these 10 consecutive pairs (up to and including that in question) is greater than or equal to 5% of the mean of the compressive strength test results of all 20 cylinders, the compressive strength for a pair is taken as the average of the 2 results.

Core strength testing

26.9 Core strength testing, where required, must be carried out as follows:

a) For slipformed paving, take 2 cores at locations separated from each other by at least one third of the length of the Sub-Lot.

b) For fixed-form paving, take 2 cores at locations separated from each other by at least one third of the length of the Sub-Lot.

c) For transition Sub-Lots, take one core.

d) Wet-condition the cores up to the time of testing and in accordance with AS 1012.14, except that Clause 6.4 (d)(i)(B) therein is amended by replacing the words ‘for 3 days’ with the words ‘for not less than 2 days nor more than 3 days’.

26.10 Additional cores must not be taken for this purpose without the prior approval of the ~~Principal~~Administrator.

26.11 The test results must be adjusted for age and shape in accordance with Clause 26.18.

Assessment of compressive strength – Test cylinders

26.12 The concrete must be assessed within the following discrete categories:

a) slipformed

b) fixed-formed.

26.13 If the 28 day compressive strength of test cylinders for any Sub-Lot is less than 0.9 f_{cMin}, the Sub-Lot represented by the test cylinders must be removed and replaced in accordance with Clause 30.

Concrete with 28 day cylinder strength between 0.9f_{cMin} and f_{cMin} occurring during progress of the Contract is nonconforming but may be accepted by the Administrator at a reduced level of service, typically only if it represents less than 5% of the area of the applicable base category placed up to and including that sublot.

~~Sub-Lot with 28 day compressive strength of between 0.9 f_{cMin} and f_{cMin} occurring during progress of the Contract will be accepted, subject to a deduction, provided that it represents less than 5% of the area of the applicable base category placed up to and including that Sub-Lot. Deduction will be made under the applicable item in the payment schedules at 4% of the schedule rate under the payment for supply and place concrete in base, for each 0.5 MPa or part thereof deficiency in compressive strength~~.

Assessment of compressive strength – Cores

26.14 Where required to be tested in accordance with Clause ~~10.3~~ 25.6 a) to Clause 25.9 a), the Sub-Lot will conform to compressive strength if the corrected compressive strength is greater than or equal to f_{cMin} for all core specimens from that Sub-Lot.

Where this criterion is not met, the sublot is nonconforming but may be accepted by the Administrator at a reduced level of service, typically only if:

a) the mean of all corrected core strength results from the sublot is greater than or equal to f_{cMin}

b) no result is less than 0.9 f_{cMin}

c) the total area of such a sublot is less than 5% of the area of the applicable base category placed up to and including that sublot, and

d) the deficiency in strength is based on the lowest corrected core strength result from that sublot.

~~26.15 Where this criterion is not met, the Sub-Lot is nonconforming but will be accepted subject to a deduction of 4% for each 0.5 MPa or part thereof deficiency in compressive strength, provided that:~~

~~a) the mean of all corrected core compressive strength test results from the Sub-Lot is greater than or equal to f_{cMin}~~

~~b) no result is less than 0.9 f_{cMin}~~

~~c) the total area of such a Sub-Lot is less than 5% of the area of the applicable base category placed up to and including that Sub-Lot~~

~~d) the deficiency in strength is based on the lowest corrected core compressive strength test result from that Sub-Lot.~~

~~26.16~~26.15 Nonconforming Sub-Lots which do not meet these criteria must be removed and replaced in accordance with Clause 30.

Correction factors for age and shape

~~26.17~~26.16 Correction factors, AF for age and SF for shape, must be applied as shown in Table 26.~~20~~18(a) and Table 26.~~20~~18(b) respectively. For intermediate ages, the factor AF is determined on a pro-rata basis rounded to 2 decimal places.

~~26.18~~26.17 Alternatively, AF may be derived as follows:

a) Derive AF for cylinders and beams as part of the trial mix or on the basis of standard cylinders cast during the Works.

b) Calculate AF for cores by apportioning the cylinder AF in the ratio used at specific ages in Table 26.~~20~~18(a).

~~26.19~~26.18 The strength test result is multiplied by SF and divided by AF to derive the factored strength. The correction factors are applied to the unrounded strength.

Table 26.~~20~~18(a) – Age Correction Factor (refer to Clauses 26.16 and 26.17)

Age of Specimen at Time of Test	Age Correction Factor (AF)					
	Compressive Strength				Flexural Strength[2]	
	Cylinders		Cores		Beams	
	SCM content (%)[1]					
days)	0	≥ 15	0	≥ 15	0	≥ 15
28 [3]	1.00	1.00	0.90	0.90	1.00	1.00
35	1.02	1.03	0.93	0.94	1.01	1.02
42 [3]	1.04	1.06	0.96	0.98	1.02	1.03
49	1.06	1.09	0.98	1.01	1.02	1.04
56 [3]	1.08	1.12	1.00	1.04	1.03	1.05
70	1.10	1.15	1.02	1.07	1.03	1.07
84	1.12	1.18	1.03	1.09	1.04	1.07
112 [3]	1.14	1.21	1.06	1.12	1.05	1.09
140	1.16	1.24	1.07	1.14	1.06	1.11
168	1.18	1.27	1.08	1.16	1.07	1.12
196	1.20	1.30	1.09	1.18	1.07	1.12
224	1.22	1.33	1.09	1.19	1.08	1.13
308	1.24	1.36	1.10	1.20	1.09	1.13

Age of Specimen at Time of Test	Age Correction Factor (AF)					
	Compressive Strength				Flexural Strength[2]	
	Cylinders		Cores		Beams	
	SCM content (%)[1]					
365 or greater	1.25	1.38	1.10	1.21	1.10	1.13

Notes:

[1] Relative to the total cementitious content.

[2] Not specified for Sub-Lot acceptance.

[3] Where the Contractor elects to derive AF for its mix, the data, as a minimum, must be obtained at these ages, with a tolerance of 3 days.

Table 26.~~20~~18(b) – Shape Correction Factor (refer to Clause 26.16)

Length-Diameter Ratio of Core	Shape Correction Factor (SF)
2.0	1.00
1.75	0.98
1.5	0.96
1.25	0.93
1.0	0.87

27 Conformity – Geometry and thickness

Alignment tolerances

27.1 Within 4 days of placing an area of concrete base, the alignment must be surveyed and each joint inspected for conformity. Tolerances on horizontal alignment are given in Clause 19 for the outer edges of the base and for joints.

27.2 If nonconformity is detected, Corrective Action in accordance with the requirements of ~~ATS 1120~~MRTS50 *Specific Quality System Requirements* must be immediately implemented.

Level survey

27.3 Within 4 days of placing an area of concrete base, a survey in accordance with the survey requirements included in the Contract documents to determine conformity of the base surface level and thickness must be carried out.

27.4 The level at any point on the top of the base must not vary by more than 20 mm above or 5 mm below the contract level.

27.5 Levels within Sub-Lots must be assessed and departures from the contract level rounded to the nearest 5 mm. A Sub-Lot is nonconforming if it contains any individual nonconforming levels.

27.6 Levels must be taken and reported to the nearest millimetre (using with a flat based staff of base area between 300 mm² and 4000 mm²) at the following locations:

a) at cross-section offsets shown in Figure 25.248 (to a tolerance of 0.5 m)

b) at the same longitudinal plan locations as those surveyed for the invert levels under Clause 6 (to a tolerance of 0.5 m), and

c) randomly selected at a minimum frequency of at least half the frequency required to conform to Clause 27.6 a) and b).

27.7 If a survey procedure is adopted which produces an as-built level model of the top of both the subbase and base, each with comparison to the design model, this model may be accepted by the ~~Principal~~Administrator. A condition of acceptance is continued correlation with all pavement thickness results calculated from the model with pavement thickness measured from cores and production of a schedule at locations the same as those for accurately located levels.

27.8 The schedules of measured levels must show actual and contract levels (after applying the approved design adjustment, refer to Clause 6.17) and differences. All levels and differences that are out of tolerance and locations specially surveyed for apparent nonconformity must be highlighted. Actual levels that are above contract levels must be shown as positive differences and actual levels that are below contract levels as negative differences.

27.9 Exclude locations that are nonconforming and then calculate the mean of differences.

27.10 The base surface levels must be assessed for conformity on the basis of individual survey points. Submit a nonconformity report and attach the survey report and the relevant assessment of thicknesses in accordance with Clause 27.11 and Clause 27.12. **Record**

Thickness assessment

27.11 The Contractor must assess thickness as follows:

a) Assess thickness within Sub-Lots. Calculate base thickness to the nearest 1 mm at individual survey points selected in accordance with Clause 27.~~3~~6 as the difference between the finished base level and the base invert level surveyed in accordance with Clause 6.6.

b) Adjust the calculated thickness to allow for the design surface longitudinal and transverse slopes between the 2 surveyed points. Include in the Quality Plan the method of determining the thickness adjustment.

c) Measure the base thickness to the nearest 1 mm on the cores taken for compaction testing. Adjust the measured thickness in accordance with Clause ~~6.17~~ 6.13 to remove the contribution of the interlayer treatment.

d) Wherever a core result differs by 5 mm or more from a survey result located within 1.5 m, or by 10 mm or more in the range 1.5 m to 2.5 m, the core result must be accepted and the survey result culled from the assessment.

e) The surveys are deemed to be nonconforming if the frequency of such occurrences is higher than 3 in any group of 10 consecutive comparisons.

f) Show excess thicknesses as positive values and deficient thicknesses as negative values. Calculate the mean thickness for each Sub-Lot using all core results and un-culled survey results (all to the nearest 1 mm). Round the mean to the nearest 5 mm.

g) Then, for the purpose of assessing thickness conformity, round all individual results to the nearest 5 mm.

Conformity for thickness

27.12 ~~Where a~~ Sub-Lot~~s must is nonconforming, it will~~ be assessed in accordance with Table 27.12.

Table 27.12 – ~~Classification of Work determined by pavement~~Assessment criteria for thickness

Thickness Deficiency (mm)				Status	~~Payment Adjustment (where applicable)~~[3]
Mean of Sub-Lot[1]	Individual Points[1, 2]				
	≥ 20 mm	10–15 mm	5 mm		
≥ 15 mm	U	U	U	Nonconforming, remove and replace	-
10 mm	2 or more	U	U	Nonconforming, remove and replace	-
	0–1	3 or more	U	Nonconforming,	~~60% deduction~~
5 mm	2 or more	U	U	Nonconforming, remove and replace	-
	0-1	3 or more	U	Nonconforming	~~60% deduction~~
		0–2	U	Nonconforming	~~45% deduction~~
≥ 0 mm[3]	2 or more	U	U	Nonconforming	~~60% deduction~~
	1	3 or more	U	Nonconforming	~~45% deduction~~
		0–2	U	Nonconforming	~~24% deduction~~
	0	3 or more	U	Nonconforming	~~24% deduction~~
		1–2	U	Nonconforming	~~12% deduction~~
		0	U	Conforming	-

Notes:

[1] All values represent deficiencies except as stated in Note 3.

[2] In cells labelled 'U', there is no limit to the allowable number of points with thickness deficiency.

~~[3] Refer to Clause 27.13.~~

[43] A value less than zero denotes mean thickness that exceeds the specified minimum and is conforming.

~~27.13 A payment adjustment for non-conforming work accepted by the Principal, as set out in Table 27.12, only applies if specified in the Contract documents. If nothing is specified, a payment adjustment does not apply and any non-conforming work must be rectified.~~

28 Conformity – Surface profile

Transverse profile

28.1 Within 2 days of paving, surface deviations must be tested in a transverse direction in accordance with ATM 453 or ~~TfNSW T188~~Q712. Deviations under a 3 m straightedge must not exceed 5 mm, except for areas within 10 m of superelevation transitions where deviations must not exceed 3 mm. Where the surface deviation is convex, place the straightedge so that the cantilever length does not exceed 0.75 m.

28.2 Commencing with trial paving, testing for conformity with the straightedge criteria must be undertaken as follows:

a) within each day's paving at random locations at a minimum frequency of:

i. one test per 15 m of paving run, until 4 conforming results are recorded, and thereafter

ii. one test per 50 m of paving run.

b) across longitudinal joints, at a minimum frequency of:

i. one test per 15 m of joint, until 4 conforming results are recorded, and thereafter

ii. one test per 50 m of joint.

The testing frequency reverts to Clause 28.2 b) i) if nonconformity is detected.

c) testing, additional to the above, must be undertaken at each superelevation transition at 3 random locations within 10 m, at both mid-slab and longitudinal joints.

Longitudinal profile

28.3 Within 2 days of paving, test the longitudinal profile must be tested by one of the following:

a) measuring deviations under a 3 m straight-edge in accordance with ATM 453 or ~~TfNSW T188~~Q712

b) testing with a Class 1 Profiler device in accordance with ~~TfNSW T369~~Q708D, or

c) a California Profilograph.

28.4 Each trafficked lane and the near-side shoulder must be tested in the following areas:

a) within 15 m each side of transverse construction joints.

b) at approach sections (as defined). The limit of profile testing beyond the defined 15 m in accordance with Clause 29 to cover any area paved under the Contract which cannot be tested for roughness. Profile testing must also extend beyond the limit of the Contract (where an abutting running surface is available at base level) by at least 10 m or whatever lesser length is available. ~~Assessment for payment deduction purposes will be limited to the first level recorded beyond the limit of Contract.~~

c) at all slab replacements, including 10 m beyond the replacement in each direction.

28.5 Where a Class 1 Profiler or California Profilograph device is used, the following procedure must be used:

a) Measure the surface profile along a straight line within 0.3 m of the centre of a traffic lane and in accordance with the operating manual for the device in use.

b) A discontinuity in measurement occurs when the data acquisition system is reset during recording. At discontinuities in measurement of a profile, provide an overlap of at least 5.0 m on a line within 0.01 m offset of the original, and record the chainage (longitudinal location) of the discontinuity to an accuracy of at least 0.2 m.

c) Discontinuities are not permitted in profile measurements of test lengths that are less than 100 m. Captured data must be discarded and testing recommenced from the start point.

d) At junctions of testing lines at ramps and intersections of road pavement, extend the measurement for a distance of at least 1.0 m beyond the junction, and record the point of intersection to an accuracy of 1.0 m in both measurement series.

e) On road pavement at the approach to a bridge structure, extend the pavement profile testing onto the bridge approach slab or abutment by 15.0 m, or the maximum lesser length available.

f) Report deviations using the simulated straightedge function.

28.6 The requirements for surface correction are as follows:

a) grind high deviations under a 3 m straightedge that exceed 5 mm.

b) grind areas which are above the specified level by 20.0 mm or more. ~~Such grinding may be used to reduce the level of deduction or to increase the level of incentive payment~~.

c) grinding may be carried out at the Contractor's discretion for areas which are above the specified level by less than 20.0 mm. ~~Such grinding may be used to reduce the level of deduction or to increase the level of incentive payment.~~

28.7 Any grinding must be caried out in accordance with Clause 31.

29 Conformity - Ride quality

Testing

29.1 After completion of any grinding, the ride quality of the finished surface must be assessed using either:

a) a laser profilometer (~~using either AGAM-T001 or TfNSW T188~~Q708B), or

b) a Class 1 profiler in accordance with ~~TfNSW T369~~Q708D.

29.2 The Contractor must report the longitudinal profile in terms of the International Roughness Index (IRI), with units of 'metres level change per kilometre (m/km)' as follows:

a) For test lengths of 100 m or less, report results at 10.0 m test intervals, and

b) For test lengths greater than 100 m, report results at both 10.0 m and 100 m test intervals.

29.3 The timing of testing must also conform to Clause 17.13. ~~The ride quality must be measured within the sections nominated in Table 29.8.~~

29.4 For testing under ~~Test Method AGAM-T001 or TfNSW T188~~Q708B, adopt a test speed of 50 km/h where the posted speed limit is less than 80 km/h, and 80 km/h where the posted speed is 80 km/h or greater.

29.5 The roughness value for any Sub-Lot is the average of 3 survey runs over that Sub-Lot.

29.6 Roughness testing must extend as close as practicable to approach sections (as defined). Assess any area not assessed for roughness for profile in accordance with Clause 29.1 b) above. An area is not to be assessed by both tests.

29.7 The following procedure for testing ride quality must be adopted:

a) Divide each nominated pavement test section into segments 100 m long.

On multiple lane carriageways, test and assess each traffic lane separately.

Include any segment less than 100 m with the segment immediately preceding it, and determine an average roughness for the total segment.

b) Include transverse construction joints in the count except where they constitute the limits of Contract or where they border an area of pavement which is exempt from assessment for roughness. For the purpose of roughness testing, transverse joints are deemed to include the pavement within 5 m of the joint.

c) Conduct testing within each traffic lane and within the planned wheel paths, except that the testing line must be adjusted to conform to ~~(iv)~~Clause 29.7 d) hereunder.

d) The testing wheels must not run closer than 0.3 m to a formed longitudinal joint except at ramp junction zones as e) hereunder. Ramp junction zones (for the purpose of this Technical Specification) are indicated in Figure 29.7.

e) Test ramp junction zones in the wheel path along which a vehicle would typically follow when loading on or off the through carriageway.

Ignore longitudinal joints within the ramp junction for the purpose of roughness testing.

For ramp junction zones which have been widened to dual ramp lanes, the roughness result is the average of separate runs along wheel paths leading to each lane.

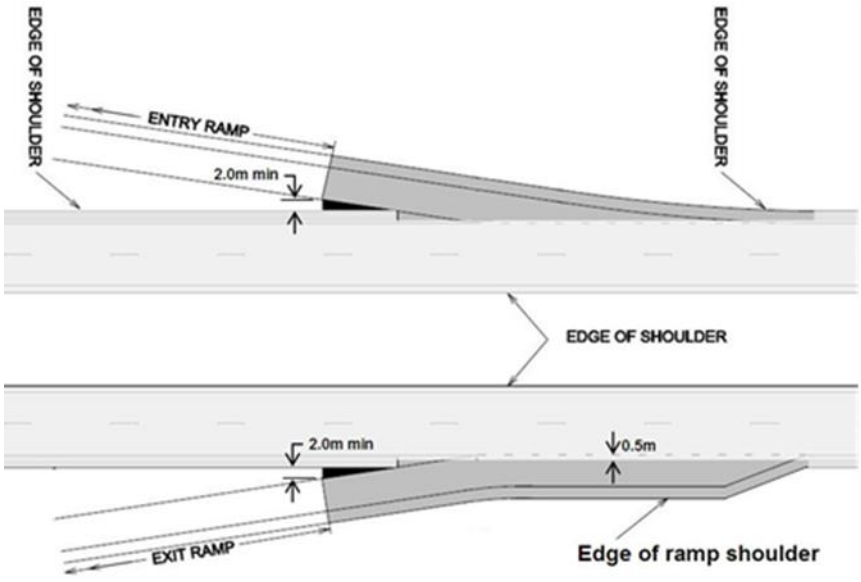
f) Where a longitudinal joint runs down the middle of a traffic lane, ignore the joint for the purpose of roughness testing, subject to compliance with ~~(iv)~~Clause 29.7 d) above. The result so obtained applies to the combined width of the 2 adjoining slabs bounded by the next longitudinal joints.

For the purpose of profile testing, adjust the test line where required in order to conform to d) above.

g) Where shoulders are too narrow to fully contain the test vehicle, run the vehicle with 2 wheels within the test lane and the other wheels within the adjacent lane. The result so obtained is hereafter referred to as a composite result.

Where the adjacent lane was constructed under the Contract, the composite result applies to the shoulder in accordance with this Technical Specification.

Figure 29.7 – Ramp Junction Zones



~~***Incentives / Deduction for pavement roughness***~~

~~29.8 A payment adjustment for non-conforming work accepted by the Principal only applies if specified in the Contract documents. If nothing is specified, Clauses 29.9 to 29.18 do not apply.~~

~~29.9 The incentive/deduction for any segment applies to the width of the slab bounded by longitudinal joints. It does not apply to composite results where an adjacent lane was constructed by others.~~

~~29.10 For the left (slow) lane of a typical dual lane carriageway, the incentive/deduction applies to the base slab width bounded by the formed shoulder joint and the induced central joint.~~

~~29.11 For the adjacent right (fast) lane, the incentive/deduction applies to the base slab width bounded by the central induced joint and the outer median edge, including any integrally placed median shoulder.~~

~~29.12 Within ramp junctions, the incentive/deduction applies to the total width of the traffic lanes bounded by outer edge lines.~~

~~29.13~~29.8 A pavement roughness category (PRC) must be assigned in accordance with Table 29.~~8~~9(a) for each test segment.

~~29.14~~29.9 The pavement roughness must be assessed in accordance with Table 29.~~8~~9(b). **Record**

~~29.15 Segments of base which score a positive value will earn an incentive payment. Segments of base which score a negative value are deemed to be nonconforming but may be accepted subject to a deduction.~~

Table 29.~~8~~9(a) – Pavement Roughness Category (PRC) (refer to Clause 29.8)

Nominated Pavement Section		PRC
Through carriageways	trafficked lanes(2) – longitudinal grade ≤ 4.0%	1
	trafficked lanes(2) – longitudinal grade > 4.0%	3
	shoulders(1)	3
Ramps(1)	within ramp junction zones(3)	3
	~~beyond ramp junction zones(3)~~	
	beyond ramp junction zones(3) - speed limit greater than or equal to 80 km/h - speed limit less than 80 km/h	 2 3
Minor roads(1)	speed limit greater than or equal to 80 km/h	3
	speed limit less than 80 km/h	4
Under asphalt surfacing(3)		Refer to Note(4)
Project specific areas		As specified in Contract documents

Notes:

(1) Shoulders on ramps and minor roads are not to be separately assessed.

(2) Refer Clause 29.7 for possible exemption of approach sections.

(3) The Principal may elect to add further areas which will be asphalt surfaced at a later date under a separate Contract.

(4) Under asphalt surfacings, the PRC will be one category below that applicable for the same pavement section without the application of asphalt above. (For example, a PRC of 1 would become 2 under an asphalt surfacing.)

Table 29.9(b) – Maximum Roughness (refer to Clause 29.9)

PRC of Pavement Section(1)	Maximum Roughness (m/km)(2)	Grinding Limit Roughness (m/km)(3)
1	1.70	2.90
2	1.90	3.30
3	2.10	3.30
4	2.50	3.50
5	2.70	N/A

Notes:

(1) Pavement roughness category as defined in Table 29.9(a).

(2) Segments with roughness exceeding the values in this column are nonconforming.

(3) Grind segments with roughness exceeding the values in this column.

~~29.16~~29.10 The Contract documents may also specify PRC values for project specific areas.

~~29.17 An incentive/deduction value for each segment in accordance with Table 29.18 and the applicable item in the payments schedules, except that:~~

~~a) An incentive/deduction will not apply to any area of a segment which is to be removed, for whatever reason, at no cost to the Principal.~~

~~b) For base which is nonconforming in thickness, compaction or strength:~~

~~i. an incentive will not apply, notwithstanding its possible acceptance by the Principal~~

~~ii. a deduction will be applied to the base which is accepted by the Principal.~~

~~c) Replacement base (refer to Clause 30) will be assessed for both incentive and deduction.~~

~~29.18~~29.11 Surface grinding must be carried out in accordance with Clause 31 where specified in Table 29.~~18~~9(b).

Table 29.18 – Incentive / Deduction Levels

NAASRA Roughness (Informative[3]) R (counts per km)	Roughness Index (RI)[2]	Incentive/Deduction (%) "+" denotes an incentive "–" denotes a deduction			
		PRC 1[1]	PRC 2[1]	PRC 3[1]	PRC 4[1]
R < 20	RI < 0.9	+ 3.0	+ 3.0	+ 3.0	+ 3.0
20 ≤ R < 25	0.9 ≤ RI < 1.1	+ 2.0	+ 2.0	+ 2.0	+ 2.0
25 ≤ R < 30	1.1 ≤ RI < 1.3	+ 1.0	+ 1.0	+ 1.0	+ 1.0
30 ≤ R < 35	1.3 ≤ RI < 1.5	+ 1.0	+ 1.0	+ 1.0	+ 1.0
35 ≤ R < 40	1.5 ≤ RI < 1.7	0	0	0	+ 1.0
40 ≤ R < 45	1.7 ≤ RI < 1.9	– 2.0	0	0	+ 1.0
45 ≤ R < 50	1.9 ≤ RI < 2.1	– 2.0	– 1.0	0	0
50 ≤ R < 55	2.1 ≤ RI < 2.3	– 4.0	– 3.0	– 2.0	0
55 ≤ R < 60	2.3 ≤ RI < 2.5	– 8.0	– 5.0	– 2.0	0
60 ≤ R < 65	2.5 ≤ RI < 2.7	– 16.0	– 8.0	– 4.0	– 1.0
65 ≤ R < 70	2.7 ≤ RI < 2.9	Grind	– 12.0	– 8.0	– 4.0
70 ≤ R < 75	2.9 ≤ RI < 3.1	Grind	– 16.0	– 16.0	– 8.0
75 ≤ R < 80	3.1 ≤ RI < 3.3	Grind	Grind	Grind	– 12.0
80 ≤ R ≤ 85	3.3 ≤ RI ≤ 3.5	Grind	Grind	Grind	– 16.0
R > 85	RI > 3.5	Grind	Grind	Grind	Grind

Notes:

[1] Categories defined in Table 29.8.

[2] RI: measured Roughness Index using the quarter-car model (IRIqc).

[3] This column is Informative only. Base the assessment on the Roughness Index.

30 Removal and replacement of concrete base

General

30.1 Where nonconforming base must be removed and replaced, the proposed method must be submitted to the Principal Administrator with the nonconformity report at least 5 working days before the work is expected to commence. The proposal must include precautions to prevent damage to the adjoining base and the underlying subbase. **Hold Point 12 Record**

HOLD POINT 12	
Process Held	Sawcutting for removal and replacement of concrete pavement base.
Submission Details	A nonconformity report for each location to be removed and replaced with the proposed method and precautions to prevent damage at least 3 working days before the work is expected to commence.

30.2 Waste from sawcutting operations must be managed in accordance with ~~the environmental management requirements included in the Contract documents~~MRTS51 *Environmental Management*.

30.3 The nonconforming base must be replaced for full slab widths between longitudinal joints and/or external edges.

30.4 Paving must be carried out by the slipform method, where practicable.

Jointed base

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

a) in a straight line and continuous between adjacent longitudinal joints and at an angle of 90° ± 6° to the longitudinal joint

b) at a location not closer than 1.5 m to a transverse contraction joint in the concrete which is to remain, and

c) for the full depth of the base without over-sawing into the adjacent base or the underlying subbase.

30.6 At each longitudinal edge of the nonconforming base, the Contractor must:

a) Make longitudinal sawcuts along existing longitudinal joints to define the edges of the base section to be removed. These must extend neither more than 250 mm past the transverse sawcut at each end of the section to be removed, nor into the underlying subbase.

b) Prepare each longitudinal joint in compliance with the criteria for longitudinal construction joints as defined in this Technical Specification.

30.7 Additional internal sawcuts, without over-sawing, must be made into the adjacent base or the underlying subbase. Also remove and replace any base adjoining the removed slabs, which is damaged by the Contractor's operations.

30.8 The removed base slabs must be disposed of in accordance with the MRTS51 *Environmental Management*~~environmental management requirements specified in the Contract documents~~.

30.9 LCS must be prepared and debonded in accordance with ~~ATS 3520~~MRTS39 *Lean-mix Concrete Subbase* prior to the construction of replacement base.

30.10 All work involved in the replacement of base must conform to this Technical Specification, including the following requirements:

a) Seal all joints and cracks which become exposed with silicone sealant to prevent ingress of mortar and other incompressible matter.

b) At tied joints, the joint faces on the adjoining slabs must be scabbled (unless the removal has resulted in the exposure of a corrugated face), and assessed and treated in accordance with Clause~~s~~ 19~~.5 and 19.46~~, including the installation of tiebars, as appropriate.

c) Transverse contraction joints must be continuous across the full width of the base containing the replaced section. Seal the length of the joint across the full width of the base with a silicone sealant conforming to this Technical Specification.

Continuously Reinforced Concrete Pavement (CRCP)

30.11 For CRCP, the proposed method must take appropriate account of the daily movements within the adjacent base.

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

a) in a straight line and continuous between adjacent longitudinal joints and at an angle of 90° ± 6° to the longitudinal joint

b) to a depth of 50 mm ± 5 mm

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

d) without over-sawing into the adjacent base.

30.13 The concrete within these sawcuts must be removed in such a way that:

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

b) not less than 0.15 m of every longitudinal bar is left protruding and undamaged beyond those joints. Mechanical couplers must be used at all of these laps in lieu of tied laps.

30.14 At each longitudinal edge of the nonconforming base, the Contractor must:

a) Make longitudinal sawcuts along existing longitudinal joints to define the edges of the base section to be removed. These must not extend more than 250 mm past the transverse sawcut at each end of the section to be removed, nor into the underlying subbase.

b) Prepare each longitudinal joint in accordance with the criteria for longitudinal construction joints.

30.15 Additional internal sawcuts without over-sawing into the adjacent base or the underlying subbase must be made and any damaged base adjoining the removed slabs removed and replaced.

30.16 At the time of casting replacement concrete, the longitudinal steel must be straight and must not be in compression.

30.17 The removed base concrete must be disposed of in accordance with the ~~environmental management requirements specified in the Contract documents~~MRTS51 *Environmental Management*.

31 Rectification of finished surface and ride quality

31.1 Areas requiring surface rectification must be ground with diamond and purpose-built equipment conforming to ATS 3550. Impact methods such as milling or profiling must not be used.

31.2 The work must be carried in accordance with ATS 3550 as modified by this Clause 31.

31.3 Unless stated otherwise in the contract documents, grinding equipment must create a longitudinal texture as follows:

a) Grooves must be uniformly spaced, using 3.2 mm wide blades separated by 2.5 mm wide blade spacers.

b) Minimum average texture depth must be in accordance with Clause 15.~~13~~4.

31.4 Grinding must not be carried out until all necessary pavement base replacements have been completed within the area to be grinded.

31.5 Where grinding is required, it must be carried out over the full width of a traffic lane.

31.6 Within 7 days of grinding, the surface must be reassessed for conformity in accordance with Clauses 27 and 28.

31.7 Sealants and surface texture must be restored in accordance with this Technical Specification.

31.8 Diamond grinding must not be the only corrective action implemented for finished surface and ride quality Nonconformances. The Contractor must also detail in the Nonconformance Reports the other corrective actions that will be implemented to avoid repeated finished surface and ride quality Nonconformances.

32 Steel fibre reinforced concrete

General

32.1 The use of steel fibre reinforced concrete (SFRC) is limited to applications specifically shown on the Drawings. In summary:

a) It is always used in steel fibre reinforced concrete base pavement (SFCP) and SFCP-R.

b) It is not used in PCP or JRCP.

c) It is not used in CRCP under this Technical Specification.

32.2 The requirements for the supply and placement of SFRC and SFCP are the same as those for other types of concrete pavement base in this Technical Specification, except for those in this Clause 32. The requirements of this clause are in addition to, and, where in conflict, take precedence over the requirements of the other clauses of this Technical Specification.

Steel Fibres

32.3 Steel fibres must comply with the following properties determined in accordance with EN 14889-1:

a) Ultimate tensile strength ≥ 750 MPa

b) Aspect ratio (λ) greater than 30 and less than 68

c) Hardness (Group II fibres only) > 84 HRB (Hardness Rockwell; B Scale).

32.4 Fibres must not be longer than 50 mm.

Fibre Dose Rate

32.5 The minimum allowable unit mass of steel fibre (Mf) must be determined as follows:

$$Mf = \frac{F \times F_s \times F_D}{F_A \times \lambda \times 100}$$

Or 55 kg/m³, whichever is the higher.

where:

M_f = minimum unit mass of steel fibre (kg/m³)

F = fibre factor (25)

F_S = fibre size factor as per Table ~~R~~32.5 (a)

F_D = fibre density (7,850 kg/m³)

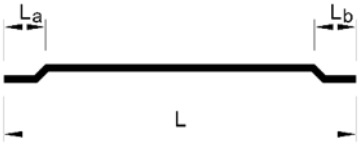
F_A = fibre anchorage performance factor as per Table 32.5 (b)

λ = fibre aspect ratio (refer to EN 14889-1)

Table 32.5(a) – Steel Fibre Size Factor (F_S)

Volume of Single Fibre (mm³)	Size Factor (F_S)
0–5	1.2
6–10	1.3
11–20	1.4
21–30	1.5
31–40	1.6
41–50	1.7
51–60	1.8

Table 32.5(b) – Steel Fibre Anchorage Performance Factor (F_A)

Category	Characteristic Fibre Shapes		Anchorage Performance Factor (F_A)
No deformation			0.7
Fully deformed			0.75
Partially deformed (or anchored)[1]		5–20% deformation	0.8
		21–50% deformation	0.9
		51–99% deformation	0.7
Note: [1] For partially deformed fibres, the proportion of deformation is calculated as: Deformation % = $\frac{L_a + L_b}{L} \times 100$			

Steel fibre reinforced concrete

Strength

32.6 Acceptance of strength in the Works is based on 28 day flexural strength.

32.7 Compressive strength testing is only required as follows:

a) In the trial mix (in accordance with Clause 6) and in the paving trial (in accordance with Clause 18), at both 7 days and 28 days.

b) In the Works at 7 days for the purpose of a statistical check on concrete uniformity (in accordance with Clause 10.9).

32.8 28 day compressive strength testing is not required in the Works, except for the paving trial.

Compressive strength

32.9 In the trial mix, the compressive strength must be determined in accordance with AS 1012.9 and the specimens prepared in accordance with TfNSW T304 (TS 02800.05). The specimens must be cured in accordance with AS 1012.8.1.

32.10 Compressive strength specimens must be of the size listed in Table 32.18 according to the maximum length (Lf) of steel fibre in the mix.

32.11 The 28 day compressive strength of the trial mix (F_{28}) must be not less than 40 MPa.

32.12 The assessment of 7 day compressive strength in the Works must be in accordance with Clause 10.9. One pair of cylinder test specimens must be prepared from each Sub-Lot.

28 day flexural strength

32.13 Samples of concrete for testing in must be taken in accordance with AS 1012.1. The test specimens must be prepared in accordance with Test Method TfNSW T304 (TS 02800.05) using the compaction method specified.

32.14 Cure the test specimens in accordance with AS 1012.8.2.

32.15 Flexure beams must be inspected and tested in accordance with AS 1012.11, this clause and Clauses 32.32. to 32.~~38~~37. Their unit mass must be determined in accordance with AS 1012.12.2.

32.16 The flexural strength of the trial mix at 28 days (F_{28}) must be not less than 5.8 MPa.

32.17 The flexural strength of concrete in the Works must be not less than 5.5 MPa.

32.18 Flexural strength specimens must be of the size listed in Table 32.18. Precautions must be taken during sampling and preparation to minimise disturbance to the fibre distribution and orientation in the test specimen.

Table 32.18 – SFCP specimen sizes (refer to Clauses 32.10 and 32.18)

	Flexural Strength Specimen		**Compressive Strength Specimen**
Fibre Length L_f (mm)	Specimen Size (mm)	Test Method	Specimen Diameter (mm)
$L_f \leq 33$	100x100x350	AS 1012.8.2	100
$33 < L_f \leq 50$	150x150x500	AS 1012.8.2	150

Key:
L_f = maximum length of steel fibre in the mix

Consistence

32.19 The consistence must be determined by measuring the slump in accordance with AS 1012.3.1.

32.20 A slump must be nominated for each nominated concrete mix, within the range specified below and such as to allow the production of a dense, non-segregated base without excessive bleeding.

32.21 The nominated slump must be:

a) between 15 mm and 40 mm for slipform mixes

b) between 50 mm and 60 mm for fixed-form mixes.

Shrinkage

32.22 The drying shrinkage must conform to Clause ~~16~~7.13.

Air content

32.23 An air entraining agent must not be used in SFRC. Air content testing is not required.

Batching, mixing and transport

Charging

32.24 In addition to the requirements of Clause 10, the method of charging the mixer must be consistent with the recommendations of the supplier of the steel fibre.

Mixing

32.25 For mobile mixers, carry out the full period of mixing at either the testing station or the point of placement. Ignore all other mixing and agitation for the purpose of assessing the actual mixing time for a specific batch.

32.26 The minimum mixing time for SFRC is:

a) 5.0 minutes for initial mixing.

b) As determined under Clause 10 for subsequent re-mixing.

Nominated concrete mixes

32.27 In addition to the requirements of Clause 8.1, details of the source, dimensions and nominated mix quantity of steel fibres must be submitted.

32.28 In addition to the requirements of Clause 10, the permissible tolerance for weigh batching of steel fibres is +10% and −0%. If the Contractor proposes to vary the quantity of steel fibres in the nominated mix, a new nominated mix must be submitted in accordance with Clause 8.1.

Texturing

32.29 With reference to Clause 15, light brooming in lieu of longitudinal hessian drag must be applied. Brooming may be either longitudinal or transverse.

32.30 Tining must be applied in accordance with Table 15.4 and Clause 15.8.

32.31 Do not use power trowelling.

Conformity for flexural strength

Test specimens

32.32 Test specimens for determining the flexural strength of pavement base must be standard beams conforming to Table 32.18, based on the maximum length (L_f) of steel fibre in the mix. Samples of concrete must be taken for testing in accordance with AS 1012.1. The test specimens must be moulded in accordance with TfNSW T304 (TS 02800.05) using the compaction method specified and cured in accordance with AS 1012.8.

Frequency of test specimens

32.33 For each Sub-Lot of base placed at one time, a set of 3 test specimens must be taken to determine the flexural strength at 28 days.

Flexural Strength

32.34 The flexural strength of the pavement base represented by a set of beams taken from one sample is the average of individual results not more than 0.5 MPa from the median value.

32.35 Should any specimen be tested more than 28 days after preparation, the equivalent 28 day flexural strength is the test flexural strength divided by the factor AF applicable to the age of the specimen at the time of test as shown in Table 26.189(a).

32.36 For intermediate ages, determine the AF on a pro rata basis.

32.37 If the 28 day flexural strength of test beams for any Sub-Lot is less than 5.0 MPa, remove and replace the Sub-Lot represented by the flexural strength test beams in accordance with Clause 30.

The Administrator may, based on an engineering risk assessment, accept sublots with flexural strength between 5.0 MPa and 5.5 MPa. Typically, this dispensation would be limited to a maximum of 1 in 20 sublots and be based on appropriate corrective action by the Contractor.

~~32.38 Pavement base with 28 day flexural strength of between 5.0 MPa and 5.5 MPa may be accepted, provided that it represents isolated sections and such sections comprise less than 5% of the area of base placed up to and including that Sub-Lot. Such concrete is subject to a deduction of 8% of the applicable schedule rate for each 0.1 MPa or part thereof deficiency in flexural strength.~~

~~Conformity for thickness~~

~~32.39 Clause 27 applies with the following amendments to the deduction values given in Table 27.12.~~

~~a) 18% for areas with a mean thickness of 5 mm less than the specified thickness~~

~~b) 45% for areas with a mean thickness of 10 mm less than the specified thickness.~~

~~32.40 These deductions will be to the applicable item in the payment schedule.~~

Conformity for compaction

~~32.41~~32.38 The relative compaction must be calculated in accordance with TfNSW T381 (TS 02800.55).

~~32.42~~32.39 The unit mass of cores must be determined in accordance with Clause ~~2.2 of Annexure B.~~ 33.4

~~32.43~~32.40 The unit mass of flexure beams must be determined in accordance with AS 1012.12.2, amended in accordance with Clause 32.4~~5~~2.

~~32.44~~32.41 If the relative compaction of the core specimen is less than 97.0%, the Sub-Lot represented by the core must be removed and replaced in accordance with Clause 30.

Representative Beam Unit Mass

~~32.45~~32.42 For SFRC, the unit mass reference values for concrete compaction must be determined using standard prepared beams and in accordance with the following provisions:

a) The test beams are those which are prepared for 28 day flexural strength testing. At an age of between 4 days and 7 days, determine the MUV on all 28 day beam specimens in accordance with AS 1012.12.2, amended in accordance with (b) and (c) hereunder.

b) Determine MUV in the saturated surface-dry (SSD) condition and without dressing of voids (refer to Test Method TfNSW T368 (TS 02800.43)).

c) Round individual results to the nearest even number (in contrast to AS 1012.12.2 which requires rounding to the nearest 10 kg/m³). The MUV for a set of beams is the average of individual results not more than 20 kg/m³ from the median value. Round the average result to the nearest 5 kg/m³.

~~32.46~~32.43 For each nominated mix in use, a statistical check must be made to determine the RBUM, using the set unit mass as defined in Clause 32.4~~4~~2 c).

~~32.47~~32.44 For the paving trial, the RBUM is the mean of all 28 day sets from that trial of the same concrete mix. The mean result is rounded to the nearest 5 kg/m³.

~~32.48~~32.45 Thereafter, the RBUM for any Sub-Lot is taken as the mean of 5 consecutive sets of 28 day beams of that mix, up to and including that Sub-Lot and the results from the paving trial, where applicable. Where fewer than 5 sets of a nominated mix are available, the RBUM is taken as the mean of all available sets from that mix. In each case, the mean result is rounded to the nearest 5 kg/m³.

33 Testing procedures

Mixer uniformity

33.1 As required by Clause ~~5~~B3, a minimum of 24 test cylinders must be cast in accordance with TfNSW T304 (TS 02800.05) from grab samples taken linearly throughout the batch. Sufficient material in each grab sample must be obtained to cast one cylinder only. Sub-samples must not be mixed.

33.2 Each sample must be tested at 7 days for mass per unit volume (MUV) and compressive strength as follows:

a) mass per unit volume (MUV) in accordance with Clause 25.10, except that results are to be rounded to the nearest 1 kg/m³ and

b) compressive strength, with sampling and moulding in accordance with Clause 26.1 to Clause 26.5 except that results are to be rounded to the nearest 0.1 MPa.

The Coefficient of Variation of both result sets is determined as follows:

$$C_oV_C = \frac{\sigma_{compressive}}{\mu_{compressive}} \times 100$$

where:

C_oV_C = compressive strength Coefficient of Variation, reported to the nearest 0.1%

$\sigma c_{compressive}$ = standard deviation of compressive strength, to the nearest 0.1 MPa

$\mu_{compressive}$ = mean of compressive strength, to the nearest 0.1 MPa.

$$C_oV_{MUV} = \frac{\sigma_{MUV}}{\mu_{MUV}} \times 100$$

where:

C_oV_{MUV} = MUV Coefficient of Variation, reported to the nearest 0.1%

σ_{MUV} = standard deviation of MUV, to the nearest 1 kg/m³

μ_{MUV} = mean of MUV, to the nearest 1 kg/m³.

Unit mass of cylinders and cores

Cylinders

33.3 The unit mass of cylinders must be determined in accordance with AS 1012.12.2, qualified as follows:

a) Determine m1 the initial mass of the specimen prior to dressing, in accordance with AS 1012.12.2 Clause 6(a) and in the saturated surface-dry (SSD) condition. This will require wet conditioning for 24 hours in accordance with Clause 6(c).

b) Assess the cylinder in accordance with TfNSW T368 (TS 02800.43) for excessive voids. Dress and/or seal voids where required.

c) Determine m2 the immersed mass including dressing in accordance with AS 1012.12.2.

d) Determine m3 the SSD mass including dressing. The dressing must be fully intact at the time of weighing.

e) Calculate the volume and mass per unit volume in accordance with AS 1012.12.

f) The concrete age at testing must be at least 3 days.

g) Report the height and diameter of the core, as tested.

h) Round individual results for unit mass to the nearest even number (in contrast to AS 1012.12, which requires rounding to the nearest 10 kg/m³).

Cores

33.4 The unit mass of cores must be determined in accordance with AS 1012.12.2, qualified as follows:

a) Determine m1 the initial mass of the specimen including any steel but prior to dressing, in accordance with AS 1012.12.2 Clause 6(a) and in the saturated surface-dry (SSD) condition. This will require wet conditioning for 24 hours in accordance with Clause 6(c).

b) Assess the cores in accordance with TfNSW T368 (TS 02800.43) for excessive voids. Dress and/or seal voids where required.

c) Determine m2 the immersed mass including steel and dressing in accordance with AS 1012.12.2.

d) Determine m3 the SSD mass including steel and dressing. The dressing must be fully intact at the time of weighing.

e) Calculate the volume and mass per unit volume in accordance with AS 1012.12.

f) The concrete age at testing must be at least 3 days.

g) Adjust the unit mass for the presence of steel reinforcement in accordance with TfNSW T368 (TS 02800.43).

h) Report the height and diameter of the core, as tested.

i) Round individual results for unit mass to the nearest even number (in contrast to AS 1012.12 which requires rounding to the nearest 10 kg/m³).

Appendix~~nnexure~~ A: Summary of Hold Points, Witness Points, Milestones and Records

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

The Hold Points, Witness Points, Milestones and Records~~following is a summary of the Witness Points/Hold Points that apply to this Specification and the Records~~ that the Contractor must submit to the ~~Principal~~ Administrator to demonstrate compliance with this Technical Specification, are summarised in Table A.

~~Clause~~	~~Hold Point~~	~~Witness Point~~	~~Record~~
~~4.1~~	1. ~~Commencement of concrete production~~		~~Quality Plan~~
~~6.10~~	2. ~~Paving of base if high underlying surface levels exist~~		~~Schedule of underlying surface levels and relevant nonconformity report~~
~~8.1~~		1. ~~Laboratory trial mixing~~	
~~8.9~~	3. ~~Production of each concrete mix~~		~~Mix details~~
~~9.11~~	4. ~~Placement of concrete around steel reinforcement~~		~~Certificate of conformity~~
~~9.43~~	5. ~~Use of an authorised nominated mix~~		~~Test results and proposed corrective action~~
~~22~~	6. ~~Production of concrete for paving~~		~~Results demonstrating conformity of mixer uniformity~~
~~11.6~~	7. ~~First concrete base in the Works, including paving trial~~		~~Details of the paving crew~~
~~18.1~~		2. ~~Construction of section of trial pavement~~	
~~17.16~~	8. ~~Trafficking of vehicles in accordance with Clauses 17.13 b) and 17.13 e)~~		~~Compressive strength test results~~

~~Clause~~	~~Hold Point~~	~~Witness Point~~	~~Record~~
~~17.16~~	9. ~~Trafficking of vehicles in accordance with Clause 17.13 c)~~		~~Compressive strength test results~~
~~18.3~~	10. ~~Commencement of base paving other than trial paving~~		~~Report of paving trial~~
~~19.10~~		3. ~~Testing of joints and silicone sealants~~	
~~25.40~~	11. ~~Slipform paving in the event of a nonconformity~~		~~Test results and proposed for corrective action~~
~~30.1~~	12. ~~Sawcutting for removal and replacement of concrete pavement base~~		~~Nonconformity report for each location~~

Table A – Hold Points, Witness Points, Milestones and Records

Clause	Hold Point	Witness Point	Milestone	Record
4.1	1. Commencement of concrete production			Quality Plan
5.3				Aggregate production procedure
6.10	2. Paving of base if high underlying surface levels exist			Schedule of underlying surface levels and relevant nonconformity report
8.1	3. Production of each concrete mix	1. Laboratory trial mixing		Nominated mix details and associated documents
9.1 to 9.11	4. Placement of concrete around steel reinforcement			Certificate of conformity
10.38	5. Use of an authorised nominated mix			Test results and proposed corrective action

Clause	Hold Point	Witness Point	Milestone	Record
10.44	6. Production of concrete for paving			Results demonstrating conformity of mixer uniformity
11.6	7. First concrete base in the Works, including paving trial			Details of the paving crew
17.16	8. Trafficking of vehicles in accordance with Clauses 17.13 b) and 17.13 e)			Compressive strength test results
17.16	9. Trafficking of vehicles in accordance with Clause 17.13 c)			Compressive strength test results
18.1		2. Construction of section of trial pavement		
18.3	10. Commencement of base paving other than trial paving			Report of paving trial
19.10		3. Testing of joints and silicone sealants		Joint and sealant test results
25.40	11. Slipform paving in the event of a nonconformity			Compaction test results and proposal for corrective action
27.10				Survey data and assessment of levels and thickness
29.9				Results from profile testing and ride quality testing

Clause	Hold Point	Witness Point	Milestone	Record
30.1	12. Sawcutting for removal and replacement of concrete pavement base			Nonconformity report for each location

A~~nnexure~~ppendix B: Mixer Uniformity Testing

B1 Mixer Uniformity Testing - General

For the purpose of conducting the mixer uniformity test, the mixer must be charged:

a) in accordance with the manufacturer's instructions

b) in the sequence proposed to be used in the Works, and

c) to the maximum volume (or throughput) proposed to be used in the Works.

Thereafter, the same charging sequence must be used and the volume (or throughput) at test must not be exceeded unless a further uniformity test is conducted.

Concrete from the mixer uniformity test may be incorporated into the base or into associated works such as anchors, kerbs, subgrade beams or drainage structures on the condition that all concrete from the test conforms to the relevant Specification and is placed in a discrete Sub-Lot which must be removed in total if the mixer fails to meet the criteria as specified in ~~subclause (e) hereunder~~Clause B5.

B2 Uniformity Testing of Continuous Mixers

Continuous mixers must be assessed in accordance with ~~the following Clauses 5 to 12~~Clause B3, with each sample separated by an interval equivalent to at least 2 m³ of throughput.

B3 Uniformity Testing of Central Batch Mixers

Where concrete is to be produced and mixed by a central mixer, conduct mixer uniformity tests before production paving is commenced with that mix, and thereafter upon production of each 30,000 m³ of concrete from that mixer, or as otherwise required in accordance with AS 1379 Clause 3.5. All types of mixes (including subbase, base and kerbs) and to all clients in this volumetric total must be included.

Tests must 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 respective minimum mixing time so determined must thereafter be adopted for all base mixes.

Tests on 3 batches or runs of the same mix which conform to all of the requirements of this Technical Specification must be carried out. A run from a continuous mixer must comprise not less than 5 m³ of mix.

The following must be assessed and included in a report:

a) mixing speed

b) batch (or run) volume

c) duration of charging

d) total mixing time or, for continuous mixers, the throughput rate, and

e) mixing time after the last addition of water.

The whole of a single batch (or run) must 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 must be from the truck prior to tipping. Obtain the samples by using a shovel or scoop but exclude the top 100 mm of concrete.

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

In each case, the batch (or run) must be sampled at 3 points approximately 15%, 50% and 85% along the discharged length of the mix but not closer to either end than 10% of the length. The sample must be approximately 50 litres from each point.

Samples must be individuals (not composites) in accordance with AS 1012.1 Clause 7.2.2.

Additionally, test cylinders must be cast and assed for mass per unit volume (MUV) and compressive strength in accordance with Clause 33.3. The results must be assessed in accordance with Clause ~~21~~B5.

B4 Uniformity Testing of Mobile Batch Mixers

All mobile batch mixers must display an identification plate (or equivalent certification) in accordance with AS 1379 to certify conformity with mixer uniformity criteria.

All mixers must be certified as belonging to a fleet which is operating under a mixer uniformity and compliance program as detailed below. Such program must record the progressive maintenance regime for each mixer and the results of compliance by mixers which have been tested for mixer efficiency under a statistical sampling procedure. Such individual results must comply with the limits given in AS 1379. Where a mixer is one of the test samples, show the date of the latest test on its mixer compliance plate (or Certificate).

Further tests must be carried out:

a) upon evidence of non-uniformity of mixing which appears to be associated with mixer wear, or

b) where the discharge time for that mixer is more than 25% longer than the typical time for other trucks using the same mix.

Because of the retempering provisions of this Technical Specification, these criteria apply also to mobile mixers which are used to transport centrally-mixed concrete.

All samples for uniformity testing must be individuals and not composites (refer to AS 1012.1).

To satisfy the mixer uniformity and compliance program, all mixers must be regularly inspected to determine the extent of internal wear, internal build up and the ability to rotate at the required rate (revolutions/minute). A progressive maintenance record must be kept for each mixer showing inspection frequency and details of any repair or rectification, and make this available on request.

The Contractor must ensure that over a period of 24 months, the number of mixers shown in Table ~~19~~B4 have been randomly tested. The fleet will be deemed to conform if all selected mixers satisfy the requirements of Appendix A in AS 1379.

Table B4 – Mobile Mixer Fleet Testing

Population Size	Sample Size
< 16	All
16-25	17
26-50	22
51-90	24
91-150	26
151-280	28
281-500	32

This sampling program is predicated on an 8% Limiting Quality Value, and where a mixer fails to satisfy a mixer uniformity test, the entire fleet is deemed to have failed, until:

c) the producer immediately stands down the mixer while reasons for the failure are investigated to determine whether the failed result is a true outlier. If it is found that the failure was due to extraordinary reasons, it may be treated as a one-off event, and

d) another randomly selected mixer from the same fleet is immediately tested and that result will determine the continued compliance of the fleet, as follows:

   i. if it passes, the fleet will carry provisional compliance until the failed mixer is either repaired and passed or is withdrawn from operational service

ii. if it fails, Clause ~~20 a)~~B4 c) will apply.

B5 Compliance for Uniformity

For central batch mixers and continuous mixers, the mixer will be deemed to have passed the uniformity test if:

a) three consecutive passes are obtained when batches are tested and assessed under the following criteria. If testing is not carried out on consecutive batches, the test batches must be selected at random and there must be 3 consecutive passes

b) in each batch, the differences between the highest value and the lowest value for the corresponding properties of the 3 samples do not exceed the limiting values given in AS 1379 Table A1 for any of the 3 batches or runs

c) no slump value is outside the specified range

d) C_oV_C is less than 4.5%, and

e) C_oV_{MUV} is less than 1.0%.

For mobile batch mixers, the assessment must be in accordance with AS 1379.

Annexureppendix C: Minimum Frequency of Testing

Clause	Characteristic Tested	Test Method	Minimum Frequency of Testing
Constituent Material: Fine Aggregate(1)			
5.8	Material finer than 75 µm (TF)	AS 1141.11.1 or AS 1141.12	One per 5,000 t(4) for first 15,000 t and thereafter one per 10,000 t
5.8	Material finer than 2 µm (TF)	AS 1141.13	One per 5,000 t(4) for first 15,000 t and thereafter one per 10,000 t
5.8	Methylene Blue Adsorption Value (MBV) (Ind)	AS 1141.66	One per 20,000 t(4)
5.8	MBV75 value (Ind)		One per 20,000 t(4)
5.8	Bulk Density (compacted)	AS 1141.4 Procedure 7.2	At trial mix submission(3)
5.8	Water Absorption	AS 1141.6.1 or AS 1141.6.2	At trial mix submission(3)
5.8	Aggregate soundness	AS 1141.24	One per 5,000 t(4) ffirst 15,000 t and thereafter one per 10,000 t
5.8	Organic impurities (TF)	AS 1141.34, AS 1289.4.1.1. Refer to Table R83.2 Note(4).	One per 2,000 t(4) for the first 10,000 t and thereafter one per 10,000 t
5.8	Sugar content (TF)	AS 1141.35	One per 5,000 t(4)
5.8	Acid insoluble residue	TxDOT Tex-612-J	At nominated mix submission(4) (TF)(4)
5.8	Micro-Deval loss(6)	ASTM D7428	At nominated mix submission(4,6) (TF)(4)
5.8	Flow Cone time	T279	One per 10,000 t(4)
5.8	Hardness	Vickers Hardness (macro) ASTM E384-16	At nominated mix submission(4) (TF)(4)
5.8	Glass content	ATS 3130	At nominated mix submission(3) (TF)(4)
Constituent Material: Coarse Aggregate			
5.9	Bulk and particle density	AS 1141.4, AS 1141.6	In the trial mix
5.9	Water absorption	AS 1141.6	At nominated mix submission(3) (TF)(4)

Clause	Characteristic Tested	Test Method	Minimum Frequency of Testing
5.9	Material finer than 75 mm (TC)	AS 1141.11.1 or AS 1141.12	One per 5,000 t[4] for the first 15,000 t and thereafter one per 10,000 t
5.9	Particle shape (Ind)	AS 1141.14	One per 10,000 t
5.9	Ratio AGD/ALD (Ind)	AS 1141.20.1	One per 10,000 t
5.9	Wet strength (Ind)	AGBT-T060	One per 10,000 t[1]
5.9	Wet/dry strength variation (Ind)	AGBT-T060	One per 10,000 t[1]
5.9	Weak particles (Ind)	AS 141.32	One per 20,000 t
5.9	Light particles (Ind)	AS 1141.31	One per 20,000 t
5.9	Fractured faces (Ind)	AGBT-T061	One per 10,000 t
5.9	Foreign materials content (Ind)	AGBT-T065	One per 4,000 t
5.9	AAR	AS 1141.60.1	At nominated mix submission[3]
Constituent Material: Other Materials			
5	Cementitious materials	Refer to Clause 5	Refer to Clause 5
5.25	Curing compound conformity	AS 3799	Refer to Clause 5.26
5.40	Joint sealant	Refer to Clause 5.40	Refer to Clause 5.40
5.44	Water	AS 3799	At the trial mix and thereafter one per 5,000 m³ of concrete
Placing Concrete in Base			
7.13	Shrinkage	AS 1012.13	At nominated mix submission[3]
7.15	Chloride ion content	Refer to Clause 7.15	One per 30,000 m³ of concrete
7.15	Sulphate ion content	Refer to Clause 7.15	One per 30,000 m³ of concrete
7.15	Bleeding	AS 1012.6	At the production mix
7.15	Coefficient of Thermal Expansion (CTE)	AASHTO T336	At nominated mix submission[3]. Report only.
9.20	Tiebars; pull-out testing		As per Clause 9.20
9.27	Tiebars; location and compaction		As per Clause 9.27
9.34	Tiebars; concrete cover		As per Clause 9.34

Clause	Characteristic Tested	Test Method	Minimum Frequency of Testing
9.39	Dowels; pull-out testing	TfNSW T366	Trial mix submission, 3 dowels and as per Clause 9.39
10.7	Particle size distribution of combined aggregate: – by calculation or – by wet-sieving[3]	AS 1141.11.1 AGBT-T720[3]	One per 500 m³ for the first 5,000 m³ and thereafter one per 1,500 m³ of concrete[5]
10.20	Flexural strength	AS 012.11	As per Clause 10.20
10.3	Water content		One per 500 m³ for the first 5,000 m³ and thereafter one per 2,500 m³
10.41	Mixer Uniformity	AS 1379	As per Clause 10.41
10.61	Concrete slump	AS 1012.3.1	As per Clause 10.61
10.79	Air content of concrete	AS 1012.4.2	As per Clause 10.79
15.13	Average depth of surface texture		
	a) Hessian drag only	Either: AGAM-T013 AGPT-T250 TfNSW T240, or TfNSW T192	Only where tining and/or grooving is not specified, one per 2,000 m²
	b) Combined surface texture	Either: AGAM-T013 AGPT-T250 TfNSW T240, or TfNSW T192	One per 2,000 m²
	Application rate of curing compound	As per Clause 16.19	As per Clause 16.12 or 16.13
17.4	In situ compressive strength (for trafficking purposes)	Cylinders as per TS 02800.42 or Cores as per Clause 17.4	As per Clause 17.4 As per Clause 17.4
	Cylinder compressive strength of concrete at:		
26.1	– 7 days	AS1012.9	As per Clause 26.1

Clause	Characteristic Tested	Test Method	Minimum Frequency of Testing
26.1	= 28 days	AS 1012.9	As per Clause 26.1
19.9	Joints and sealants	AGBT-T745	As per Clause 19.9
25	Relative compaction of concrete	TS 02800.55	As per Clause 25
	Surface level and alignment	Various	As per Clause 27
27	Thickness	Survey and core length	As per Clause 27
	Surface profile	As per Clause 28	As per Clause 28
29	Ride quality	AGAM-T001 or TfNSW T188	As per Clause 29
Steel Fibre Reinforced Concrete			
32.12	Compressive strength	AS 1012.9	As per Clause 32.12
32.19	Consistence	AS 1012.3.1	As per Clause 32.19
32.18	Flexural strength	AS 1012.11	As per Clause 32.18
32.38	Thickness	Survey and core length	As per Clause 27
25	Relative compaction of concrete	T381	As per Clause 25

Notes:

(1) Provided that all of the 6 previous tests have met specification requirements for both wet strength and wet/dry strength variation, then the following reduced frequency may apply:

- where all wet/dry variation results are < 25%: 1 per 15,000 t.

(2) As tested within 18 months prior to the commencement of paving and to be included in the nominated mix submission.

(3) Frequencies are based on aggregate quantities as follows:

Ind: individual aggregate quantities

TF: total fine aggregate quantities

TC: total coarse aggregate quantities

(4) Where a plant produces less than 1,000 t per day of fine or coarse aggregate for use under the Contract, a minimum of one test per day is required for grading.

(5) Refer to Table 5.8 Note (7) regarding the warrant for testing.

Clause	Characteristic Tested	Test Method	Minimum Frequency of Testing
Constituent Material: Fine Aggregate (source rock tests)			
5.8	Petrographic Analysis	Q188	Refer to Clause 8.1.1 of MRTS50

Clause	Characteristic Tested	Test Method	Minimum Frequency of Testing
5.8	Water absorption	AS 1141.5	Refer to Clause 8.1.1 of MRTS50
5.8	Particle density	AS 1141.5	Refer to Clause 8.1.1 of MRTS50
5.8	Chloride content	AS 1012.20.1	Refer to Clause 8.1.1 of MRTS50
5.8	Sulphate content	AS 1012.20.1	Refer to Clause 8.1.1 of MRTS50
5.8	Micro-Deval abrasion loss	Q229A	Refer to Clause 8.1.1 of MRTS50
5.8	Soundness (sodium sulfate)	AS 1141.24	Refer to Clause 8.1.1 of MRTS50
5.8	Organic impurities (natural sand quarries only)	AS 1141.34	Refer to Clause 8.1.1 of MRTS50
5.8	Sugar presence (natural sand quarries only)	AS 1141.35	Refer to Clause 8.1.1 of MRTS50
5.8	Light particles (natural sand quarries only)	AS 1141.31	Refer to Clause 8.1.1 of MRTS50
5.8	Material passing 75 µm sieve (natural sand quarries only)	AS 1141.12	Refer to Clause 8.1.1 of MRTS50
5.8	Material finer than 2 µm (natural sand quarries only)	AS 1141.13	Refer to Clause 8.1.1 of MRTS50
Constituent Material: Fine Aggregate (product tests)			
5.8	Particle size distribution	AS 1141.11.1	One per 5,000 t[(1)] for first 15,000 t and thereafter one per 10,000 t
5.8	Material passing 75 µm sieve (hard rock quarries only)	AS 1141.12	One per 5,000 t[(1)] for first 15,000 t and thereafter one per 10,000 t
5.8	Material finer than 2 µm (hard rock quarries only)	AS 1141.13	One per 5,000 t[(1)] for first 15,000 t and thereafter one per 10,000 t
5.8	Methylene Blue Adsorption Value (MBV)	AS 1141.66	One per 20,000 t
5.8	Deleterious Fines Index (DFI)	Not applicable	One per 20,000 t
5.8	Flow Cone time (total fine)	TfNSW T279 (TS 02799.54)	One per 10,000 t

Clause	Characteristic Tested	Test Method	Minimum Frequency of Testing
5.8	Glass content (total fine) and requirements (individual)	Refer to MRTS36 *Recycled Glass Aggregate*	Glass content at trial mix submission Other requirements refer to MRTS36 *Recycled Glass Aggregate*
Constituent Material: Coarse Aggregate (source rock tests)			
5.9	Petrographic Analysis	Q188	Refer to Clause 8.1.1 of MRTS50
5.9	Wet strength	AS 1141.22	Refer to Clause 8.1.1 of MRTS50
5.9	Wet/dry strength variation	AS 1141.22	Refer to Clause 8.1.1 of MRTS50
5.9	Weak particles	AS 141.32	Refer to Clause 8.1.1 of MRTS50
5.9	Water absorption	AS 1141.6	Refer to Clause 8.1.1 of MRTS50
5.9	Degradation factor	Q208B	Refer to Clause 8.1.1 of MRTS50
5.9	Particle density	AS 1141.6.1	Refer to Clause 8.1.1 of MRTS50
5.9	Chloride content	AS 1012.20.1	Refer to Clause 8.1.1 of MRTS50
5.9	Sulphate content	AS 1012.20.1	Refer to Clause 8.1.1 of MRTS50
5.9	Soundness (sodium sulfate)	AS 1141.24	Refer to Clause 8.1.1 of MRTS50
Constituent Material: Coarse Aggregate (product tests)			
5.9	Particle shape (individual)	AS 1141.14	One per 5,000 t
5.9	Flakiness index (individual)	AS 1141.15	One per 5,000 t
5.9	Particle size distribution (individual)	AS 1141.11.1	One per 5,000 t[(1)] for the first 15,000 t and thereafter one per 10,000 t
5.9	Material passing 75 µm sieve (individual)	AS 1141.12	One per 5,000 t[(1)] for the first 15,000 t and thereafter one per 10,000 t
5.9	Material finer than 2 µm	AS 1141.13	One per 5000 t
5.9	Crushed particles (natural gravel quarry only)	AS 1141.18	One per 10,000 t
Constituent Material: Other Materials			
5.10 to 5.22	Cementitious materials	Refer to Clauses 5.10 to 5.22	Refer to Clauses 5.10 to 5.22
5.25 to 5.36	Curing compound conformity	Refer to Clauses 5.25 to 5.36	Refer to Clauses 5.25 to 5.36

Clause	Characteristic Tested	Test Method	Minimum Frequency of Testing
5.37 to 5.38	Joint sealant	Refer to Clauses 5.37 to 5.38	Refer to Clause 5.39
5.43 to 5.46	Water	Refer to Clauses 5.43 to 5.46	At the trial mix and thereafter one per 5,000 m³ of concrete
Placing Concrete in Base			
7.12 to 7.13	Shrinkage	AS 1012.13	At trial mix submission(2)
7.14 to 7.18	Chloride ion content	Refer to Clauses 7.14 to 7.18	One per 30,000 m³ of concrete
7.14 to 7.18	Sulphate ion content	Refer to Clauses 7.14 to 7.18	One per 30,000 m³ of concrete
7.14	Bleeding	AS 1012.6	At the trial mix
9.17 to 9.24	Tiebars; pull-out testing	Refer to Clauses 9.17 to 9.24	As per Clauses 9.20 to 9.23
9.25 to 9.33	Tiebars; location and compaction	Refer to Clauses 9.25 to 9.33	As per Clauses 9.26 to 9.29
9.34 to 9.38	Tiebars; concrete cover	Refer to Clauses 9.34 to 9.38	As per Clauses 9.34 to 9.35
9.39	Dowels; pull-out testing	TfNSW T366 (TS 02800.41)	Trial mix submission, 3 dowels and as per Clause 9.39
10.6	Particle size distribution of combined aggregate: – by calculation or – by wet-sieving(3)	AS 1141.11.1 TfNSW T329 (TS 02800.26)(3)	One per 500 m³ for the first 5,000 m³ and thereafter one per 1,500 m³ of concrete(1)
10.15 to 10.34	Flexural strength	AS 1012.11	As per Clause 10.17
10.3	Water content		One per 500 m³ for the first 5,000 m³ and thereafter one per 2,500 m³
10.44	Mixer Uniformity	AS 1379 and Appendix B	As per Clause 10.44
10.57 to 10.63	Concrete slump	AS 1012.3.1	As per Clause 10.59

Clause	Characteristic Tested	Test Method	Minimum Frequency of Testing
10.78 to 10.84	Air content of concrete	AS 1012.4.2	As per Clauses 10.79 to 10.82
15.13 to 15.15	Average depth of surface texture		
	a) Hessian drag only	Either: ATM 250 or TfNSW T192 (TS 02795.50)	Only where tining and/or grooving is not specified, one per 2,000 m²
	b) Combined surface texture	Either: ATM 250 or TfNSW T192 (TS 02795.50)	One per 2,000 m²
16.19	Application rate of curing compound	As per Clause 16.19	As per Clause 16.19
17.14 to 17.5	In situ compressive strength (for trafficking purposes)	Cylinders as per TfNSW T367 (TS 02800.42) or Cores as per Clause 17.15	As per Clause 17.14 As per Clause 17.15
	Cylinder compressive strength of concrete at:		
26.1	– 7 days	AS 1012.9	As per Clause 26.1
26.1	– 28 days	AS 1012.9	As per Clause 26.1
19.9	Joints and sealants	TfNSW T379 (TS 02800.53) and TfNSW T380 (TS 02800.54)	As per Clause 19.9
25	Relative compaction of concrete	TfNSW T381 (TS 02800.55)	As per Clause 25
27	Surface level and alignment	Various	As per Clause 27
27	Thickness	Survey and core length	As per Clause 27
28	Surface profile	As per Clause 28	As per Clause 28
29	Ride quality	Q708B or Q708D	As per Clause 29

Clause	Characteristic Tested	Test Method	Minimum Frequency of Testing
Steel Fibre Reinforced Concrete			
32.12	Compressive strength	AS 1012.9	As per Clause 32.12
32.19	Consistence	AS 1012.3.1	As per Clause 32.19
32.13 to 32.18	Flexural strength	Refer to Clauses 32.13 to 32.18	As per Clause 32.33
27	Thickness	Survey and core length	As per Clause 27
25	Relative compaction of concrete	TfNSW T381 (TS 02800.55)	As per Clause 25

Notes:

(1) Where a plant produces less than 1,000 t per day of fine or coarse aggregate for use under the Contract, a minimum of one test per day is required for grading.

(2) As tested within 18 months prior to the commencement of paving and to be included in the nominated mix submission.

(3) Only the +1.18 mm fraction need be tested. Clause 10.6 refers.