DELIVERING FOR QUEENSLAND

Technical Specification

Transport and Main Roads Specifications
MRTS39 Lean-mix Concrete Subbase

May 2026

(ATS 3520 Lean-mix Concrete Subbase, Ed 1.0 March 2025)

Queensland Government

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Purpose

This ancillary document outlines the adopted national Austroads Technical Specification ATS 3520 *Lean-mix Concrete Subbase* and modified Queensland-specific content with tracked changes.

The following table summarises the relationship between the Austroads Technical Specification ATS 3520 *Lean-mix Concrete Subbase* 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 3520 *Lean-mix Concrete Subbase* as part of national harmonisation. It sets out the requirements for the supply of lean-mix concrete and construction of lean-mix concrete subbase.

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 3520 *Lean-mix Concrete Subbase* applies in Queensland
- has precedence over the Austroads Technical Specification ATS 3520 *Lean-mix Concrete Subbase* when applied in Queensland
- has the same clause numbering and headings as the Austroads Technical Specification ATS 3520 *Lean-mix Concrete Subbase*.

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
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.

Contents

1 Scope

1.1 ThisAustroads Technical Specification ATS 3520 sets out the requirements for the construction of lean-mix concrete subbase (LCS). It includes the requirements for:

a) constituent materials

b) concrete mix design

c) production and transport of concrete

d) concrete subbase paving

e) survey

f) sampling and testing, and

g) conformity criteria.

1.2 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.

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

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*

Reference	Title
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 1012.8.1 ~~Method 8.1~~	*Method for making and curing concrete – Compression and indirect tensile test specimens*
AS 1012.9 ~~Method 9~~	*Compressive strength tests – Concrete, mortar and grout specimens*
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 securing 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 aggregates – Nitric acid extraction method*
AS 1141	*Methods for sampling and testing aggregates*
AS 1141.3.1 ~~Method 3.1~~	*Sampling – Aggregates*
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)*

Reference	Title
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	*Crushed particles in coarse aggregate derived from gravel*
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	*Light particles*
AS 1141.32	*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~~	*Detection of sugar contamination in concrete aggregates*
~~AS 1141 Method 60.1~~	~~*Potential alkali-silica reactivity – Accelerated mortar bar method*~~
~~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 1289.1.4.1	*Sampling and preparation of soils – Selection of sampling or test sites – Random number method*
~~AS 1289 Method 4.1.1~~	~~*Soil chemical tests – Determination of the organic matter content of a soil – Normal 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	*Chemical admixtures for concrete, mortar and grout*
AS 1478. ~~Part~~ 1	*Admixtures for concrete*
AS 1478. ~~Part~~ 2	*Methods of sampling and testing admixtures for concrete, mortar and grout*

Reference	Title
AS 2341.18	*Methods of testing bitumen and related roadmaking products – ~~Method 18:~~ Determination of softening point (ring and ball method)*
~~AS/NZS 2341.27~~	~~*Methods of testing bitumen and related roadmaking products – Method 27: Determination of sedimentation*~~
AS/NZS 2350	*Methods of testing portland, blended and masonry cements*
AS/NZS 2350.2 ~~Method 2~~	*Chemical composition*
AS/NZS 2350.8 ~~Method 8~~	*Fineness index of portland cement by air permeability ~~method~~*
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 3799	*Liquid membrane-forming curing compounds for concrete*
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*
Austroads	
~~ATS 1120~~	~~*Quality Management Requirements*~~
~~ATS 3050~~	~~*Supply of Recycled Crushed Glass Sand*~~
~~ATS 3460~~	~~*Sprayed Bituminous Surfacing*~~
~~ATS 3530~~	~~*Concrete Pavement Base*~~
~~AGPT-T250~~	~~*Road Surface Texture Depth (Sand Patch)*~~
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*
Transport for New South Wales	
Standard Drawing DS2012/001191	*Plain concrete pavement (PCP) – construction (TS 02732)*

Reference	Title
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)*
~~TfNSW T183~~	~~*Surface Deviation Using a Straightedge*~~
~~TfNSW T215~~	~~*Wet/Dry Strength Variation (TS 02799.13)*~~
~~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)*
TfNSW T321	*Drying Shrinkage of 100 x 100 x 280 mm Concrete Prisms (TS 02800.21)*
TfNSW T329	*Wet Sieving of Concrete (TS 02800.26)*
~~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)*
ASTM International	
ASTM C1064M	*Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete ~~Materials~~*
Transport and Main Roads Technical Documents	
MRTS01	*Introduction to Technical Specifications*
MRTS11	*Sprayed Bituminous Treatments (Excluding Emulsion)*
MRTS12	*Sprayed Bituminous Emulsion Surfacing*
MRTS17	*Bitumen and Multigrade Bitumen*
MRTS36	*Recycled Glass Aggregate*
MRTS40	*Concrete Pavement Base*
MRTS50	*Specific Quality Systems – Requirements*
MRTS51	*Environmental Management*
MRTS70	*Concrete*
MRTS71	*Reinforcing Steel*

Reference	Title
Q188	*Petrographic Assessment of Aggregates*
Q208B	*Degradation Factor of Coarse Aggregate*
Q229A	*Resistance to Degradation by Abrasion of Fine Aggregate (Micro-Deval)*
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'.
Air-entraining agent	An admixture used for entraining air as discrete, non-coalescing, small bubbles.
Anchor slab	The base slab that lies over a slab anchor. See also 'slab anchor'.
Authorised mix	A mix design that has been authorised by the ~~Principal~~Administrator.
Base	The uppermost pavement structural layer.
Batch	A quantity of concrete containing a fixed amount of ingredients and produced in a discrete operation. For continuous mixers, a batch is deemed to be a load produced in a continuous process. See also 'load'.
Batching	The process of combining the concrete ingredients in fixed proportions by mass or by volume, including charging and mixing.
Charging (of mixer)	The introduction of constituent materials of the concrete into the mixer.
Coefficient of Variation	Ratio of the standard deviation of the test values to the mean of test values multiplied by 100.

Definition	Term
Concrete	A thoroughly mixed combination of cementitious materials, aggregates and water, with or without the addition of chemical admixtures or other materials, all of which separately and, when combined, conform to this Technical Specification.
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.
Debond / Debonding treatment	The application of a material to a surface to prevent the formation of a bond between the subbase concrete and the base concrete.
Edge, formed	An edge that is formed by a slipform or fixed form.
Edge, outer (of subbase)	An edge against which material other than subbase concrete is to be placed (such as granular backfill, kerb concrete or no-fines concrete).
Edge, slab	An edge of a slab, which is formed by either slipform or fixed form.
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 both 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.

Term	Definition
Load	A single truckload of concrete comprising one or more batches. For stationary batch mixers discharging into tipper trucks, a load may comprise more than one batch. For agitators, a load must not comprise more than a single batch.
Lot	As defined in ~~ATS 1120~~MRTS50 *Specific Quality System Requirements*. See also 'Sub-Lot' and 'transition Sub-Lot'.
Mixers	a) Stationary mixer: a mixer in a fixed location adjacent to the batching equipment. This category includes stationary batch mixers and stationary continuous mixers: • Stationary batch mixer: a mixer that produces a fixed amount of concrete 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. See AS 1379 Clauses 4.2 and 4.3 for further information.
Mixing time	As defined in Clause 7.11.
Nominated mix	A mix design that is developed from the laboratory trial mixes and certified by the Contractor as conforming to this Technical Specification.
Paving run	A single length of pavement placed as one continuous pour without an interruption to paving that requires a transverse construction joint.
Production mix	A concrete mix used in the Works that targets the authorised nominated mix.
Re-entrant angle	An angle, formed by joints and/or edges, that points inwards towards the concrete slab (for example, at a drainage pit).
Retemper	The addition of water to a batch after 'Completion of Batching' to restore consistence. The addition of an admixture (such as a high range water reducer) is not considered to constitute retempering.
Slab	A portion of concrete bounded by joints and/or edges.
Slab anchor	A restraining beam cast in the ground, on which an anchor slab is later cast.

Definition	Term
Slipform paving	Also referred to as 'mechanical paving' and 'machine paving'. Paving using a purpose-built machine to spread, compact, screed and finish the concrete in accordance with Clauses 10.11 to 10.24 ~~6.3~~ and without fixed formwork. This term also applies to paving by a slipform paver operated over fixed forms.
Sub-Lot	A Sub-Lot is defined as a continuous pour of area: • up to 500 m² for slipformed subbase, or • up to 300 m² for fixed-formed subbase. In transition zones, generate separate Sub-Lots in accordance with Clause 17.2.
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.
Transition Sub-Lot	A Sub-Lot that falls within a transition zone (as defined).
Transition zone	Area of machine paved concrete that requires hand vibration due to ineffective slipform vibration such as at both sides of transverse construction joints.
Transition point	The point at which vibration on a paving machine commences or ceases effective compaction. Examples include: • transition zones • boundary of a zone where a vibrator becomes faulty or irregular, and • 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
AEA	Air-entraining agent
ALD	Average least dimension (of aggregate)
ATIC	Australian Technical Infrastructure Committee
CAP	Crack Assessment Procedure
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
MUV	Mass per unit volume
NATA	National Association of Testing Authorities, Australia
PCP	Plain concrete pavement (base)
SCM	Supplementary cementitious material
SF	Shape correction factor for cores; see Clause 17.13
SFCP	Steel fibre reinforced concrete pavement (base)

Table 3.1(c) - Definitions of Symbols

Symbol	Definition
CoV	Coefficient of Variation ~~(refer to Annexure R82/E2 for definitions of CoVC and CoVMUV)~~
F_7	Actual 7 day (cylinder) compressive strength in the nominated mix
F_{28}	Actual 28 day (cylinder) compressive strength in the nominated mix
F_{28Max}	Specified maximum 28 day (cylinder) compressive strength in the nominated mix
F_{28Min}	Specified minimum 28 day (cylinder) compressive strength in the nominated mix
f_{cMin}	Specified minimum 42 day (core) compressive strength in the pavement
DFI	Deleterious Fines Index, which is MBV × (% passing 75 µm sieve of the fine aggregate)

MT_{min}	Minimum mixing time determined in accordance with Clauses 7.12 or 7.14 ~~4.3.2~~
SD	Standard deviation

Note: The symbol for concrete strength shown with the leading uppercase 'F' refers to test results on moulded cylinders from the nominated mix, while that shown with the leading lowercase 'f' refers to test results on cores taken from the constructed work.

4 Quality System Requirements

4.1 The Contractor must prepare and implement a Quality Plan for 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
5.~~32~~29	Criteria for initiating changes in admixture type with changes in season selection and dosage rate charts for various temperature ranges.
7.3	Method of handling, storing and batching materials, and method of charging mixer.
7.17	Method of incorporation of admixtures in the mix.
7.~~24~~25	Procedure for monitoring of identification certificate for compliance with batching requirements.
7.~~39~~40	Procedure for monitoring of concrete supply for conformity with retempering provisions.
7.~~41~~42	Procedure for determination of maximum forming time.
8.1	Name, qualification(s) and experience of the Paving Supervisor for concrete paving work.
10.5	Method of traceability of loads of concrete placed.
10.16	Details of slipform paver.
10.17	Operating parameters for each proposed slipform paving configuration.

Clause	Description of document
10.20	Details of the system to provide indication of malfunction of individual vibrator.
10.25	Equipment and methods for placing, spreading and finishing concrete for fixed-form paving.
10.28	Details of size and number of vibrators and pattern and spacing of vibrator insertions for fixed-form paving.
10.35	Method of paving in transition zones.
10.49	Details of meteorological data to be collected and measures to restrict evaporation and to prevent incidence of plastic shrinkage cracking.
10.51	Method of inspections of plastic concrete to monitor effectiveness of use of evaporation retarder.
11.3	Supplier's recommended procedures for storage and agitation of curing compounds under varying weather conditions.
11.14	Procedures for mechanical spraying of curing compound.
11.17	Method and application rate for applying curing compound.
13.2	Procedure for protection of concrete from low temperatures.
13.6	Procedure for protection of concrete from rain damage.
14.10	Methods for surface preparation and repair treatment.
16.7	Crack assessment procedure.
17.2	Definition of a Sub-Lot for transition zone by a different method.
18.4	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 ~~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.~~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.

5.2 ~~Aggregates 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~~The Contractor must notify the Administrator within 3 business days of any change to the Quarry Registration Certificate, including its Testing Frequency Schedule.

~~5.3 Aggregates that have become intermixed or contaminated with foreign matter must not be used.~~

~~5.4 Aggregates must be sampled in accordance with AS 1141.3.1.~~

~~5.5~~5.3 ~~The following applies to the use of stockpiles~~For each quarry that will supply material(s) to be used in 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:

a) ~~Aggregates must be sourced from stockpiles located either at the batch plant or quarry that has been certified as conforming~~area (e.g. face number, bench number and reduced level) of the quarry from which material in the lot will be won~~.~~

b) ~~Stockpiles must be formed on clear, even, well-drained, firm ground or constructed floor and separated from each other in such a way as to prevent cross-contamination and segregation~~production process and method of winning the material~~.~~

c) ~~The maximum Lot size is 4,000 tonnes~~procedures for stockpile management and traceability as part of lot control and, as applicable, stockpile sub-lot control, and~~.~~

d) ~~The materials must be stockpiled such that~~quality control procedures.~~:~~

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

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

~~e) Stockpiles must be clearly and uniquely identified through signposting that indicates the Lot identification, type and quantity of material.~~

The aggregate production procedures must be submitted to the Administrator at least 7 days prior to the commencement of aggregate production for the Works. **Record**

Fine aggregate

~~5.6~~5.4 Fine aggregate must conform to MRTS70 *Concrete* requirements for fine aggregate in Special Class concrete and the additional requirements in Table 5.4. Minimum testing frequencies for fine aggregate, including properties specified in MRTS70 *Concrete*, must conform to Appendix D of this Technical Specification~~AS 2758.1, except as qualified in Table 5.6, and be tested in accordance with Figure 5.6~~.

Table 5.~~6~~4 – Fine aggregate property requirements (additional to MRTS70 Concrete requirements)

Property	Test: individual or total fine[1]	Test Method	Requirements
~~Bulk density~~	~~Individual~~	~~AS 1141.4 Clause 7.2~~	~~Minimum 1,200 kg/m³~~
~~Particle density~~	~~Individual~~	~~AS 1141.5~~	~~Minimum 2,100 kg/m³~~
~~Water absorption~~	~~Individual~~	~~AS 1141.5~~	~~Maximum 5%~~
~~Durability~~	~~Individual~~	~~AS 1141.24~~	~~Maximum 6.0% weighted average loss~~
Material ~~finer than~~passing 75 μm sieve	Total fine	AS 1141.11.1 or AS 1141.12	Refer to Figure 5.~~6~~4

Property	Test: individual or total fine[1]	Test Method	Requirements
Material finer than 2 μm	Total fine	AS 1141.13	Refer to Figure 5.64
Methylene Blue Adsorption Value (MBV)	Individual[2]	AS 1141.66	Refer to Figure 5.64
~~MBV75~~ Deleterious Fines Index (DFI)~~value~~[3]	Individual[2]	~~TfNSW T659~~Not applicable	Refer to Figure 5.64
~~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 one part in 10,000~~
~~Alkali-aggregate reactivity~~	~~Individual[2]~~	~~AS 1141.60.1~~	~~As per Clause 2.4~~
Flow cone time[45]	Total fine	TfNSW T279 (TS 02799.54)[65]	Maximum 27 seconds
Glass content and requirements[6]	Total fine (glass content) Individual (other requirements)	~~See ATS 3050~~Refer to MRTS36 *Recycled Glass Aggregate*	Maximum 15% by mass of total fine aggregate content. Other requirements refer to MRTS36 *Recycled Glass Aggregate*[7]

Notes:

[1] ~~Individual: Determine by testing separately each individual fine aggregate component from each supply source.~~ Total fine: ~~Determine by c~~Calculating the theoretical mixed result based on ~~total fine from the~~ individual component ~~test~~ results ~~using the same~~with proportioning as per the nominated mix, or ~~by~~ testing the mixed total fine aggregate blend. Do not include the contribution from the coarse aggregates.

[2] Test all individual fine aggregates ~~components from each supply source~~. 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.

[3] ~~MBV75 =~~ DFI in the product of the MBV ~~× (%~~ and the percent passing 75 μm~~m sieve of the fine aggregate)~~ value.

[4] ~~Test initially in accordance with AS 1141.34. If the presence of organic impurities is indicated, test in accordance with AS 1289.4.1.1.~~

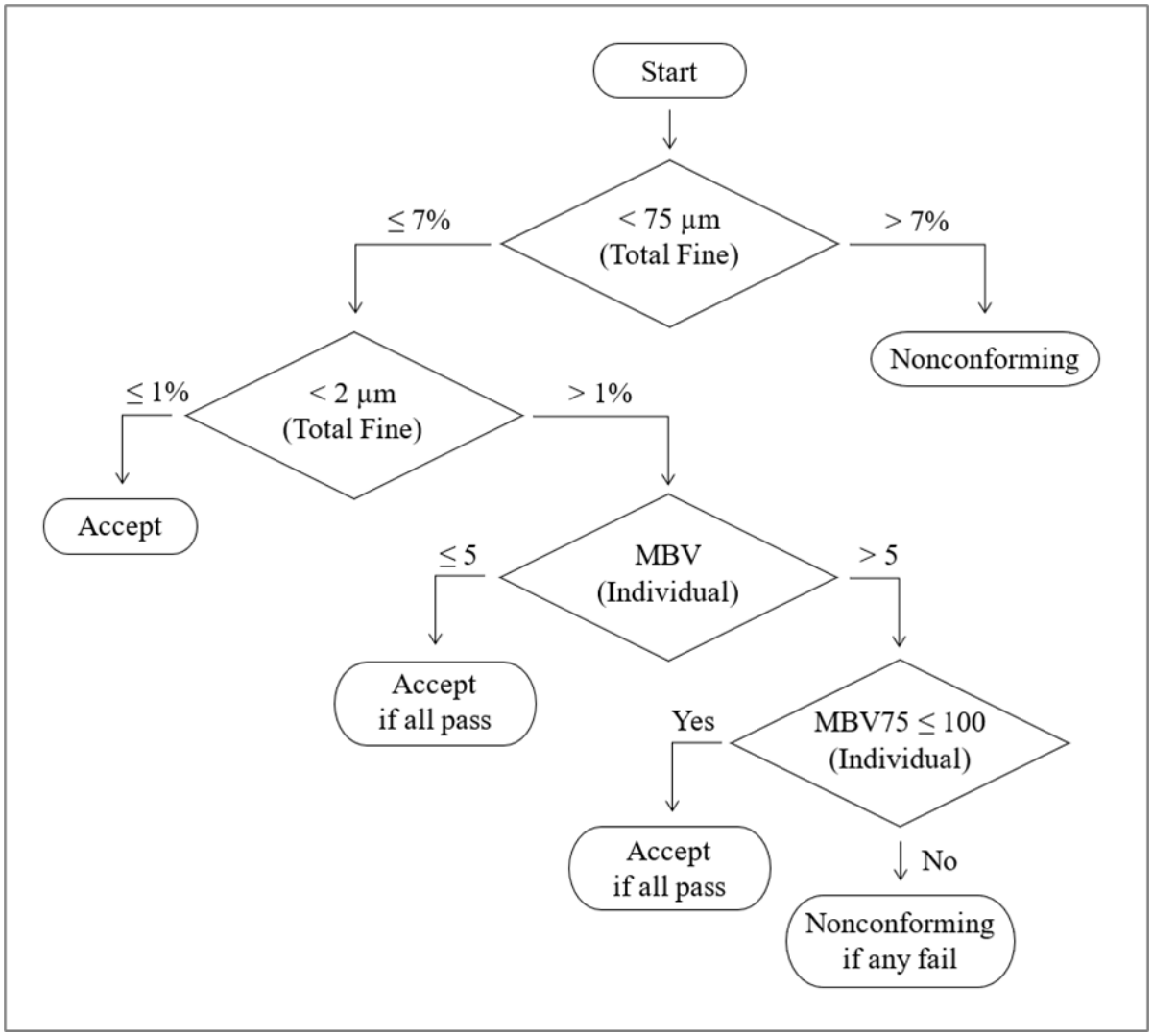
[45] Flow cone testing is not mandatory if the manufactured fine aggregate content is less than 20% by mass of the total fine aggregate.

(65) Flow cone test results need not beWhere NATA endorsed or IANZ registration is unavailable, provide test results endorsed by an AS/NZS ISO 9001 certified laboratory, whose Quality Management System is certified by a conformity assessment body or by JASANZ.

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

(8) Determined by washing.

Figure 5.64 – Fine aggregate testing



Notes:

[1] Testing must be in accordance with Table 5.64. The contribution from the coarse aggregates must be excluded.

[2] Total Fine: Total fine aggregate.

[3] Individual: Individual fine aggregates component from each supply source.

[4] MBV75 has the same meaning as DFI.

Coarse aggregate

~~5.7~~5.5 Coarse aggregate must conform to ~~AS 2758.1, except as qualified in Table 5.7~~ MRTS70 *Concrete* requirements for coarse aggregate in Special Class concrete and the additional requirements in Table 5.5. Minimum testing frequencies for coarse aggregate, including for properties specified in MRTS70 *Concrete*, must conform to Appendix D of this Technical Specification.

Table 5.~~7~~5 – 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 1141.6.1 or AS 1141.6.2~~	~~Minimum 2,100 kg/m³~~
~~Water absorption~~	~~Individual~~	~~AS 1141.6.1 or AS 1141.6.2~~	~~Maximum 2.5%~~
~~Material finer than 75 mm~~	~~Total coarse~~	~~AS 1141.11.1 or AS 1141.12~~	~~Maximum 1.0%~~
For material retained on a 9.50 mm sieve: Particle shape~~:~~, 2:1 ratio and 3:1 ratio	Individual	AS 1141.14	Maximum ~~3~~25% (2:1 ratio) and ~~M~~maximum 10% (3:1 ratio)
Flakiness index	Individual	AS 1141.15	Maximum 25%
Crushed particles[1]	Individual	AS 1141.18	Minimum 80%
~~Wet strength~~	~~Individual~~[2]	~~TfNSW T215~~	~~Minimum 50 kN~~
~~Wet / Dry strength variation~~	~~Individual~~[2]	~~TfNSW T215~~	~~Maximum 35%~~
~~Alkali-aggregate reactivity~~	~~Individual~~[2]	~~AS 1141.60.1~~	~~As per Clause 2.4~~
~~Foreign materials content~~	~~Individual~~	~~TfNSW T276~~	~~Maximum 0.1%~~[3]

Notes:

[1] ~~Individual: Determine by testing separately each individual coarse aggregate component from each supply source. Total coarse: Determine by calculating the theoretical mixed total coarse from the individual component test results using the same proportion as the nominated mix, or by testing the mixed total coarse aggregate blend.~~Not required for material from a blasted quarry face.

(2) The fraction to be tested is the particle size distribution interval in Table 1 of AS 1141.22, which represents at least 50% of the aggregate by mass.

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

Alkali-aggregate reactivity

5.8 Clause 5.9 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.

5.9 The Contractor must carry out testing on aggregates 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 the 18 month period prior to the commencement of paving. From the classification obtained by the testing, the action specified in Table 5.9 applies.

Table 5.9 – 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/m^3(1) or use an approved concrete mix design containing supplementary cementitious materials.
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 Na2O equivalent and calculated as the sum of Na_2O and 0.658 K_2O.

Combined aggregate particle size distribution

~~5.10~~5.6 The combined particle size distribution must be determined during trial mixing (see Clause ~~3.7~~6.25) by separately obtaining the particle size distribution for each constituent aggregate component in accordance with AS 1141.11.1 and calculating the combined particle size distribution from the nominated mix proportions.

Cementitious materials

~~5.11~~5.7 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.

~~5.12~~5.8 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 Type SL/Type GP cement content, allowable blend proportions and supplementary cementitious material requirements.

~~5.13~~5.9 Supplementary cementitious material (SCM) must be fly ash and/or ground granulated iron blast furnace slag (GGBFS).

~~5.14~~5.10 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.

~~5.15~~5.11 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.

~~5.16~~5.12 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**

~~5.17~~5.13 Bulk cementitious materials must only be stored in watertight silos.

~~5.18~~5.14 Bagged cementitious materials must be stored above ground in dry, weatherproof sheds and be protected from dampness that may be acquired from contact with floors or walls. Bags must be stacked so as to allow counting, inspection and identification of each consignment.

~~5.19~~5.15 As far as practicable, cement must be used in order of receipt.

~~5.20~~5.16 Cementitious materials containing lumps, signs of moisture absorption or other contamination must not be used.

~~5.21~~5.17 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.

~~5.22~~5.18 Fly ash must:

a) be fine grade

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

c) comply with Table 5.18~~21~~ (calculated using the 30 most recent successive test results).

Table 5.18~~21~~ – 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 = $SD \div Fineness_{average} \times 100\%$.

~~5.23~~5.19 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.

Water

~~5.24~~5.20 Water used in the production of concrete must be free from materials harmful to concrete and steel reinforcement and be neither salty nor brackish. The water must conform to AS 1379 Clause 2.4 and Table 2.2, Limits for Impurities in Mixing Water, with the addition of ~~and~~ the following:

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

b) sulphate ion: maximum 400 mg/L determined by AS 1289.4.2.1.

~~5.25~~5.21 Mixing ~~W~~water ~~that~~which is drawn solely from a reticulated drinking water supply is deemed to conform ~~to the above~~.

~~5.26~~5.22 If the mixing water contains a component from a source other than a reticulated drinking water supply, the combined water must conform to the requirements of Clause 5.~~23~~20.

Admixtures

~~5.27~~5.23 Chemical admixtures and their use must conform to AS 1478.1 and ~~AS 1478.2 and must be used in accordance with~~ AS 1379.

~~5.28~~5.24 Admixtures must not contain calcium chloride.

~~5.29~~5.25 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]

~~5.30~~5.26 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.

~~5.31~~5.27 Air entraining agents must be used in slipform paving mixes.

~~5.32~~5.28 Air entraining agents may be used in fixed-form (hand placed) paving mixes or in non-pavement concrete mixes such as anchors and subgrade beams, but ~~their use is~~ are not mandatory.

~~5.33~~5.29 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, also provide dosage rate charts for various temperature ranges. Additional testing in the mix design process is not required if admixture dose rate changes are based solely on ambient temperature.

Curing compounds

~~5.34~~5.30 Curing compounds must conform to AS 3799 and Table 5.3~~3~~0.

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 5.3~~3~~0 – Curing compound requirements

Curing compound type	Requirement (in accordance with AS 3799)
Hydrocarbon resin (HCR)	Class B Type 1-D, with minimum 30% non-volatile content
Water-borne hydrocarbon resin (WHCR)	Class B Type 1-D or Type 2, with minimum 30% non-volatile content

Curing compound type	Requirement (in accordance with AS 3799)
Bitumen emulsion binder (BE)	Class Z
Blended bitumen and waterborne hydrocarbon resin (B HCR)	Class Z Bitumen Class C170 or C240 must constitute at least 40% of the total mass of the curing compound
Wax emulsion (WE)	Class A, with minimum 30% non-volatile content[1, 2]

Notes:

[1] When tested for stability in accordance with ~~AS/NZS 2341.27~~TfNSW T862 (TS 02809.16), the rate of separation in 3 days must not exceed 3%.

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

~~5.35~~5.31 Bitumen used as a curing compound must be Class C170 or C240 to ~~AS 2008~~MRTS17 *Bitumen and Multigrade Bitumen*.

~~5.36~~5.32 The curing compound manufacturer 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.

~~5.37~~5.33 For each nominated curing compound, a written certificate that the compound conforms to this Technical Specification must be provided, with the relevant test results attached to the certification. This Certificate of Conformity must relate only to the formulation on which the tests were made. The test results must not be older than 3 years at the date of submission.

~~5.38~~5.34 The certificate must report the following properties:

a) non-volatile content

b) efficiency index

c) density

d) drying time

e) viscosity, and

f) infrared spectrum.

~~5.39~~5.35 Items 5.3~~7~~4 a) to e) must be determined in accordance with AS 3799. The test results obtained must conform to Table 5.3~~3~~0 and AS 3799 Clause 3.1. Item 5.3~~7~~4 f) must be determined in accordance with TfNSW T1005 (TS 02811.05) on the residue from the non-volatile content test.

~~5.40~~5.36 Uniformity testing must be conducted in accordance with AS 3799 Clause 3.2. The test results obtained must conform to Table 5.3~~3~~0 and AS 3799 Clause 3.2.

~~5.41~~5.37 Additionally, testing for viscosity must be conducted in accordance with AS 3799 Clause 3.1.5. The test results obtained must comply with AS 3799 Clause 3.1.5.

~~5.42~~5.38 On the basis of uniformity testing, written certification must be provided (accompanied by relevant test results) that the delivered product has the same formulation as that of the sample in Clause 5.~~36~~33.

Steel reinforcement (for subgrade beam)

~~5.43~~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.

~~5.44~~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.

~~5.45~~5.41 Steel reinforcement must conform to ~~AS/NZS 4671~~MRTS71 *Reinforcing Steel*. Reinforcement must be readily identified as to its grade and origin.

~~5.46~~5.42 When galvanized steel reinforcement is specified, the reinforcing steel must be hot dip galvanized in accordance with AS/NZS 4680.

6 Design of concrete mixes

General

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

Cementitious Content

6.2 The cementitious materials content must comply with the following:

Type SL or Type GP cement: ≥ 90 kg/m³.

Total cementitious material: ≥ 250 kg/m³.

6.3 ~~If specified in the Contract documents or if required for the control of Alkali-Aggregate Reactivity, t~~The proportions of cement and SCM in batched concrete must comply with Table 6.3.

Table 6.3 – Allowable proportions of cement and SCM in batched concrete

Blend	Cement	Fly ash	GGBFS
Binary (cement / fly ash)	≥ 25%	≥ 40%	
Binary (cement / GGBFS)	≥ 30%		≥ 30%
Ternary (cement / fly ash / GGBFS)	≥ 25%	≥ 40%	≥ 20%

~~Range of single SCM in binary blended cement~~		
~~SCM~~	~~Minimum (% by mass)~~	~~Maximum (% by mass)~~
~~Fly ash~~	~~40~~	~~75~~
~~GGBFS~~	~~10~~	~~70~~

~~Range of SCM in ternary blended cement~~					
~~SCM I~~	~~SCM II~~	~~Combination A (% by mass)~~		~~Combination B (% by mass)~~	
		~~Maximum % SCM I~~	~~Minimum % SCM II~~	~~Minimum % SCM I~~	~~Maximum % SCM II~~
~~GGBFS~~	~~Fly ash~~	~~50~~	~~40~~	~~10~~	~~75~~

~~Notes:~~

~~(1) Combinations A and B represent the 2 outer limits, respectively, when one SCM is used in combination with another SCM.~~

~~(2) For combinations within these outer limits, the respective percentages of SCM I and SCM II may be determined by linearly interpolating between these outer limits.~~

Compressive Strength

6.4 Concrete compressive strength must comply with the requirements shown in Table 6.4.

Table 6.4 – Concrete strength

Description	Nominated mix	Insitu pavement concrete(1)
Test specimen	Cylinder (100 mm diameter)	Core (see Clause 17)
Test methods	Preparation: AS 1012.8.1(2) Testing: AS 1012.9	AS 1012.14, as amended by Clause 17
Compressive strength	At 28 days: minimum 6.0 MPa (F_{28Min}) maximum 17.0 MPa (F_{28Max})	Within 42 days: minimum 5.0 MPa (f_{cMin})

Notes:

(1) Insitu pavement core concrete strength requirements are provided in this Clause for comparison with the cylinder strength requirements of the nominated mix.

(2) As amended by TfNSW T304 (TS 02800.05).

6.5 To determine the compressive strengths F_7 and F_{28} for each batch of the nominated mix, a minimum of 3 specimens are tested at age 7 days and a minimum of 3 specimens at age 28 days. F_7 and F_{28} are taken as the mean of all individual results from all batches that are not more than 10% from the median value of all individual results.

Consistence

6.6 The consistence of the concrete must be determined by measuring the slump in accordance with AS 1012.3.1.

6.7 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: 15-50 mm, and

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

6.8 This slump must be within ± 5 mm from the slump value obtained from laboratory tests on the nominated mix.

6.9 The adopted slump must allow the production of a dense, non-segregated subbase without excessive bleeding.

6.10 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

6.11 The shrinkage of the trial mix must comply with Table 6.11. Specimens must be prepared and tested in accordance with AS 1012.13 (for aggregate ≤ 20 mm) or T~~23~~321 (TS 02800.21) (for aggregate > 20 mm) with compaction by external vibration. Conformity with Table 6.11 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 deemed to be conforming.

Table 6.11 – Maximum shrinkage strain ~~for aggregate~~

Mix type	**Maximum shrinkage strain in nominated mix (microstrain, με)**	
	Drying period: 21 days	**Drying period: 56 days**
Nominal maximum size of aggregate ≤ 20 mm		
GGBFS mixes(1)	700	750
Other mixes	550	650
Nominal maximum size of aggregate > 20 mm		
GGBFS mixes(1)	580	680
Other mixes	450	580

Note:

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

6.12 The shrinkage is taken as the mean of all readings that are not more than ± 40 microstrain from the median value.

6.13 For the purpose of Table 6.11, a GGBFS mix is defined as having a minimum of 40% GGBFS (by mass).

6.14 Unless specified otherwise in the Contract documents, testing in accordance with Clause 6.11 is not required during the production of the concrete.

Other concrete attributes

6.15 The chloride ion, sulphate ion and air content of the concrete must comply with Table 6.15.

Table 6.15 – Other concrete attributes

Attribute	Test Method	Requirement
Chloride ion content	See Clause 6.16	Maximum 0.8 kg per m³ of concrete
Sulphate ion content	See Clause 6.16	Maximum 5% relative to cementitious binder mass
Air content of fresh concrete(1)	AS 1012.4.2, with compaction by internal vibration(2)	5.0 ± 2.0%

Notes:

(1) For mixes that contain an air-entraining agent, the air content must be tested in accordance with Clause 7.445.

(2) Use the same vibration pattern and duration as for cylinders in accordance with Test Method TfNSW T304 (TS 02800.05)~~AGPT-T704~~.

6.16 The chloride and sulphate ion content of concrete constituents or hardened concrete must be determined in accordance with either Clause 6.17 or Clause 6.18. Testing is required by only one method.

6.17 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 for 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.

6.18 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.

Trial mixing for mix design

6.19 Trial mixing must be conducted in the laboratory to demonstrate that the proposed mix designs conform to this Technical Specification. **Witness Point 1**

WITNESS POINT 1	
Process	Laboratory trial mixing for development of nominated mix design.
Notification Period	At least 5 working days before the commencement of trial mixing.

6.20 The trial mixing must conform to the Contractor's proposals under Clause 7 for batching and mixing, including the dilution and incorporation of admixtures and the sequence of addition of the constituent materials.

6.21 The date of testing of both the laboratory trial mix and all constituent materials must not be older than 18 months from the date on which the nominated mix is proposed to be used.

6.22 If sufficient production mix test results are available within this period in accordance with AS 1379, the ~~Principal~~ Administrator may reduce the scope of the laboratory trial mix or may waive it altogether.

~~WITNESS POINT 1~~	
~~Process~~	~~Laboratory trial mixing for development of nominated mix design.~~
~~Notification Period~~	~~At least 5 working days before the commencement of trial mixing.~~

Submission of nominated mixes

6.23 Prior to commencing production of each subbase concrete mix, the Contractor must ~~either propose a mix that has been previously registered/approved by the Principal or~~ submit the following information to the ~~Principal~~Administrator: **Hold Point 2 Record**

a) details of each nominated concrete mix in accordance with Clauses 6.~~25~~24 to 6.28

b) NATA or IANZ endorsed test results for all specified tests (except that the Vebe test result need not be NATA or IANZ endorsed)

c) nominated slump for each mix within a tolerance of ± 5 mm from the slump value obtained from laboratory tests on the nominated mix

d) a copy of a verification checklist covering the items listed in Clauses 6.~~25~~24 to 6.28, and

e) a statement signed by you certifying that each nominated mix and its constituents meet the requirements of this Technical Specification.

~~For work carried out in New South Wales, a mix that is currently listed as conforming to this Specification in the TfNSW Register of Concrete Mixes may be proposed as an alternative to the submission in Clause 6.23, available at: Register of Materials | Transport for NSW.~~

HOLD POINT 2	
Process Held	Production of each concrete mix.
Submission Details	At least 5 working days before production, the documentation required under Clause 6~~one of the following~~ must be submitted to the ~~Principal~~Administrator.~~:~~ ~~a) for new mixes: details and attachments as specified in Clause 6.23, or~~ ~~b) for nominated mixes previously registered / approved by the Principal: a statement stating that the mix conforms to this Specification and is suitable for its intended use.~~

6.24 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, 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, and

g) t~~r~~est results for chloride and sulphate content in accordance with Clause 6.16.

6.25 The following details of the mix design 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, and

c) nominated slump.

6.26 The ~~Principal~~ Administrator may approve the use of a particle size distribution outside the specified limits if evidence is provided that concrete made with this particle size distribution meets all other requirements of this Technical Specification, both in the fresh and hardened state. Supply additional evidence of acceptable performance for segregation, bleeding, plastic shrinkage and finishing properties.

6.27 For each nominated mix, details and demonstrated conformity for the following must be submitted to the ~~Principal~~Administrator:

a) compressive strength at age 7 days (F_7) (information only)

b) compressive strength at age 28 days (F_{28})

c) Vebe reading, only for slipform concrete mixes (information only)

d) slump

e) drying shrinkage, and

f) air content, if air entraining agent is used.

6.28 All test specimens must be moulded from the same homogeneous batch, and certification must be provided to the ~~Principal~~ Administrator that the specimens were moulded in accordance with the requirements of this Technical Specification.

Change to authorised nominated mix

6.29 After the nominated mix has been accepted by the ~~Principal~~ Administrator for production, it becomes the authorised nominated mix for use.

6.30 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: 10 kg/m³

b) other cementitious material: 20 kg/m³

c) other solid constituents: 5% by mass

d) admixture dosages in accordance with Clause 5.~~26~~23, and

e) water: not specified.

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

6.32 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 6.23.

7 Production and transport of concrete

General

7.1 Concrete produced for the Works must be homogeneous, without segregation or loss of materials during transport. The concrete must have workability, at the time of incorporation, that is compatible with the capacity of the paving equipment to uniformly achieve the required compaction, and a surface finish requiring only minimal manual finishing.

7.2 The handling, storing and batching of materials and the mixing, transport and consistence of concrete, including any retempering, must comply with AS 1379 Sections 3 and 4 and Appendix A, modified by the requirements of this Clause 7.

7.3 The Quality Plan must include details of the proposed methods of handling, storing and batching 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.

7.4 For slipform paving, the production and transport equipment must have an operational capacity that allows continuous paving at the target paving speed. The capacity must not be less than that required to maintain a continuous paving speed, with adequate allowance for mixer efficiency and control testing.

Production mixes

7.5 For production mixes, the ~~approved~~ authorised nominated mix design must be targeted. Table 7.5 lists the tolerances for constituents in individual batches from the ~~approved~~ authorised nominated mix.

Table 7.5 – Production Tolerances

Description	Tolerance (% by mass)
Aggregate particle size distribution: (AS sieve)	
37.50 mm	± 5
19.00 mm	± 10
13.20 mm	± 10
4.75 mm	± 10
1.18 mm	± 5
600 mm	± 5
150 mm	± 2
Other Materials	
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 in Clause 7.~~6~~7.

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

Production monitoring

7.6 During production, the properties and proportions of the constituent materials must be monitored. The combined aggregate particle size distribution must be measured using the method specified in Clause 5.~~10~~6. Alternatively, the combined particle size distribution may be determined by wet-sieving of the production mix for the fractions coarser than the 1.18 mm sieve in accordance with TfNSW T329 (TS 02800.26). For the fraction passing the 1.18 mm sieve, the most recent (within 18 months) result obtained using AS 1141.11.1 must be adopted.

7.7 For all batches within a Lot, the mean content of each cementitious material must be monitored. The mean must not be less than that of the authorised nominated mix or as varied in accordance with Clause 6.~~31~~30. Each cementitious material must be weighed separately.

7.8 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.

7.9 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.

7.10 A Batching Record that records the actual masses of each constituent in every batch, together with departures beyond the allowable tolerances, must be maintained and monitored. Nonconforming batches or loads must not be incorporated into the Works.

Measurement of mixing time

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

Stationary batch mixers: The mixing time is measured from the time when at least 90% of the total water content and all other ingredients are in the mixing drum, until mixing ceases, or after the completion of specified revolutions.

Mobile mixers: The 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.

Minimum mixing time

7.12 For stationary batch mixers, the minimum mixing time MT_{min} must be the greater of that determined from mixer uniformity testing in accordance with ~~Annexure~~ Appendix B and the following:

Stationary twin-shaft mixers:	Not be less than 30 seconds plus 5 seconds for each cubic metre (or part thereof).
All other stationary batch mixers:	Not be less than 54 seconds plus 6 seconds for each cubic metre (or part thereof).

7.13 Up to 10% of the remaining total water content for the authorised nominated mix may be added after the defined mixing time, and the mixing time increased as follows:

Stationary twin-shaft mixers:	A minimum of 15 seconds of mixing must be provided after the final addition of water.
All other stationary batch mixers:	A minimum of 30 seconds of mixing must be provided after the final addition of water.

7.14 For mobile mixers, the minimum mixing time M_{Tmin} after charging must be the greater of that shown on the mixer identification plate and 3.0 minutes.

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

Maximum mixing time

7.16 The maximum mixing time is 5 minutes for twin-shaft and split-drum mixers, and 10 minutes for all other mixer types.

Mixer uniformity testing

7.17 Testing for conformity of mixers must be undertaken in accordance with Appendix B. **Hold Point 3** **Record**

HOLD POINT 3	
Process Held	Production of concrete for paving (including paving trial).
Submission Details	Results demonstrating conformity of mixer uniformity as per Appendix B.

Admixture addition

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

7.19 The admixtures must be incorporated in accordance with the manufacturer's instructions and by a method that ensures that no adverse interaction occurs.

7.20 Where incorporation during initial batching is used, prior to their mixing with other constituent materials, the admixtures must be separately diluted and thoroughly mixed in the water by either one of the following methods:

a) addition into the water weigh hopper, or

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

7.21 Where addition into the mobile mixer after Completion of Batching is used, immediately after the addition of admixtures, the mixing mechanism must be operated at the designated mixing speed for no less than 30 revolutions or for such additional time as may be necessary to re-establish uniformity of the mix. However, if assurance is not available that the batch was initially mixed for 55 revolutions, re-mix the adjusted batch for a minimum of 55 revolutions.

Discharge

7.22 For batch mixers, after the Completion of Batching, the entire batch of concrete must be discharged from the mixer before any further charging takes place, with the exception of conforming retempering.

~~HOLD POINT 3~~	
~~Process Held~~	~~Production of concrete for paving (including paving trial).~~
~~Submission Details~~	~~Results demonstrating conformity of mixer uniformity as per Annexure B.~~

Transport of concrete

7.23 An identification certificate (delivery docket) that 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.

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

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

7.26 Any addition of water that occurs after the Completion of Batching must be in accordance with Clause 7.~~38~~39.

7.27 Any addition of admixture that occurs after the Completion of Batching must be in accordance with this Clause 7.

7.28 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.

7.29 Agitator vehicles must be used to deliver concrete that will be placed manually; however, material transfer placers and tipper trucks may be used where haul lengths are such that segregation does not occur and compaction and finishing of the mix is not compromised.

Consistence (slump) of concrete

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

7.31 Sampling of the concrete must be undertaken as follows:

Delivery 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.
Delivery by agitators:	Obtain an individual sample in accordance with AS 1012.1 Clause 7.2.2.

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

a) slipformed concrete: ± 10 mm, and

b) fixed-formed concrete: ± 15 mm.

7.33 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.

7.34 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 7.3~~8~~9.

7.35 Concrete that is nonconforming in relation to consistence must not be incorporated into the Works.

Minimum frequency of routine consistence testing

7.36 Consistent testing for tipper delivery must be as follows:

Initial daily slumping: Every load before discharge must be tested until there are 8 consecutive conforming loads. The standard deviation (SD) of these 8 loads must be calculated as follows:

- if the SD is less than or equal to 8.0 mm, proceed in accordance with the requirements for process slumping below, and
- if the SD is greater than 8.0 mm, continue slumping every load until any 8 consecutive loads have an SD less than or equal to 8.0 mm.

Process slumping: Every fourth load must be tested. Every load must be intermediate visually checked before discharge, and any load that appears, in the opinion of either party, to be nonconforming must be tested for slump.

Visual assessment 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

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.

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

7.37 Consistent testing for agitator delivery must be as follows:

a) 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.

b) Additional slump tests must be carried out as required in accordance with the provisions for retempering in Clause 7.3~~8~~9.

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

Retempering

7.38 For concrete that is delivered by a means other than an agitator, water or any other ingredient must not be added to the mixed batch.

7.39 Concrete that is delivered by agitator 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 ~~by~~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 no 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.

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

Forming time

7.41 The maximum forming time for each authorised nominated mix must be determined with consideration of the prevailing weather conditions and concrete temperature.

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

7.43 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.

7.44 Subbase constructed from such loads may be accepted if the compressive strength of cores taken from the section of subbase constructed with the specific load are conforming. The specific location of the load placed in the Works must be recorded.

Air Content of Concrete

7.45 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 6.15.

7.46 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.

7.47 The frequency reverts to that specified under Clause 7.4~~5~~6 a) if a nonconforming result is obtained at any stage of testing.

7.48 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.

7.49 Air entrained concrete with an air content higher than the specified range is nonconforming and must not be used in the Works.

7.50 Air entrained concrete with an air content of less than the specified range is nonconforming. However, subbase constructed from such concrete may be accepted as part of the Works if the compressive strength of cores taken from the section of the subbase constructed with the specific load is conforming.

7.51 This testing is in addition to routine random sampling, unless that particular load has been chosen in the random selection process.

8 Concreting personnel

General

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

Paving Supervisor

8.2 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.

8.3 For the purpose of Clause 8.2, 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

8.4 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.

8.5 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.

8.6 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 4 Record**

HOLD POINT 4	
Process Held	First LCS subbase in the Works, including paving trial.
Submission Details	Details of the paving crew must be submitted to the ~~Principal~~ Administrator in accordance with Clauses 8.5 and 8.6.

9 Subgrade beam

General

9.1 The subgrade beam must be constructed prior to the placing of the LCS.

9.2 Subgrade beams must be provided below the LCS at the locations shown on the Drawings. The subgrade beam must extend to the full length of the joint, unless shown otherwise on the Drawings.

9.3 Excavation for the subgrade beam must be undertaken to the dimensions and levels shown on the Drawings. The top of the subgrade beam must be level with the top of the ~~Selected Material Zone (SMZ) (i.e. top of subgrade)~~improved layer.

9.4 All loose material must be removed and the vertical faces must be trimmed to neat edges. Where required, the bottom of the excavation must be compacted to the same degree of compaction as that of the adjacent undisturbed material.

9.5 Any holes in the ~~SMZ~~improved layer adjacent to the subgrade beam must be repaired and the ~~SMZ~~improved layer must be compacted to provide a smooth and dense surface at the correct level.

Steel reinforcement

9.6 Steel reinforcement must comply with Clauses 5.39 to 5.42. **Hold Point 5** **Record**

HOLD POINT 5	
Process Held	Placing of concrete for subgrade beam.
Submission Details	Certificate of conformity for installation of steel reinforcement.

9.7 Reinforcement must be stored above the ground surface and protect it from damage and deterioration due to exposure.

9.8 Steel reinforcement placed in the Works must be free from loose or thick rust, grease, tar, paint, oil, mud, mortar or any other coating, or any other condition that would impair its bond to the concrete or its performance within the concrete member.

9.9 Steel reinforcement must be cut to the dimensions and shapes as shown on the Drawings. The nominal internal diameter of a reinforcement bend is taken as the external diameter of the pin around which the reinforcement is bent. The diameter of the pin must not be less than 5 times the bar diameter.

9.10 Steel reinforcement with kinks or bends not shown on the Drawings must not be used. Steel reinforcement must not be bent or straightened in a manner that will damage the material.

9.11 Steel 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 system that is likely to impede compaction of the enveloping concrete must not be used.

9.12 Place the chairs 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.

9.13 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. Reinforcement must be secured in place by wiring the bars and/or fabric together with annealed steel wire having a diameter of no less than 1.2 mm.

9.14 Unless shown otherwise on the Drawings, the minimum length of lapped splices is:

a) Grade 500: 35 bar diameters

b) Grade 250: 25 bar diameters and

c) Hard-drawn wire: 45 bar diameters.

9.15 The ends of bars forming a lapped splice must be securely wired together in at least 2 places.

9.16 For reinforcing fabric, splices are measured as the overlap between the outermost wire in 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.

Concrete for subgrade beam

9.17 The concrete supplied for subgrade beams must either:

a) conform to ~~ATS 3530~~MRTS40 *Concrete Pavement Base* (except for flexural strength requirements and air content); or

b) be N32 concrete in accordance with ~~AS 1379~~MRTS70 *Concrete*, with nominal maximum aggregate size of 20 mm and slump within the range of 50 mm to 80 mm at the point of placement.

9.18 The concrete must be mixed and delivered in accordance with AS 1379, but as amended by Clause 7.

9.19 The concrete must be placed and compacted in accordance with Clause 7, and finished with a steel float to produce a smooth surface, free of any texture.

9.20 The compressive strength at 7 days must be determined in accordance with AS 1012.9 using one pair of moulded specimens for each subgrade beam pour. The compressive strength at 7 days must not be less than 16.0 MPa.

Curing and protection from damage

9.21 The top surface of the subgrade beam must be cured in accordance with Clause 11, either by application of curing compound or by wet curing before placing the subbase.

9.22 The curing must be maintained for a minimum of 7 days after the placing of concrete for the subgrade beam.

9.23 Plastic covers may be used for curing, 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.

9.24 The subgrade beam must be protected from damage by plant, motor vehicles and the paving operation.

9.25 Vehicular traffic is not permitted to traverse over the subgrade beam until it has achieved the compressive strength of 16.0 MPa specified in Clause 9.20.

10 Subbase concrete paving

General

10.1 The concrete must be placed, spread and finished in such a manner as to:

a) avoid segregation or loss of materials

b) avoid premature stiffening, and

c) produce a uniformly dense and homogeneous product throughout the subbase layer. **Hold Point 6 Record**

HOLD POINT 6	
Process Held	Paving of LCS (including paving trial).
Submission Details	Schedule of underlying surface levels and any relevant nonconformity report.

10.2 The surface on which the LCS is to be placed must be clean and free of loose or foreign matter, including loose sealing aggregate, and must not hold ponded water. At the time of paving, it must be in a condition that minimises the absorption of mortar and water from the LCS.

10.3 During construction of the LCS, allowance must be made for the construction of base slab anchors (which are not within the scope of this Technical Specification) at the locations shown on the Drawings.

Traceability

10.4 Records showing the location of each load of concrete in the finished work must be maintained in accordance with ~~ATS 1120~~MRTS50 *Specific Quality System Requirements*. The method of traceability must be sufficiently accurate to enable subsequent identification of specific loads for examination and/or testing.

10.5 The Quality Plan must include details of the method of achieving traceability.

Temperature and weather condition

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

10.7 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; however, 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.

10.8 The ambient 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 at intervals not exceeding 30 minutes.

10.9 Concrete batching and/or placement must stop when the ambient air temperature reaches 32°C and is rising.

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 35ºC 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 35ºC 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.

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

Slipform (mechanical) paving

10.11 Where practicable, paving must be placed by the slipform method.

10.12 The unsupported longitudinal edge produced must maintain its shape and must not sag or tear.

10.13 At locations where the paver is unable to fully compact and finish the concrete (such as, but not limited to, transverse construction joints), supplementary fixed-form paving methods in accordance with this Technical Specification must be used.

Paving equipment

10.14 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 minimum hand finishing.

10.15 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.

10.16 The Quality Plan must include details of the slipform paver.

10.17 The Quality Plan must include the following parameters for each of the proposed slipform paving configurations:

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

b) target (optimum) paving speed

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

d) gross operating mass per linear metre of paving width.

10.18 The 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 loss.

10.19 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.

10.20 The Quality Plan must include details of the system, which can provide an indication of any malfunction of each individual vibrator.

10.21 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.

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

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

10.24 If excessive bleed water occurs, such that it flows over the slab edge, paving must be stopped and the consistence of the mix must be adjusted to prevent such flow or until the mix is redesigned.

Fixed-form (manual) paving

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

10.26 The formwork must:

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

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

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

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

10.27 The concrete must:

a) be deposited and spread uniformly and without segregation within the formwork by means other than vibration, and

b) be compacted by internal vibrators using suitable vibrator operating parameters that have been established and documented for the specific site conditions using systematic spacing and durations to achieve a homogeneous slab with uniform and thorough compaction.

10.28 The Quality Plan must include details of the size and number of vibrators and pattern and spacing of vibrator insertions.

10.29 The internal vibrators must have the following operating parameters:

a) a minimum diameter of 50 mm, and

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

10.30 The number of working internal vibrators in use during a concrete pour must be no less than one for each 10 m^3 of concrete placed per hour. For paving widths in excess of 2.5 m, a minimum of 2 vibrators must be used. The number of standby vibrators must be no less than one fourth of the number in use, with a minimum of one.

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

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

10.32 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.

10.33 Power trowelling must not be used on the surface.

Paving in transition zones

10.34 For transition zones, methods of placing that will ensure adequate compaction of the concrete must be used.

10.35 The Quality Plan must include the following details:

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

b) length of paving run between a transverse construction joint and the point of effective slipform vibration, at both the start and finish of paving runs

c) size and number of manual vibrators

d) spacing and duration of vibrator insertions in the concrete

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

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

Joints and edges

General

10.36 Construction joints do not need to be scabbled or corrugated. The first-placed face must be dense, fully compacted and free from honeycombing and re-entrant angles.

10.37 Where a joint is nonconforming or its edge is damaged, it must first be reinstated or repaired and allowed to set before new concrete for the adjoining section is placed.

10.38 Unless shown otherwise on the Drawings, slabs formed by the joints (both transverse and longitudinal) must comply with the minimum dimensions or corner angles stated in Table 10.38.

Table 10.38 – Minimum dimensions or corner angles of slab

Description	Minimum value
Slab length (m)	1.5[(1)]
Slab width (m)	1.0[(2)]
Corner angle (°)	70[(3)]

Notes:

[(1)] Measured parallel to the control line.

[(2)] Measured orthogonal to the control line.

[(3)] Measured in plan view.

Transverse construction joints

10.39 Transverse construction joints must be provided at discontinuities in the placement of concrete, as determined by the paving operations.

10.40 If the TfNSW Standard Drawings – Concrete Pavement – Construction are included in the Contract documents, the location of the transverse construction joints must:

a) not be located within 0.2 m from the outside edge of subgrade beams under Type 14 (i.e. P14/C14/J14/F14) isolation joints in the overlying concrete base

b) not be located within 0.5 m from Type 15 (i.e. P15/C15/J15/F15) isolation joints in the overlying concrete base, and

c) be located at a minimum of 0.3 m from the planned location of Type 8 (i.e. P8/F8) joints in the overlying concrete base at roundabouts.

For details on joint types, refer to TfNSW Internet website Standard Drawings – Concrete Pavement – Construction, available at: http://www.rms.nsw.gov.au/business-industry/partners-suppliers/document-types/standard-drawings/pavement.html)

10.41 Transverse joints must be:

a) continuous over the full paving width, without steps or offsets in any axis, so that along the line of the joint, it does not deviate by more than 20 mm from a 3 m straightedge, nor by more than 10 mm from a 0.3 m straightedge, and

b) constructed at 90° to the longitudinal joints with a butt (flat) joint face that is orthogonal (± 10°) to the finished top surface of the LCS.

Longitudinal construction joints

10.42 There is no upper limit on the width of LCS that may be constructed between longitudinal joints and/or edges. The minimum dimensions and corner angles of the slabs must, however, comply with Table 10.38.

10.43 Where such joints are required, unless shown otherwise on the Drawings, their locations must comply with Table 10.43.

Table 10.43 – Longitudinal construction joint location

Type of base	Location
Under concrete bases	Within 0.1 m to 0.4 m offset from a longitudinal joint in the base layer. However, where a crown exists in the base layer, any underlying longitudinal crown joint in the subbase must be constructed within 0.1 m of the plan location of the longitudinal crown joint in the base.
Under asphalt bases	Within 0.25 m offset from a design lane line.

10.44 The joint locations must not deviate from the nominated position at any point by more than 25 mm.

10.45 Longitudinal joints must:

a) along the line of joint, not deviate horizontally by more than 20 mm from a 3 m straightedge placed along the joint, after due allowances for any planned curvature, nor by more than 10 mm from a 0.3 m straightedge

b) be orthogonal (± 10°) to the finished top surface of the LCS, and

c) along the line of joint, not deviate vertically by more than 3 mm from a 0.3 m straightedge placed along the joint.

Subbase width and outer edges

10.46 Unless shown otherwise on the Drawings, the LCS must be constructed wider than the plan position of the overlying base by the following amounts (with a tolerance of ± 25 mm):

a) 50 mm, where the overlying base is concrete base, and

b) 25 mm, for all other base types.

10.47 Outer edges must be constructed orthogonal to the finished top surface of the subbase with a tolerance of ± 10°, be dense, fully compacted, and free of honeycombing and re-entrant angles.

Inspection

10.48 Each joint and edge must be inspected within 24 hours of its construction, and again before paving of the next adjoining section of the LCS. If nonconformity is detected, corrective action must be implemented before proceeding with the paving of the adjoining section.

Prevention of moisture loss

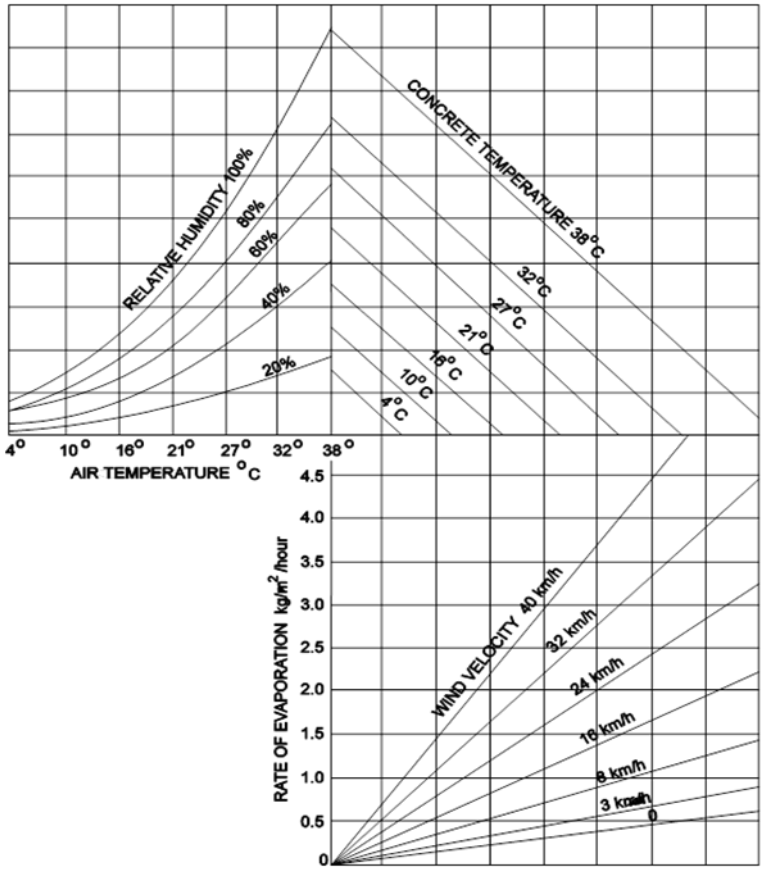
10.49 The Quality Plan must include details of what meteorological or other data will be collected, how such data will be used and what measures will be taken to restrict the evaporation of water from the concrete surface and limit the incidence of plastic shrinkage cracking.

10.50 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 a manner that does not incorporate the evaporation retarder into the surface mortar.

10.51 The Quality Plan must include details of regular inspections of the plastic concrete to monitor the effectiveness of the adopted procedures.

10.52 The evaporation rate must be determined using Figure 10.52.

Figure 10.52 – 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.

Surface finish

10.53 The paved surface of the LCS must be uniform, dense and compact.

10.54 Where the LCS is to be covered by an asphalt base or granular flexible base, a hessian drag or broomed finish must be provided.

10.55 Where the LCS is to be covered by a sprayed bituminous seal followed by a concrete base, a light hessian drag is optional.

10.56 In both cases, the mean texture must not be more than 0.5 mm when tested in accordance with ~~AGPT – T~~ATM 250~~ or TfNSW T240~~.

11 Curing

General

11.1 The LCS must be cured by spraying curing compound to form a continuous and unbroken film to all exposed surfaces, including the faces of fixed formed joints and sections of slipformed edges which were supported by temporary forms at the time of initial spraying.

11.2 The curing compound, when sprayed, must have a uniform consistency.

11.3 The Quality Plan must include details of the supplier's recommended procedures for storage and agitation of curing compounds under varying weather conditions in order to maintain uniformity.

Curing times

11.4 The curing compound must be applied within 15 minutes of the surface reaching the low-sheen bleed water condition. On fixed-formed surfaces, the compound must be applied within 30 minutes of stripping. At the time of application, the concrete must be in damp condition.

11.5 The curing membrane must be intact in a continuous and unbroken membrane for 7 days, or until insitu concrete strength of 4.0 MPa is achieved, whichever occurs first.

Respraying

11.6 If the curing membrane is damaged, the affected area must be hand sprayed to maintain the required moisture condition.

11.7 Additionally, for a minimum distance of 7 m adjoining the commencement of each paving run, any hardened concrete of age less than 7 days (or 4.0 MPa) that has been trafficked by persons during placement at the construction joint, even though membrane damage may not be apparent, must be resprayed with a single application.

11.8 The cost of any respraying, and of making good any damage to the curing membrane, will be borne by the Contractor.

Curing compound types

11.9 The curing compound type to be used must comply with Table 11.9 for the applicable overlying base types.

Table 11.9 – Curing compound types

Overlying base layer	Curing compound type[1]
Concrete base – PCP, JRCP, CRCP or SFCP	WE
Asphalt base	B-HCR or BE binder
Granular flexible base	HCR, WHCR, B-HCR or BE binder

Legend:
WE: wax emulsion
CR: hydrocarbon resin
WHCR: water-borne hydrocarbon resin
BE: bitumen emulsion
B-HCR: blended bitumen and water-borne hydrocarbon resin
Notes:
[1] 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. Where a fugitive dye is used, it must be incorporated in the curing compound by the manufacturer.

Equipment

11.10 The curing compound must be applied in a fine spray that complies with Table 11.10.

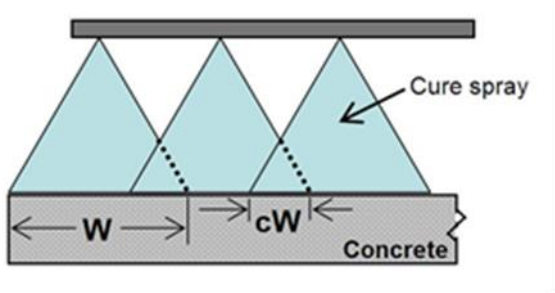
Table 11.10 – Curing compound application

Method of application	Permitted paving widths
Hand lance, with either single or multiple nozzles.	Up to 3.5 m
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.	Up to 4.5 m
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.	All

11.11 Protective hoods must be fitted to 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.

11.12 The spray nozzles must be set to provide an overlap factor (by width measurement) as shown in Figure 11.12. This factor must be determined through field trials in accordance with Clause 11.14 c).

Figure 11.12 – Overlap factor



Where:

W = theoretical coverage.

C = overlap factor (≤ 1.0).

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

11.14 The Quality Plan must include details of the procedures to demonstrate the following, where mechanical spraying is used:

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

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

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 11.12), and to demonstrate uniform and conforming coverage, including edges.

11.15 These parameters must be determined before any paving trial (see Clause 12) that requires mechanical curing.

11.16 During the paving trial, the operating parameters developed under Clause 11.14 c) must be verified.

Application rate

11.17 The Quality Plan must include details of the method and application rate for applying the curing compound.

11.18 The application rate must comply with Table 11.18.

Table 11.18 – Application rate

Compound / application method	Application rate
Curing compound other than bitumen emulsion – mechanical spraying.	The rate stated on the test certificate for curing efficiency, but at a minimum of 0.25 L/m² in a single pass.
Curing compound other than bitumen emulsion – manual spraying.	25% above the rate stated on the test certificate for curing efficiency, but at a minimum of 0.25 L/m².
Bitumen emulsion binder.	No less than 0.50 L/m² residual bitumen.

Verification of application rate

11.19 The curing compound application rate must be verified as follows and at the frequency shown in Table 11.19.

Test Method A: Calculate the average application rate from the total measured quantity of compound applied within the area specified in Table 11.19.

Test Method B: Measure the amount of curing compound locally on test mats placed on the pavement at random locations. Use 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 11.19 – Frequency of testing for application rate of curing compound

Spraying method	Test Method	Area[(1)]
Manual	A	Each paving area of between 500 m² and 1,000 m².
Mechanical	A	Each paving area up to a maximum of 2,000 m².
	A and B	During paving trial; and thereafter: a) one in every 6 Sub-Lots until 3 consecutive conforming results are obtained, then b) one in every 50 Sub-Lots. The testing frequency reverts to ~~b~~a) if a nonconforming result is obtained.

Notes:

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

Conformity of application

11.20 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 11.19 are conforming.

11.21 For any section at which the application is nonconforming, it must be resprayed within 6 hours of initial spraying at an application rate no less than twice the deficiency in the original application.

Wet curing

11.22 In confined spaces, such as tunnels, where the use of curing compounds is considered undesirable, the LCS must be cured for a minimum of 7 days using water curing or plastic covers in accordance with Clause 9.23.

12 Concrete paving trial

General

12.1 Prior to full-scale LCS paving, a trial section of LCS must be constructed using the authorised nominated concrete mix, equipment and methods, and in accordance with the quantity limits stated in Table 12.1. **Witness Point 2**

Table 12.1 – Quantity limits for paving trial

Parameter		Requirements	
		Slipform	**Fixed-form**
Length of paving trial[1, 2]	Minimum	50 m	15 m
	Maximum	100 m	50 m
Concrete volume in paving trial	Minimum	Not applicable	20 m³

Notes:

[1] The ~~Principal~~ Administrator may accept an extension of the paving trial to a full day of paving if the Contractor has demonstrated satisfactory paving performance in recent past projects.

[2] Construct the trial section(s) in a continuous operation without intermediate construction joints.

WITNESS POINT 2	
Process	Construction of section of trial pavement.
Notification Period	At least 5 working days before the commencement of the trial.

12.2 If a paving trial is conducted at a paving width of less than 70% of the maximum paving width proposed, the ~~Principal~~ Administrator may call for a new trial section prior to paving of sections with widths equal to or greater than 70% of the maximum width proposed.

Assessment and reporting

12.3 The concrete mix(es) produced during the trial paving must be assessed in comparison with that produced in the laboratory during the development of the authorised nominated mix. For the purpose of the comparison, the particle size distribution of fresh concrete must be determined during the trial paving using wet-sieving in accordance with Clause 7.~~2~~6 for a minimum of 3 loads, at 10%, 50% and 90% of discharge of each load.

12.4 The curing compound application rate must be verified in accordance with Clause 11.19.

12.5 The constructed trial pavement must be assessed for conformity with respect to cracking, core compressive strength, thickness, alignment, levels and surface profile in accordance with Clause ~~8~~16.

12.6 A written report containing the results of the paving trial must be submitted to the ~~Principal~~Administrator. The report must be in the form of a table showing, as a minimum, the information listed in ~~Annexure~~ Appendix C, and attaching the 7 day core compressive strength test results. The 28 day core compressive strength test results do not need to be submitted as part of the report but must be submitted to the ~~Principal~~ Administrator when available later.

12.7 The report must highlight any notable inconsistencies between the mixes produced during the paving trial and that of the authorised nominated mix, and provide comments on any consequential risks that may arise as a result. **Hold Point 7 Record**

HOLD POINT 7	
Process Held	Commencement of LCS paving other than trial paving.
Submission Details	The report of paving trial, including relevant test results, must be submitted to the ~~Principal~~ Administrator at least 2 working days prior to the commencement of pavement works.

Acceptance of trial section

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

12.9 If the trial section is nonconforming, it must be removed, a new trial section must be prepared and the evaluation detailed in this clause must be repeated.

New trial section

12.10 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, materials, plant or rate of paving, or

b) recurring nonconformities of the concrete subbase occur.

13 Protection of work

Temperature

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

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

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

13.4 ~~The Contractor must obtain the prior written agreement of the Principal if it proposes to use s~~Subbase protective covers ~~and claim payment under an item in a payment schedule~~may be used.

Rain

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

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

13.7 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 that 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.

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

Trafficking of subbase

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

13.10 Except for personnel or equipment undertaking essential inspection and testing, the LCS must not be trafficked until an insitu compressive strength of 4.0 MPa has been reached. **Hold Point 8 Record**

HOLD POINT 8	
Process Held	Trafficking of LCS.
Submission Details	Insitu compressive strength test results of the LCS must be submitted to the ~~Principal~~ Administrator at least 2 working days before trafficking of the ~~NFC subbase~~LCS.

13.11 Thereafter, only foot traffic, vehicles with a gross mass of less than 2.0 tonnes and any construction equipment necessary for the following operations are permitted to traffic the LCS:

a) surface debonding / bonding treatment and spall treatment

b) base paving, but only for a distance of up to 300 m immediately ahead of the base paver (not within the scope of this Technical Specification)

c) slipform paving tracks associated with paving of adjoining subbase

d) construction of no-fines concrete (NFC) layer under the kerbs, but only within 300 mm from the nearest edge of the NFC layer, and

e) coring and backfilling of core holes.

13.12 Any damage to the LCS must be repaired in a way that produces a dense, homogeneous subbase with the specified surface finish.

14 Surface debonding / bonding treatment

General

14.1 Where the overlying base layer is concrete, a debonding treatment must be applied to the subbase to prevent an interlayer bond.

14.2 Where the overlying base layer is part of a flexible pavement (such as asphalt), a bonding treatment must be applied to the LCS to provide a strong interlayer bond.

14.3 This debonding / bonding treatment is in addition to the curing treatment applied under Clause 11. **Hold Point 9 Record**

HOLD POINT 9	
Process Held	Surface debonding / bonding treatment.
Submission Details	At least 5 working days before commencing surface debonding / bonding treatment, submit the schedule of measured levels and subbase thickness, and any relevant nonconformity report.

Types of debonding / bonding treatments

14.4 The types of debonding / bonding treatment to the LCS surface for the different overlying base type must be in accordance with Table 14.4.

Table 14.4 – Debonding / bonding treatments

Planned base type	Treatment type	Material
Concrete base – PCP, CRCP and JRCP	Debonding	BS[1, 3]
Concrete base – SFCP		WE[2] or BS[3] or BES[3]
Concrete shoulders – PCP		BS[1, 3] or WE[2]
Asphalt base	Bonding	BS[3]
Granular flexible base		BS[3]

Legend:

WE: Wax emulsion

BS: Cutback bitumen seal

BES: Bitumen emulsion seal

Notes:

[1] The ~~Principal~~ Administrator may approve BES as an alternative under PCP shoulders and in piecemeal construction where BS is impractical.

[2] Wax emulsion must conform to Clauses 14.12 to 14.14.

[3] Bitumen seals (BS and BES) must conform to Clause 14.11.

Times for treatment

14.5 The surface debonding/bonding treatment must not be applied until:

a) the LCS has achieved strength of 4.0 MPa (see Clause 17.15), and

b) schedules of LCS levels have been submitted (see Clause 15.6) and disposition of any nonconformities completed ~~(see Clause 8)~~.

14.6 The treatment must be completed within 49 days of placement of the LCS, or within 14 days of the achievement of strength conformity under Clause 17.1~~5~~4, whichever occurs first.

Surface preparation and repair treatment

14.7 The LCS surface must be cleaned of all loose, foreign and deleterious material before applying the surface debonding / bonding treatment.

14.8 Spalled areas (with the exception of full-depth cracks) greater than 10 mm deep and 15 mm wide must be filled with a low-shrink rapid-hardening cement mortar or a mixture of aggregate and bitumen to provide a surface flush with the LCS surface. The repair material used must adhere to the LCS concrete.

14.9 Fill full-depth cracks that have spalled more than 10 mm deep and 15 mm wide with a suitable flexible sealant or a mixture of sand and bitumen to provide a surface flush with the LCS surface.

14.10 The Quality Plan must include details of the methods for surface preparation and repair treatments.

Cutback bitumen and bitumen emulsion seals

14.11 A bitumen seal must be designed and applied. The seal must comply with ~~ATS 3460~~MRTS11 *Sprayed Bituminous Treatments (Excluding Emulsion)* or MRTS12 *Sprayed Bituminous Emulsion Surfacing*, with the following amendments:

a) the residual bitumen limits are 0.60 L/m² (minimum) and 0.80 L/m² (maximum), measured at 15°C

b) susceptibility to aggregate polishing requirements do not apply

c) the nominal aggregate spread rate is 250 m²/m³ to provide a mosaic of single stone thickness, and

d) aggregate must be of 7 mm nominal size.

Where a cutback bitumen is used, the bitumen must be class C170 or C240 and may be cut back with cutter oil, up to a maximum of 2%.

Wax emulsion (under concrete base)

14.12 A wax emulsion debonding treatment must be applied at an application rate of no less than 0.20 L/m². This is in addition to any wax emulsion curing treatment applied in accordance with Clause 6.9.

14.13 The wax emulsion must be applied before the reinforcing steel for the base is placed.

14.14 Wax emulsion must conform to Table 5.33. All other aspects of application and testing must comply with Clause 11.

15 Survey

General

15.1 The subbase must be surveyed in accordance with this Technical Specification and *TMR Surveying Standards* ~~any other requirements for survey included in the Contract documents~~.

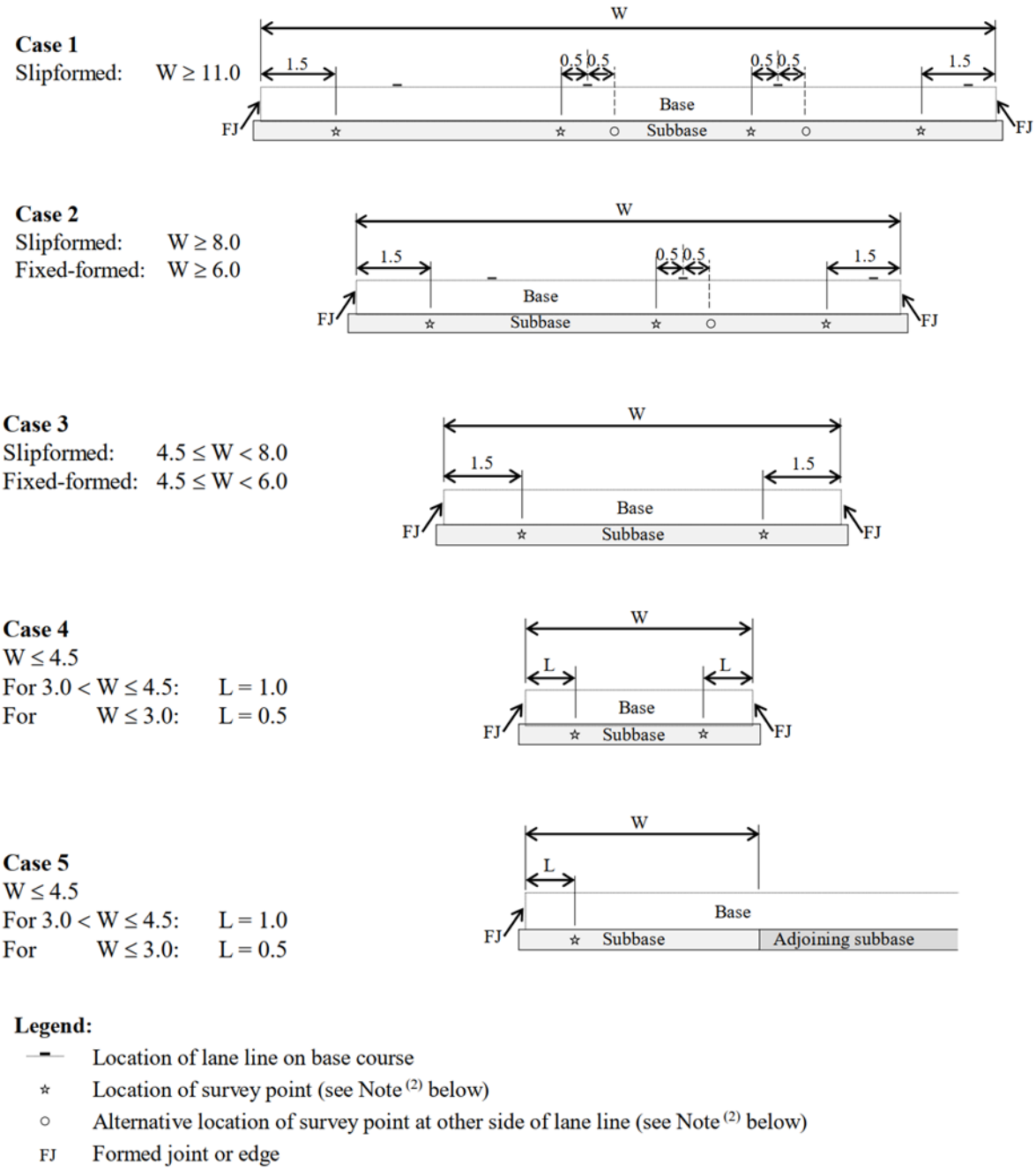
15.2 When determining the levels, a survey staff (or reflector) with flat base of area between 300 mm² and 4,000 mm² must be used. The levels obtained must be reported to the nearest millimetre.

Survey of underlying surface levels

15.3 A survey of the underlying surface levels must be carried out prior to the commencement of LCS paving. Where the underlying layer has been constructed by others or where the survey is for measurement for payment, the survey of the underlying layer must be a joint survey for determination of payment or deductions. **Record**

15.4 Levels of the underlying surface must be taken at a spacing of 10.0 m longitudinally and at the transverse offsets shown in Figure 15.4, with a tolerance of 0.5 m. Where the underlying layer has a sprayed seal over it, levels must be taken on the top of the seal after removal of foreign or loose material, such as excess aggregate. Alternatively, the subbase bottom levels may be taken as the levels before sealing plus the average least dimension (ALD) of the cover aggregate, as determined in accordance with ~~ATS 3460~~AS 1141.20.3.

Figure 15.4 – Survey locations



Notes:

(1) All dimensions shown in the figure above are in metres.

(2) Where an alternative location of survey point is shown (Cases 1 and 2), the Contractor can take survey levels at either side of the lane line (i.e. at either of the locations marked with '○' or with '☆').

(3) Survey levels must be taken for both the underlying surface (see Clause 15.3) and the LCS finished surface (see Clause 15.~~6~~5).

(4) At locations where the distance between a formed edge and the adjacent lane line is varying (i.e. is tapered in plan view), the survey point will be at a 0.5 m offset from that lane line.

Survey of LCS finished surface levels

15.5 A survey of the finished surface levels of the LCS must be carried out for conformity of levels and thickness within 4 days of placing, unless agreed otherwise with the ~~Principal~~Administrator. Levels must be taken at the following locations:

a) at the same plan locations as those surveyed for the levels on the underlying layer under Clause 15.4, with a tolerance of 0.5 m, and

b) randomly selected locations at a minimum frequency of at least half the frequency required to comply with item a) above.

15.6 Schedules of levels showing the measured actual levels and their corresponding design levels, and the difference between them, must be submitted to the ~~Principal~~Administrator. Those levels and differences that are out of tolerance and those locations which were specially surveyed for apparent nonconformity must be highlighted. The following convention for the difference between the actual and design levels must be used:

a) where actual levels are above design levels, show the difference as positive, and

b) where actual levels are below design levels, show the difference as negative. **Record**

Alignment

15.7 A survey for conformity of the alignment of the edges and joints must be carried out within 4 days of placing a Sub-Lot of LCS.

15.8 Each outer edge (see Clause 10.46) must be surveyed for alignment conformity at random locations, commencing with the trial paving and, thereafter, independent of the boundaries to Sub-Lots, at a frequency no less than the following:

a) one reading per 10 m of edge, until 5 conforming results are recorded, and, thereafter,

b) one reading per 50 m of edge.

15.9 The survey frequency reverts to Clause 15.8 a) if nonconformity is detected.

Surface profile

15.10 A survey of the surface profile must be carried out within 4 days of placing a Sub-Lot of LCS, or at the times agreed with the ~~Principal~~Administrator.

15.11 The surface profile under a 3 m straightedge must be determined in accordance with Test Method ATM~~-~~ 453 or ~~TfNSW T183~~Q712. Where the surface is convex, the straightedge must be placed so that the cantilever length does not exceed 0.75 m.

15.12 The surface profile must be surveyed for conformity at random locations, commencing with the trial paving and thereafter independent of the boundaries to Sub-Lots, at a frequency of no less than the following:

a) one reading of longitudinal and transverse surface profile per 10 m of paving run, until 5 conforming results are recorded; and, thereafter,

b) one reading of longitudinal and transverse surface profile per 100 m of paving run.

15.13 The survey frequency reverts to Clause 15.12 a) if nonconformity is detected.

16 Conformity – Concrete cracking

Types of concrete cracking

Typical drying shrinkage cracking

16.1 Typical drying shrinkage cracks comprise full-depth transverse cracks continuous for the full width of the paving run at a spacing of between 2.5 m and 15 m with crack width less than 0.5 mm and cracking step less than 1 mm at any point using a 3 m straightedge.

16.2 Where subbase is placed in a single pass exceeding 6 m width, longitudinal full-depth cracking might also typically occur at the following locations:

a) single longitudinal full-depth crack in the centre third of the paved width, and

b) multiple longitudinal cracks at a spacing of approximately 4 m and at a minimum distance of 1 m from an edge.

16.3 No action is required for typical drying shrinkage cracking.

Typical plastic shrinkage and surface cracking

16.4 Typical plastic shrinkage cracks comprise discrete cracks of less than 500 mm length each and depth less than 50% of the slab thickness, which do not intersect a formed edge. For such cracks, no remedial action is required where debonding / bonding treatment is to be applied, but corrective action to minimise recurrence must be implemented.

16.5 Surface cracks are cracks that are less than 0.5 mm deep and are confined to the surface mortar. For such cracks, corrective action to minimise recurrence must be implemented.

Non-typical cracking

16.6 Non-typical cracking is subbase cracking other than the typical cracking described ~~above~~ in Clauses 16.1 to 16.5. Non-typical cracking must be dealt with in accordance with Clauses 16.7 to 16.14.

Crack assessment

General

16.7 The Quality Plan must include details of a Crack Assessment Procedure (CAP) for crack assessment of the LCS.

Crack Inspection

16.8 A site inspection must be jointly carried out with the ~~Principal~~ Administrator to determine the types of cracks and their extent before application of the debonding / bonding treatment but after compressive strength of 4.0 MPa has been achieved in the LCS.

16.9 Unless specified otherwise in the Contract documents, the inspection must be completed before the following times:

a) between 1 October and 31 March: 9:00 am, and

b) between 1 April and 30 September: 11:00 am. **Witness Point 3**

WITNESS POINT 3	
Process	Inspection of LCS and assessment using the CAP.
Notification Period	At least one working day's notice of intention to carry out inspection of LCS and assessment using the CAP.

Crack map

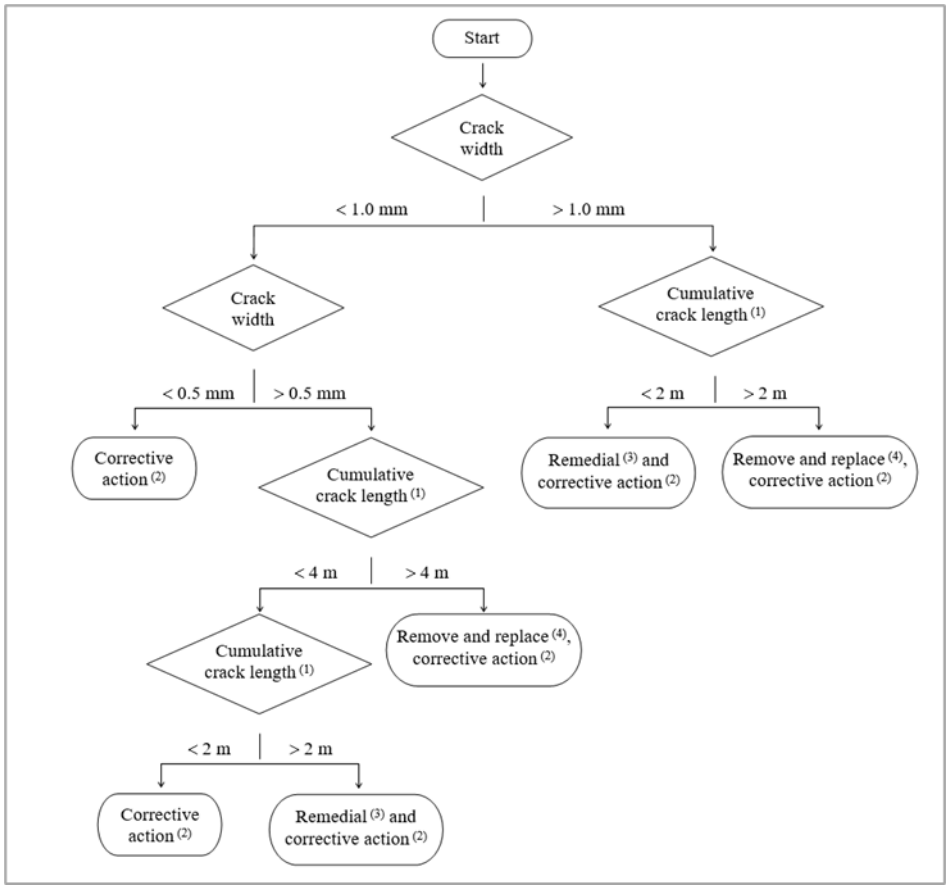
16.10 Where non-typical cracks are present, a crack map must be prepared showing all cracks, including both typical and non-typical cracks, by drawing them on a plan at a scale of 1:100 for the whole paving run. All typical cracks must be plotted in green and all non-typical cracks in red.

16.11 The crack map must show the associated road chainages, date of inspection, crack widths of the non-typical cracks and crack stepping.

Assessment of non-typical cracking

16.12 Where non-typical cracks are present, the non-typical cracking must be assessed within a 5 m × 5 m area in accordance with the process shown in Figure 16.12(a) for non-typical drying shrinkage cracking and in Figure 16.12(b) for non-typical plastic shrinkage cracking. The required remedial and corrective actions must be identified.

Figure 16.12(a) – Assessment process for non-typical drying shrinkage cracks



Notes:

(1) Cumulative crack length is the total length of all non-typical drying shrinkage cracks within a 5 m × 5 m area.

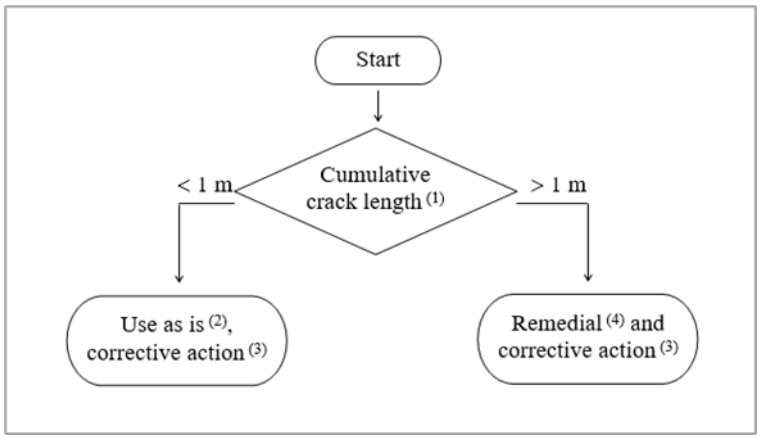
(2) Identify required corrective action through a review of your paving process. The review may include details such as mix constituents, forming time, moisture condition of the paved surface, ambient temperature at placement and during first 24 hours after placement, curing spray rate and timing of application.

(3) Use engineering judgement to identify the required remedial action.

- Under a concrete base, the remedial action may include filling cracks with a low viscosity grout.
- Under an asphalt base, the remedial action may include filling cracks with a low viscosity grout or low viscosity cutback bitumen, the application of bituthene tape over the crack and the application of PMB seal in place of conventional seal.

(4) Remedial action is 'remove and replace'. Use engineering judgement to identify the areas of LCS to be removed and replaced.

Figure 16.12(b) – Assessment process for non-typical ~~drying~~ plastic shrinkage cracks



Notes:

(1) Cumulative crack length is the total length of all non-typical plastic shrinkage cracks within the 5 m × 5 m area.

(2) Only where debonding/bonding treatment is to be applied.

(3) Identify required corrective action through a review of your paving process.

(4) Use engineering judgement to identify the required remedial action.

16.13 Where non-typical cracks are present, the Contractor must prepare a nonconformity report, including details of investigations to determine the cause of non-typical cracking at each location, 'to scale' crack maps, paving details such as mix constituents, forming time, moisture condition of the paved surface, ambient temperature at placement and during the first 24 hours after placement, curing spray rate and timing of application. **Hold Point 10 Record**

HOLD POINT 10	
Process Held	Application of bonding / debonding treatment after crack assessment (where non-typical cracks are present).
Submission Details	The Contractor must submit the nonconformity report to the ~~Principal~~ Administrator at least 3 working days prior to the commencement of remedial action.

16.14 In addition, Hold Points apply in accordance with ~~ATS 1120~~MRTS50 *Specific Quality System Requirements* to the remedial actions not covered by the above Hold Point and to corrective actions.

17 Conformity – Concrete compressive strength

Sub-Lot delineation

17.1 The conformity of LCS for compressive strength is assessed on the basis of Sub-Lots.

17.2 Transition zones are treated as separate Sub-Lots in accordance with the following rules:

a) At each transverse construction joint in slipform work, one discrete transition Sub-Lot is generated on each side of the joint, each with a length of 3 m, or as nominated otherwise in Clause 10.34.

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. 2 transition Sub-Lots are generated as in Clause 17.2 a)).

c) If the Contractor chooses to define a Sub-Lot for a transition zone by a method that is different from Clause ~~14~~17.2 a) and b), the method must be detailed in the Quality Plan. The details must include how the method incorporates the requirements of Clause ~~14~~17.2 a) and b).

Test groups

17.3 A test group of cores is defined as a group comprising 2 cores taken from the LCS that are within a distance of 0.3 m to 1.0 m apart from each other, except that:

a) if either of the cores has a compressive strength of less than 4.5 MPa, or

b) the difference between the strengths is greater than 1.0 MPa, a third core is taken at a distance within 0.3 m to 1.0 m from the others and included in the test group.

17.4 The insitu compressive strength of the Sub-Lot is the mean (rounded to the nearest 0.1 MPa) of the corrected compressive strengths of all the cores in the particular test group.

Location and frequency of coring

17.5 The locations for coring must be selected at random (AS 1289.1.4.1) and as set out below:

Take one test group of cores from:

a) each Sub-Lot of slipformed concrete

b) each Sub-Lot of fixed-formed concrete, and

c) in transition zones, commencing with the trial section, the minimum frequency of coring is as follows:

i. one group from each Sub-Lot until 3 consecutive conforming Sub-Lots are obtained, and then

ii. one group from each third Sub-Lot, selected on the basis of time sequence, until 4 consecutive Sub-Lots conform, and then

iii. one group from each fifth Sub-Lot, selected on the basis of time sequence.

17.6 If a nonconforming result in Clause 17.~~1~~5 c) ii) or c) iii) is obtained, the frequency of testing, starting from the nonconforming Sub-Lot, reverts to that specified in Clause 17.~~1~~5 c) i).

17.7 Additional cores for the purpose of core compressive strength testing must not be taken without the prior approval of the ~~Principal~~Administrator.

17.8 Further samples must be taken at specific (non-random) locations that are visually non-homogeneous and/or non-representative.

17.9 Core holes must be backfilled in accordance with Clauses 21.1 to 21.4.

Test Specimens

17.10 Core specimens must be prepared and tested in accordance with AS 1012.14, but with the following amendments:

a) Concrete in the LCS must have hardened enough to permit removal of the cores without the coarse aggregate coming loose.

b) AS 1012.14 Clause 6.3.2 (b) is amended to read as follows: 'The diameter at any cross-section deviates from the mean diameter by more than 5 mm.'

c) AS 1012.14 Clause 6.4 (d) is amended to exclude dry conditioning. Instead, cores must be wet conditioned by submersion in water at a temperature of 23 ± 5°C for no less than 24 hours and no more than 72 hours immediately before testing.

d) The individual core strengths must be corrected for shape in accordance with Clause 17.13 below.

e) AS 1012.14 Clauses 9 (k), 9 (l), 10 (h) and 10 (i) are amended by the addition of the following words: 'except where the strength is less than 10 MPa, in which case it must be calculated to the nearest 0.1 MPa.'

17.11 Prior to testing, all non-concrete materials such as bitumen must be removed by sawcutting. The minimum amount necessary must be removed and up to a maximum of 20 mm at each end.

Correction factors

17.12 Age correction factors must not be applied to core compressive strength results.

17.13 The shape correction factors (SF) shown in Table 17.13 must be applied to the core compressive strengths by multiplying them by the factor SF to obtain the 'factored core strength'. The shape correction factor must be applied to the unrounded core strength.

Table 17.13 – Shape correction factor

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

Conformity for core compressive strength

17.14 The LCS must achieve insitu compressive strength of 5.0 MPa within 42 days of placement.

17.15 Any Sub-Lot of LCS that fails to achieve an insitu compressive strength of 4.0 MPa within 42 days of placement must be removed and replaced.

~~***Acceptance of Sub-Lots with Core Compressive Strength Deficiency***~~

~~17.16 Any Sub-Lot with insitu compressive strength of between 4.0 MPa and 5.0 MPa within 42 days of placement may be accepted with a deduction to the applicable rate in the payment schedule of 2% for each 0.1 MPa (or part thereof) deficiency below 5.0 MPa.~~

~~17.17 The sprayed bituminous seal (where applicable) may be applied upon achievement of insitu compressive strength of 4.0 MPa.~~

~~17.18 The base course may be placed upon achievement of insitu compressive strength of 4.0 MPa within 42 days of placement, on the following conditions:~~

~~a) the proposal to proceed is submitted with a schedule of the Sub-Lots detailing the core strength test results~~

~~b) the Sub-Lots of LCS that have failed to achieve the specified 42 day insitu compressive strength of 5.0 MPa are accepted by the Principal, and~~

~~c) the decision to proceed with base paving is deemed to be the Contractor's acceptance of the specified deductions stated above.~~

~~17.19 After placement of the base course, no further strength testing of the LCS will be allowed.~~

~~17.20 If the Contractor or the Principal elect not to use the option available in Clause 17.8 c), all LCS that has not achieved insitu compressive strength of 5.0 MPa must be removed and replaced within the specified 42 day period, including concrete covered by debonding/bonding treatment.~~

18 Conformity – Thickness

General

18.1 The LCS thickness within the Sub-Lots must be assessed, except that each transition zone must be combined with the adjacent Sub-Lot.

Thickness determination from survey

18.2 The LCS thickness must be calculated at individual survey points selected as the difference between the finished LCS surface level and underlying surface level, in accordance with Clause 15.

18.3 The calculated thickness must be adjusted to allow for the design surface longitudinal and transverse slopes between the 2 surveyed points.

18.4 The Quality Plan must include details of the method of determining the thickness with adjustment.

Thickness determination from cores

18.5 The LCS thickness must be measured on cores taken for compressive strength testing. If applicable, adjust the measured thickness by subtracting the ALD of the cover aggregate to remove the contribution of the sprayed seal on top of the underlying layer.

Discrepancy between thickness from survey and cores

18.6 Wherever a core thickness result is thinner by 5 mm or more than the thickness calculated from the survey result at a location within 1.5 m of the core or thinner by 10 mm or more at a location between 1.5 m and 2.5 m from the core, the core result will be the accepted thickness and the particular survey result will be disregarded.

18.7 If the frequency of such occurrences is more than 3 in any group of 10 consecutive comparisons, the LCS thickness calculated from the survey results for the entire area represented will be disregarded.

18.8 In areas where the LCS thickness calculated from survey results is nonconforming and no representative cores are available for comparison, the ~~Principal~~ Administrator may authorise the drilling of 40 mm diameter cores.

18.9 Additional cores for the purpose of thickness assessment must not be taken without the prior approval of the ~~Principal~~Administrator.

Mean thickness

18.10 The mean thickness for each Sub-Lot must be calculated using all results for the Sub-Lot (to the nearest 1 mm) that have not been disregarded. The calculated mean thickness must be rounded to the nearest 5 mm.

Conformity for thickness

18.11 A Sub-Lot will be conforming in thickness if:

a) the rounded mean thickness is not less than the design thickness

b) where the overlying base is concrete, no rounded individual result is 15 mm or more below the design thickness, and

c) where the overlying base is asphalt, no rounded individual result is 10 mm or more below the design thickness.

~~***Acceptance of Sub-Lots with Thickness Deficiency***~~

~~18.12 Clause 18.13 only applies if specified in the Contract documents.~~

~~18.13 The Principal may elect to accept a nonconforming Sub-Lot, in which case a deduction to the applicable item on the payment schedule must be made in accordance with Table 18.12.~~

~~***Table 18.12 – Deductions for LCS thickness deficiency***~~

~~**Deficiency in mean thickness[1] (mm)**~~	~~**Deduction to payment item (%), where overlying base type is**~~	
	~~**Concrete**~~	~~**Asphalt**~~
~~5~~	~~0~~	~~0~~
~~10~~	~~12~~	~~25~~
~~15~~	~~25~~	~~Remove and replace~~
~~20~~	~~50~~	~~Remove and replace~~

~~Deficiency in mean thickness[1] (mm)~~	~~Deduction to payment item (%), where overlying base type is~~	
	~~Concrete~~	~~Asphalt~~
~~>20~~	~~Remove and replace~~	

~~Notes:~~

~~[1] Thickness deficiency is the calculated difference between the rounded mean thickness and the design thickness.~~

Offsetting subbase thickness deficiency with increased base thickness

~~18.14~~18.12 Where the Contract also includes construction of the base, and where approved by the Administrator, a~~ny reduced~~ deficiency in mean LCS thickness may be offset by an increase in base thickness.

~~18.15~~18.13 Where the overlying base is concrete, a deficiency in thickness of the LCS up to a maximum amount of 20 mm may be offset with an ~~the offsetting~~ increase in base thickness ~~must be~~ as shown in Table 18.1~~5~~3 (where approved by the Administrator).

Table 18.1~~5~~3 – Increased concrete base thickness as offset for LCS thickness deficiency

Deficiency in mean LCS thickness[1] (mm)	Increase in specified base thickness (mm)
10	5
15	10
20	15

Notes:

[1] Thickness deficiency is the calculated difference between the rounded mean thickness and the design thickness.

~~18.16~~18.14 Where the overlying base is asphalt, a deficiency in thickness of the LCS, up to a maximum amount of 10 mm, may be offset by an identical increase in thickness in the asphalt base (where approved by the Administrator)~~without any deduction to the payment item~~.

19 Conformity – Alignment, levels and surface profile

Alignment

19.1 Tolerances on horizontal alignment are given in Clause 10.36 to 10.48 for the outer edges of the LCS and for joints.

19.2 If a nonconformity is detected, corrective action must be immediately implemented in accordance with the requirements of ~~ATS 1120~~MRTS50 *Specific Quality System Requirements*.

Surface levels

19.3 The LCS surface levels must be assessed for conformity on the basis of individual survey results. Action must be taken as specified in Table 19.3 if the levels are outside the following tolerances:

a) Where the overlying base is concrete, the level at any point on the top of the LCS must not vary by more than 0 mm above or 20 mm below the design level (+ 0/– 20 mm).

b) Where the overlying base is asphalt, the level at any point on the top of the LCS must not vary by more than 10 mm above or 10 mm below the design level (+ 10/– 10 mm).

Table 19.3 – Rectification of nonconforming surface levels

Variation from design levels	Action
Levels below the levels shown on the Drawings	After allowing for the specified tolerance, submit a nonconformity report and attach the survey report and the relevant assessment of thicknesses.
Levels above the levels shown on the Drawings	After allowing for the specified tolerance: a) submit a nonconformity report b) grind the high spots down to the design levels c) remove grinding debris by suction, and d) re-survey the area and resubmit the survey report. Alternatively, carry out a redesign of the finished levels in accordance with Clauses 20.1 and 20.2.

Surface profile

19.4 Deviations under a 3 m straightedge, laid in any direction, must not exceed 5 mm.

20 Redesign of pavement levels

Redesign by the Contractor

20.1 Where the LCS and the underlying layer are both constructed by the Contractor, and where the pavement levels are high and nonconforming, the Contractor may submit a proposed redesign of pavement levels to the ~~Principal~~Administrator. The redesign must comply with the following criteria:

a) The rate of level change on any longitudinal profile string, calculated relative to the approved 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% (expressed as actual values); hence, a specified crossfall of 3.0% may be varied within the range 3.0% ± 0.3%.

c) The transition from the redesigned pavement to abutting structures and pavements must be smooth.

d) Vertical clearance requirements must be complied with.

20.2 The redesigned pavement must be such that:

a) Water will not pond on the carriageway.

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

c) The risks and associated consequences (in terms of drainage) are not increased at locations such as superelevation transitions, taking into account the likely construction deviations (within the specified level tolerances) of the finished base levels.

20.3 The ~~Principal~~ Administrator will respond within 4 working days to the proposal. ~~The Contractor is not entitled to additional payment for redesign due to nonconformity of the underlying surface levels or the LCS finished surface levels.~~

~~***Redesign by the Principal***~~

~~20.4 Clause 20.5 applies, unless specified otherwise in the Contract documents.~~

~~20.5 The Principal may alter the LCS thickness and/or levels by up to 30 mm before the commencement of each section of work, in which case payment will be made on the basis of the actual variation to the quantities of work, in accordance with the relevant items in the applicable payment schedules.~~

21 Restoration of LCS after coring

21.1 All core holes taken in the LCS must be cleaned and backfilled with low-shrink cementitious concrete with a compressive strength no less than that in the LCS. The approved LCS or base mix may be used.

21.2 After backfilling, the finished surface of the LCS at the core hole location must be flush with the surrounding surface of the LCS.

21.3 Before trafficking or base paving, the backfill concrete in the core hole must be cured sufficiently to achieve an estimated compressive strength of 3.0 MPa.

21.4 Restoration must be completed before the application of any surface debonding / bonding treatment.

~~21.5 The cost of backfilling all holes in the LCS is borne by the Contractor, except for additional cores ordered by the Principal.~~

22 Removal and replacement of lean-mix concrete subbase

Boundaries of section for removal

22.1 Where an area of the LCS is nonconforming and is to be removed and replaced, the longitudinal boundaries of the section for removal must either coincide with existing longitudinal joints or edges or be parallel to the control line. Transverse boundaries must be orthogonal to the longitudinal boundaries ~~at~~with a tolerance of 6°.

22.2 The locations of the boundaries of the section for removal must be such that the dimensions of both the replacement slab and the residual slab (i.e. slab remaining after removal) comply with Table 22.2.

Table 22.2 – Minimum dimensions of slab

Description	Minimum value
Slab length (m)	0.6[(1)]
Slab width (m):	
For slab length ≤ 1.5 m	0.4[(2)]
For slab length >1.5 m	1.0[(2)]

Notes:

[(1)] Measured parallel to the control line.

[(2)] Measured orthogonal to the control line.

22.3 The location of the construction joints created by the removal and replacement of nonconforming LCS concrete must also conform to Clause ~~6.6.3~~10.43 with respect to the location of the longitudinal joint in the overlying base.

Sawcutting

22.4 Where sawcutting is required, the sawcut must be to the full depth of the LCS in straight lines that are continuous between opposing boundaries. Waste from the sawcutting operations must be managed in accordance with ~~the approved Environmental Management Plan (see ATS 1140)~~MRTS51 *Environmental Management*. **Hold Point 11** **Record**

HOLD POINT 11	
Process Held	Sawcutting for removal and replacement of LCS.
Submission Details	A nonconformity report for each section of nonconforming LCS to be removed must be submitted to the ~~Principal~~ Administrator at least 3 working days prior the commencement of sawcutting.

22.5 Sawcuts must not be extended by more than 150 mm beyond the boundaries that define the limits of removal. Any additional internal sawcuts that are made to aid the removal of the LCS must not be over-sawn.

Replacement

22.6 The area of nonconforming LCS must be removed and replaced with conforming lean-mix concrete.

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~~
~~6.22~~		1. ~~Laboratory trial mixing~~	
~~6.23~~	2. ~~Production of each concrete mix~~		~~Nominated mix details and associated documents~~
~~7.21~~	3. ~~Production of concrete for paving~~		~~Results demonstrating conformity of mixer uniformity~~
~~8.6~~	4. ~~First LCS in the Works, including paving trial~~		~~Details of the paving crew~~
~~9.6~~	5. ~~Placing of concrete for subgrade beam~~		~~Certificate of conformity for installation of steel reinforcement~~
~~10.1~~	6. ~~Paving of LCS (including paving trial)~~		~~Schedule of underlying surface levels and any relevant nonconformity report~~
~~12.1~~		2. ~~Construction of section of trial pavement~~	
~~12.7~~	7. ~~Commencement of LCS paving other than trial paving~~		~~Report of paving trial~~
~~13.10~~	8. ~~Trafficking of LCS~~		~~Insitu compressive strength test results~~

~~Clause~~	~~Hold Point~~	~~Witness Point~~	~~Record~~
~~14.3~~	9. ~~Surface debonding / bonding treatment~~		~~Schedule of measured levels and subbase thickness~~
~~15.3~~			~~Survey of the underlying surface levels~~
~~15.6~~			~~Schedule of LCS finished surface levels~~
~~16.9~~		3. ~~Inspection of LCS~~	
~~16.13~~	10. ~~Application of bonding / debonding treatment (where non-typical cracks are present)~~		~~Nonconformity report~~
~~22.4~~	11. ~~Sawcutting for the removal of LCS~~		~~Nonconformity report for each section of nonconforming LCS~~

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
5.12				Cementitious materials conformity results
6.22		1. Laboratory trial mixing		
6.23	2. Production of each concrete mix			Nominated mix details and associated documents
7.17	3. Production of concrete for paving			Results demonstrating conformity of mixer uniformity

Clause	Hold Point	Witness Point	Milestone	Record
8.6	4. First LCS in the Works, including paving trial			Details of the paving crew
9.6	5. Placing of concrete for subgrade beam			Certificate of conformity for installation of steel reinforcement
10.1	6. Paving of LCS (including paving trial)			Schedule of underlying surface levels and any relevant nonconformity report
12.1		2. Construction of section of trial pavement		
12.7	7. Commencement of LCS paving other than trial paving			Report of paving trial
13.10	8. Trafficking of LCS			Insitu compressive strength test results
14.3	9. Surface debonding / bonding treatment			Schedule of measured levels and subbase thickness
15.3				Survey of the underlying surface levels
15.6				Schedule of LCS finished surface levels
16.9		3. Inspection of LCS		
16.13	10. Application of bonding / debonding treatment (where non-typical cracks are present)			Nonconformity report

Clause	Hold Point	Witness Point	Milestone	Record
22.4	11. Sawcutting for the removal of LCS			Nonconformity report for each section of nonconforming LCS

A~~nnexure~~ppendix B: Mixer Uniformity Testing

B1 General

B1.1 Charging mixer

For the purpose of conducting the mixer uniformity test, charge the mixer:

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, use the same charging sequence and do not exceed the volume (or throughput) unless another uniformity test is conducted.

B1.2 Use of concrete from uniformity test

Concrete from the mixer uniformity test may be incorporated into any part of the Works on the condition that all concrete from the test conforms to the relevant specification and is placed in a discrete Sub-Lot. The entire Sub-Lot must be removed if the mixer fails to meet the criteria specified in Clause B2 or Clause B3.

B2 Stationary mixer

B2.1 General

Where concrete is to be produced and mixed by a stationary mixer, conduct mixer uniformity tests before paving with that mix and, thereafter, upon production of each 30,000 m³ of concrete from that mixer (including all mix types and customers) or as otherwise required in accordance with AS 1379 Clause 3.5.

Carry out tests on each ~~NFC subbase~~LCS mix to be placed in the Works.

For stationary batch mixers, conduct tests on 3 consecutive batches of the same mix that conform to the requirements of this Technical Specification.

For stationary continuous mixers, conduct tests on 3 consecutive batches, with each batch separated by an interval equivalent to at least 2 m3 of throughput of the same mix, that conform to the requirements of this Technical Specification. Each batch must comprise no less than 5 m³ of mix.

For each batch, report the following:

a) mixing speed

b) batch 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.

B2.2 Sampling

Discharge and sample the whole of a single batch through one of the following procedures:

a) By discharge into a tipper truck with tray length no less than 8 m. Conduct sampling from the truck before 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 Works, 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. Conduct sampling from the ground.

In each case, sample the batch 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. Take a sample of approximately 50 litres from each point, in accordance with AS 1012.1.

B2.3 Testing

Carry out tests required for each property of the concrete in AS 1379 Table A1 on each of the 50 litre samples, in accordance with Appendix A of AS 1379 and as amended by this Technical Specification.

B2.4 Compliance

The mixer will be deemed to have passed the uniformity test if for 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.

B3 Mobile mixers

B3.1 Sampling and testing

Over a period of 24 months (which may include a period prior to the term of this Contract), randomly test the number of mobile mixers listed in Table B3.1.

Table B3.1 – 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

Take 3 samples each of approximately 50 litres at uniform intervals from each of the randomly selected mobile mixers in accordance with AS 1012.1 Clause 7. Carry out tests for the properties in AS 1379 Table A1 on each sample, in accordance with Appendix A of AS 1379 and as amended by this Technical Specification.

This sampling program is predicated on an 8% limiting quality value.

Because of the retempering provisions of the Technical Specification, include mobile mixers that are used to transport centrally-mixed concrete in the fleet testing.

B3.2 Compliance

The differences between the highest value and the lowest value for the corresponding properties of the 3 samples of each randomly selected mixer in accordance with Table B3.1 must be within the limiting values given in AS 1379 Table A1.

The fleet will be deemed to conform if all the randomly selected mixers satisfy the requirements of AS 1379 Appendix A.

Where a mixer fails to satisfy a mixer uniformity test, the entire fleet is deemed to have failed, until:

a) 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.

b) The producer immediately tests another randomly selected mixer from the same fleet, 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 withdrawn from operational service, and

   ii. if it fails, proceed in accordance with item a) above.

To satisfy the mixer uniformity and compliance program, regularly inspect all mixers to determine the extent of internal wear, internal build up and the ability to rotate at the required rate (revolutions / minute). Keep a progressive maintenance record for each mixer showing inspection frequency and details of any repair or rectification and make this available on request.

Carry out further testing:

a) upon evidence of non-uniformity of mixing that 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.

All mobile mixers must display an identification plate in accordance with AS 1379 to certify conformity with mixer uniformity criteria.

Where a mixer is one of the randomly tested mixers, show the date of the latest test on its identification plate.

A~~nnexure~~ppendix C: Paving Trial Report

The report of the paving trial must be in the form of a table showing, as a minimum, the information listed below:

a) location: location of laboratory where trial mix was carried out and location of paving trial

b) mix details (of both authorised nominated mix and that produced during paving trial):

   i. mix reference number

   ii. particle size distribution(1)

   iii. water content

   iv. admixture content for each type

   v. air content, and

   vi. slump.

c) curing:

   i. curing compound type, and

   ii. actual application rate.

d) conformity of constructed pavement:

   i. cracking

   ii. compressive strength(2): 7 day cylinder (authorised nominated mix) and 7 day core (paving trial)

   iii. thickness (from core lengths)

   iv. alignment

   v. levels, and

   vi. surface profile.

Notes:

(1) Determined in accordance with Clause 6 and Clause 12.

(2) The 28 day core compressive strength test results do not need to be submitted as part of the report but must be submitted when available later.

A~~nnexure~~ppendix D: Minimum Frequency of Testing

Clause	Characteristic tested	Test Method	Minimum frequency of testing
Constituent material: fine aggregate (source rock tests)~~(1)~~			
5.4	Petrographic Analysis	Q188	Refer to Clause 8.1.1 of MRTS50
5.4	Water absorption	AS 1141.5	Refer to Clause 8.1.1 of MRTS50
5.4	Particle density	AS 1141.5	Refer to Clause 8.1.1 of MRTS50
5.4	Chloride content	AS 1012.20.1	Refer to Clause 8.1.1 of MRTS50
5.4	Sulphate content	AS 1012.20.1	Refer to Clause 8.1.1 of MRTS50
5.4	Micro-Deval abrasion loss	Q229A	Refer to Clause 8.1.1 of MRTS50
5.4	Soundness (sodium sulfate)	AS 1141.24	Refer to Clause 8.1.1 of MRTS50
5.4	Organic impurities (natural sand quarries only)	AS 1141.34	Refer to Clause 8.1.1 of MRTS50
5.4	Sugar presence (natural sand quarries only)	AS 1141.35	Refer to Clause 8.1.1 of MRTS50
5.4	Light particles (natural sand quarries only)	AS 1141.31	Refer to Clause 8.1.1 of MRTS50
5.4	Material passing 75 µm sieve (natural sand quarries only)	AS 1141.12	Refer to Clause 8.1.1 of MRTS50
5.4	Material finer than 2 µm (natural sand quarries only)	AS 1141.13	Refer to Clause 8.1.1 of MRTS50
Constituent material: fine aggegrate (product tests)			
5.4	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

Clause	Characteristic tested	Test Method	Minimum frequency of testing
5.4	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
5.4	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
5.4	Methylene Blue Adsorption Value (MBV)	AS 1141.66	One per 20,000 t
5.4	Deleterious Fines Index (DFI)	Not applicable	One per 20,000 t
5.4	Flow Cone time (total fine)	TfNSW T279 (TS 02799.54)	One per 10,000 t
5.4	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*
~~5.6~~	~~Durability (sodium sulphate soundness) (Ind)~~	~~AS 1141.24~~	~~One per 5,000 t for the first 15,000 t and thereafter one per 10,000 t~~
~~5.6~~	~~Material finer than 75 µm (TF)~~	~~AS 1141.11.1 or AS 1141.12~~	~~One per 5,000 t for first 15,000 t and thereafter one per 10,000 t~~
~~5.6~~	~~Material finer than 2 µm (TF)~~	~~AS 1141.13~~	~~One per 5,000 t for first 15,000 t and thereafter one per 10,000 t~~
~~5.6~~	~~Methylene Blue Adsorption Value (MBV) (Ind)~~	~~AS 1141.66~~	~~One per 20,000 t~~
~~5.6~~	~~MBV75 value (Ind)~~		~~One per 20,000 t~~
~~5.6~~	~~Organic impurities (TF)~~	~~AS 1141.34, AS 1289.4.1.1~~	~~One per 2,000 t for first 10,000 t and thereafter one per 10,000 t~~
~~5.6~~	~~Sugar content (TF)~~	~~AS 1141.35~~	~~One per 10,000 t~~
~~5.6~~	~~Flow cone time (TF)~~	~~TfNSW T279~~	~~One per 10,000 t~~

Clause	Characteristic tested	Test Method	Minimum frequency of testing
Constituent material: coarse aggregate (source rock tests)			
5.5	Petrographic Analysis	Q188	Refer to Clause 8.1.1 of MRTS50
5.5	Wet strength	AS 1141.22	Refer to Clause 8.1.1 of MRTS50
5.5	Wet/dry strength variation	AS 1141.22	Refer to Clause 8.1.1 of MRTS50
5.5	Weak particles	AS 141.32	Refer to Clause 8.1.1 of MRTS50
5.5	Water absorption	AS 1141.6	Refer to Clause 8.1.1 of MRTS50
5.5	Degradation factor	Q208B	Refer to Clause 8.1.1 of MRTS50
5.5	Particle density	AS 1141.6.1	Refer to Clause 8.1.1 of MRTS50
5.5	Chloride content	AS 1012.20.1	Refer to Clause 8.1.1 of MRTS50
5.5	Sulphate content	AS 1012.20.1	Refer to Clause 8.1.1 of MRTS50
5.5	Soundness (sodium sulfate)	AS 1141.24	Refer to Clause 8.1.1 of MRTS50
Constituent material: coarse aggregate (product tests)			
5.5	Particle shape (individual)	AS 1141.14	One per 5,000 t
5.5	Flakiness index (individual)	AS 1141.15	One per 5,000 t
5.5	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
5.5	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
5.5	Material finer than 2 µm	AS 1141.13	One per 5000 t

Clause	Characteristic tested	Test Method	Minimum frequency of testing
5.5	Crushed particles (natural gravel quarry only)	AS 1141.18	One per 10,000 t
~~5.7~~	~~Material finer than 75 µm (TC)~~	~~AS 1141.11.1 or AS 1141.12~~	~~One per 5,000 t for the first 15,000 t and thereafter one per 10,000 t~~
~~5.7~~	~~Particle shape (Ind)~~	~~AS 1141.14~~	~~One per 10,000 t~~
~~5.7~~	~~Wet strength (Ind)~~	~~TfNSW T215~~	~~One per 10,000 t~~[~~(2)~~]
~~5.7~~	~~Wet / Dry strength variation (Ind)~~	~~TfNSW T215~~	~~One per 10,000 t~~[~~(2)~~]
~~5.7~~	~~Foreign materials content (Ind)~~	~~TfNSW T276~~	~~One per 4,000 t~~
Constituent material: other materials			
5.~~15~~7 to 5.19	Cementitious materials	As per Clauses 5.~~15~~7 to 5.19	As per Clauses 5.~~15~~7 to 5.19
5.~~23~~20 to 5.22	Water	~~AS 1379, AS 1478.1, AS 1289.4.2.1~~As per Clauses 5.20 to 5.22	One per 40,000 m³ of concrete
5.~~33~~30 to 5.38	Curing compounds	As per Clauses 5.~~33~~30 to 5.38	As per Clauses 5.~~33~~30 to 5.38
6.15 to 6.18	Chloride ion content	As per Clauses 6.15 to 6.18	One per 30,000 m³ of concrete
6.15 to 6.18	Sulphate ion content	As per Clauses 6.15 to 6.18	One per 30,000 m³ of concrete
Concrete mixer			
A~~nnexure~~ppendix B	Mixer uniformity	AS 1379 and A~~nnexure~~ppedix B	As per A~~nnexure~~ppendix B
Batched concrete			
7.6	Particle size distribution of combined aggregate: • by calculation, or • by wet sieving[~~2, 3, 4, 5~~]	AS 1141.11.1 or TfNSW T329(TS 02800.26)[~~3~~2]	One per 500 m³ for the first 5,000 m³ and thereafter one per 1,500 m³ of concrete
7.8	Water content		One per 5,000 m³

Clause	Characteristic tested	Test Method	Minimum frequency of testing
7.~~29~~30 to 7.37	Concrete slump	AS 1012.3.1	As per Clause 7.~~29~~36 and 7.37
7.~~44~~45 to 7.51	Air content of concrete	AS 1012.4.2	As per Clause 7.~~44~~46 to 7.48
Subgrade beam placing			
~~6.4~~9.20	Compressive strength of concrete subgrade beams at 7 days	~~As per Clause 6.4~~AS 1012.9	As per Clause ~~6.4~~9.20
Subbase paving			
10.41	Geometric tolerance on transverse joints	As per Clause 10.41	2 tests per joint
10.4~~3~~5	Geometric tolerance on longitudinal joints	As per Clause 10.~~43~~45	Initially, and after each nonconformity: One per 10 linear m of joint until 5 conforming results are recorded, then one per 25 linear m
10.46	Geometric tolerance on outer edges	As per Clause 10.46	Initially, and after each nonconformity: One per 10 linear m of joint until 5 conforming results are recorded, then one per 25 linear m
11.19	Application rate of curing compound	As per Clause 11.19	As per Clause 11.19
13.10	Insitu compressive strength (for trafficking purposes)	Cores as per Clause 13.10	As per Clause 13.10
15.4	Surface level	As per Clause 15.4	As per Clause 15.4
15.8	Alignment	As per Clause 15.8	As per Clause 15.8
15.12	Surface profile	As per Clause 15.12	As per Clause 15.12
17.5	Compressive strength of concrete cores at maximum 42 days	As per Clause 17.5	As per Clause 17.5
18	Thickness	As per Clause 18	As per Clause 18

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) Only the +1.18 mm fraction need be tested. Clause 7.6 refers.