Technical Specification

Transport and Main Roads
MRTS40 Concrete Pavement Base

November 2018

Queensland Government

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1 Introduction

This Technical Specification applies to the construction of road pavements using concrete base for Plain Concrete Pavements (PCP), Jointed Reinforced Concrete Pavements (JRCP), Continuously Reinforced Concrete Pavements (CRCP) and Steel Fibre Reinforced Concrete Pavements (SFCP). Provisions specific to SFCP are provided in Appendix N.

This Technical Specification is substantially derived from the New South Wales Roads and Maritime Services (RMS) QA Specification R83 *Concrete Pavement Base* (2013). It is intended for the construction of heavy-duty road pavements carrying substantial volumes of heavy vehicles. It is unlikely to be applicable to other applications such as industrial, commercial or residential pavements without suitable modification.

Unless stated otherwise, the Contractor shall undertake and be responsible for all actions and requirements of this Technical Specification.

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

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

The RMS User Guide NR83 *Guide to QA Specifications R83 and R84 – Concrete Base* provides background information and guidance which is relevant to many of the requirements in this Technical Specification. Guidance is also provided in Part 4C: *Materials for Concrete Road Pavements of the Austroads Guide to Pavement Technology* (Austroads, 2009). When referring to these guide documents, it should be noted that some of the content may relate to superseded specifications.

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

Concrete that will be exposed to sea water, including by spraying or splashing, may require supplementary provisions. Refer to AS 3600 and AS 2758.1 for further guidance.

Where clause references to other documents are included in this Technical Specification, these clause references were correct at the date of publication of this Technical Specification. When a referenced document is updated, references in this Technical Specification are to be read as the equivalent clause in the updated reference document.

2 Definition of terms, abbreviations and symbols

The terms used in this Technical Specification are as defined in Clause 2 of MRTS01 *Introduction to Technical Specifications*, and Appendix A.

Abbreviations and symbols are as defined in Appendix A.

3 Referenced documents

Documents referenced in this Technical Specification are listed in Appendix B.

4 Standard test methods

The standard test methods listed in Appendix B shall be used, including any amendments or qualifications detailed in this Technical Specification.

Further details of test numbers and test descriptions are given in Clause 4 of MRTS01 *Introduction to Technical Specifications*.

5 Quality system requirements

5.1 Hold Points, Witness Points and Milestones

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

The Hold Points, Witness Points and Milestones applicable to this Technical Specification are summarised in Table 5.1.

Table 5.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
5.2			Quality Plan
6.2.1			Cement and SCM conformance reports and sample
6.4			Curing compound reference sample report
6.5			Certification of proposed sealant conformance and all relevant test results
7.7.2		1. Mixing of trial batch	
7.7.3	1. Submission of nominate trial mix		
7.7.4			Notification of variation(s) to an authorised mix
8.2	2. High subbase levels		Survey report comparing actual and contract base invert levels
8.3	3. Placing concrete around steel reinforcement		
8.4.1.1	4. Results from process control charts		
8.4.2.1	5. Results for mixer uniformity testing		
8.5.2	6. Base paving subject to paving trial		
8.5.8			Curing compound first and subsequent deliveries report(s)

Clause	Hold Point	Witness Point	Milestone
8.5.9.4	7. Trafficking of base (20 MPa)		
8.5.9.4	8. Trafficking of base (25 MPa)		
8.6		2. Testing of joints and silicone sealants	Certification of compliance of each production batch of sealant
9.2.2	9. Void above inserted tiebars		
9.4.2			Survey data and assessment of levels and thickness
9.5.3			Report results from profile testing and ride quality testing
9.6	10. Removal and replacement of nonconforming concrete base		

5.2 Quality plan

Develop and implement a Quality Plan, including construction procedures, for the work in accordance with MRTS50 *Specific Quality System Requirements*. The plan must also include the documents listed in Table 5.2.

Submit the Quality Plan to the Administrator at least 14 calendar days before work commences.

Milestone

Submission details:	Quality Plan, including construction procedures, in accordance with MRTS50 and Table 5.2 at least 14 calendar days before work commences.

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 5.2 – Quality plan documents and records

Clause	Documents and records
5.2	Quality plan, including construction procedures
5.3	Concrete paving crew training records
6.1.2	Construction procedure: aggregate production procedure
6.3	Construction procedure: changes in admixture type/dosage with season

Clause	Documents and records
6.5	Construction procedure: joint sealant
8.4.2	Construction procedure: handling, storage and batching of materials, and the method of charging the mixer
8.4.2.2	Construction procedure: incorporation of admixtures
8.4.2.3	Construction procedure: monitoring of identification certificate (delivery docket)
8.4.2.6	Construction procedure: monitoring of concrete supply (retempering) including nomination of Contractor's representative for retempering
8.4.2.7	Construction procedure: determination of maximum forming time
8.5.1	Construction procedure: equipment and methods to be used for placing, spreading and finishing the concrete base
8.5.3	Quality plan: method of traceability of each load of concrete
8.5.4	Construction procedure: transition zone paving
8.5.6	Construction procedure: restricting evaporation and preventing plastic shrinkage cracking
8.5.7	Construction procedure: surface texturing
8.5.9.1	Construction procedure: protection of concrete from low air temperatures
8.5.9.2	Construction procedure: protection of concrete from rain
8.9	Construction procedure: paving over anchors
9.1	Inspection schedule for cracking in base slabs
Appendix A	Method of alternative lot definition
Appendix A	Method of alternative sublot definition
Appendix D	Method of adjustment of thickness for design surface slope
Appendix E	Construction procedure: proposal to bend anchor stirrups
Appendix J	Construction procedure: equipment and methods to be used for placing, spreading and finishing the concrete base (slipform paving)
Appendix J	Construction procedure: system to indicate the malfunction of each individual vibrator
Appendix J	Construction procedure: equipment and methods to be used for placing, spreading and finishing the concrete base (fixed-form paving)
Appendix J	Construction procedure: curing compound – storage and agitation under varying weather conditions
Appendix J	Construction procedure: curing compound – use of Class 3 mechanical sprayer
Appendix K	Construction procedure: joint sealing
Appendix K	Construction procedure: temporary sealing before diamond grinding

5.3 Concrete paving crew training

Ensure the person in charge of the paving crew and at least 50% of the paving crew hold a 'Grey Card' for successfully completing the RMS Concrete Paving Crew 'Grey Card' training course, and that other crew members have been adequately trained. Submit details of such training as part of the Quality Plan.

In addition to this, it is recommended that at least the following personnel also hold a 'Grey Card' for successfully completing the RMS Concrete Paving Crew 'Grey Card' training course:

a) Contractor's Project Manager

b) the remainder of the paving crew present at each separate concrete paving site, and

c) Contract Administrator and Inspector.

The paving crew includes, but is not limited to, personnel engaged in:

- establishing stringlines and fixed forms
- placing and fixing reinforcement, tie-bars and dowels
- receiving and placing concrete
- operating slipform pavers or vibrating screeds
- compaction, finishing, texturing, curing, debonding and/or early age protection of concrete.

The RMS 'Grey Card' course is currently delivered by the Australian Society for Concrete Pavements (ASCP) under an agreement with RMS.

6 Materials

6.1 Aggregates

6.1.1 General

Aggregates for base concrete shall 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 non-conforming.

Source aggregates certified as conforming from stockpiles at the batch plant or quarry.

Stockpiles shall 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.

Do not exceed a Lot size of 5000 tonnes.

Stockpile the materials such that:

a) each stockpile represents only one Lot, or

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

Identify stockpiles clearly and uniquely by signposting which indicates the Lot identification, type and quantity of material.

6.1.2 Aggregate source assessment

Coarse aggregate and fine aggregate shall 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, shall 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 shall apply.

The Contractor shall notify the Administrator within three business days of any change to the Quarry Registration Certificate, including its Testing Frequency Schedule.

For each quarry that will supply material(s) to be used in the Works, the Contractor shall 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) area (for example, face number, bench number and reduced level) of the quarry from which the material in the lot will be won

b) production process and method of winning the material

c) proposed testing frequency level, with supporting details justifying the proposal, for each test in which the minimum frequency is specified to comply with CCAA (2005) (refer to Table 10)

d) procedures for stockpile management and traceability as part of lot control and, as applicable, stockpile sublot control, and

e) quality control procedures.

6.1.3 Combined aggregates

Ensure that the particle size distribution of combined aggregates conforms to Table 6.1.3.

Table 6.1.3 is based on materials with equal particle densities in a saturated surface dry condition. Where particle densities differ by more than 20%, adjust the combined aggregate particle size distribution accordingly.

Table 6.1.3 – Combined aggregate particle size distribution

Test sieve (mm)	Percent passing by mass
19.00	95–100
13.20	75–90
9.50	55–75
4.75	38–50
2.36	30–42
1.18	22–34
0.600	16–30
0.300	5–15
0.150	0–7
0.075	0–4([1],[2])
0.002	0–1.0([2])

Notes:

([1]) Determined in accordance with AS 1141.12.

([2]) Assess compliance in accordance with Clause 6.1.4.

The Administrator may approve an alternative combined aggregate particle size distribution where the variations are limited to the fractions retained on the 0.300 mm sieve and above. A recognised alternative method for determining a suitable particle size distribution is the Shilstone Coarseness Workability Graph. The Contractor should include their proposed acceptance criteria in any request to use an alternative particle size distribution.

6.1.4 Fine aggregate

Fine aggregate shall conform to AS 2758.1 and Table 6.1.4.

Table 6.1.4 – Fine aggregates properties

Property	Test: Individual or Total fine(1)	Requirement	Test method
Particle size distribution	Individual	Limits of deviation in AS 2758.1	AS 1141.11.1
Material passing 75 µm sieve	Total fine	As per Figure 6.1.4	AS 1141.11.1 (by washing) or AS 1141.12
Material finer than 2 µm	Total fine	As per Figure 6.1.4	AS 1141.13
Methylene blue value (MBV)	Individual(2)	As per Figure 6.1.4	AS 1141.66
Deleterious fines index (DFI)(3)	Individual(2)	As per Figure 6.1.4	AS 1141.11.1 (by washing) and AS 1141.66
Compacted bulk density	Individual	Minimum 1.20 t/m³	AS 1141.4
Particle density	Individual	Minimum 2.10 t/m³	AS 1141.5
Water absorption	Individual	Maximum 5.0%	AS 1141.5
Soundness (sodium sulfate)	Individual	Maximum 6.0% weighted loss	AS 1141.24
Light particles	Total fine	Maximum 1%	AS 1141.31
Organic impurities	Total fine	Pass/Fail (AS 1141.34) and maximum 0.5% (AS 1289.4.1.1)	AS 1141.34 and AS 1289.4.1.1(4)
Sugar presence	Total fine	Absence of sugar	AS 1141.35
Acid insoluble residue(5)	Total fine	Minimum 60%	Tex-612-J
Micro-Deval abrasion loss(5)	Total fine	Maximum 15%	ASTM D7428
Flow Cone time(7)	Total fine	Maximum 27 seconds	RMS T279(6)
Alkali-aggregate reactivity	Individual	See Clause 6.1.6	See Clause 6.1.6
Petrographic analysis	Individual	Interpretative report	ASTM C295

Notes:

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

(²) Test all individual fine aggregates. If all individual components 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) DFI is the product of the MBV and the material passing 75 µm sieve value.

(⁴) Test initially to AS 1141.34. If the presence of organic impurities is indicated, test to AS 1289.4.1.1.

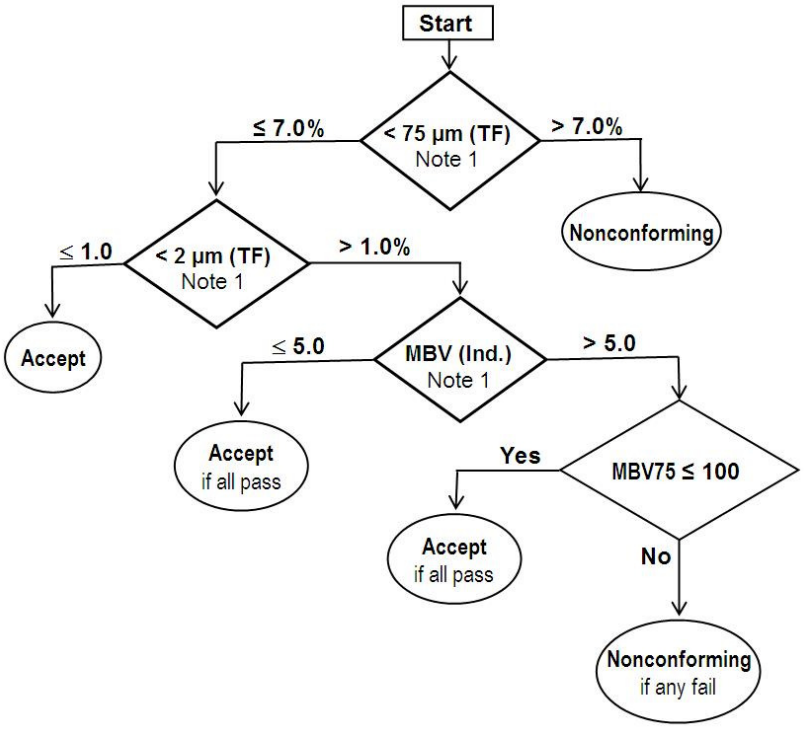
(⁵) Micro-Deval testing is not required if the acid insoluble residue conforms. If the Micro-Deval abrasion loss conforms, the acid insoluble residue does not need to conform.

(⁶) Flow cone test results need not be NATA endorsed.

(⁷) Flow cone testing is not mandatory if the manufactured fine aggregate content is less than 20% by mass of the total fine aggregate.

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

Figure 6.1.4 – Fine aggregate requirements



Note:

(1) TF: Total fine aggregate Ind: – Individual fine aggregates – MBV75 has the same meaning as DFI.

6.1.5 Coarse aggregate

Coarse aggregate shall conform to AS 2758.1 and Table 6.1.5.

Table 6.1.5 – Coarse aggregate properties

Property	Test: Individual or Total Coarse(1)	Requirement	Test Method
Compacted bulk density	Individual	Minimum 1.20 t/m³	AS 1141.4
Particle density on a saturated-surface-dry basis	Individual	Minimum 2.10 t/m³	AS 1141.6.1
Water absorption	Individual	Maximum 2.5%	AS 1141.6.1
Particle size distribution	Individual	Limits of deviation in AS 2758.1	AS 1141.11.1
Material passing 75 µm sieve	Total coarse	Maximum 1.0%	AS 1141.11.1 (by washing) or AS 1141.12
Material finer than 2 µm	Individual	Maximum 1.0%	AS 1141.13
For material retained on a 9.50 sieve: Particle shape, 2:1 and 3:1 ratios	Individual	Maximum 25% (2:1 ratio) and maximum 10% (3:1 ratio)	AS 1141.14
Flakiness index	Individual	Maximum 25%	AS 1141.15
Wet strength	Individual	Minimum 80 kN	AS 1141.22
Wet/dry strength variation	Individual	Maximum 35%	AS 1141.22
Degradation factor	Individual	Minimum 40%	Q208B
Weak particles	Individual	Maximum 0.3%	AS 1141.32
Light particles	Total coarse	Maximum 1%	AS 1141.31
Crushed particles(2)	Individual	Minimum 80%	AS 1141.18
Foreign materials content(3)	Individual	Maximum 0.1%	Q477
Alkali-aggregate reactivity	Individual	See Clause 6.1.6	See Clause 6.1.6
Petrographic analysis	Individual	Interpretative report	ASTM C295

Notes:

(1) Total coarse: Calculate the theoretical mixed result based on individual component results with proportioning as per the nominated mix or test the mixed total coarse aggregate blend.

(2) Requirement is waived for aggregate which has been extracted from mineral rock quarries by drilling and blasting.

(3) Required only for a recycled aggregate component. Foreign materials component is expressed as the percentage by mass of the individual recycled aggregate component.

6.1.6 Alkali-aggregate reactivity

6.1.6.1 Alkali-silica reactivity

Test all aggregates for alkali-silica reactivity (ASR), except testing is not required where ASR Reactive Class mix (Table 7.2.3) is used. Test aggregates for ASR in accordance with AS 1141.60.1, except where AS 1141.60.1 is not suitable for the type of aggregate being tested, or its suitability is unknown, test in accordance with AS 1141.60.2.

If all aggregates are non-reactive, no further action is required. If one or more of the aggregates is slowly reactive or reactive, assess as per Appendix C1.

6.1.6.2 Alkali-carbonate reactivity

Aggregates with constituents that are capable of alkali-carbonate reaction in concrete shall be tested for alkali-carbonate reactivity in accordance with ASTM C1105 using GP cement.

Aggregates which are reasonably classified as potentially deleteriously reactive shall not be used, unless approved otherwise by the Administrator.

Aggregates that are capable of alkali-carbonate reaction include dolomitic and argillaceous limestones, and other carbonate-containing rocks as identified through petrographic examination.

Where alkali-carbonate reactive materials are being considered for use, a project-specific engineering assessment is recommended. The assessment should demonstrate that proposed control measures are suitable for the intended application.

6.2 Cementitious materials

6.2.1 General

Cementitious material shall be either:

a) Type SL (shrinkage limited) cement, or

b) Type GB (general blended) cement that complies with the shrinkage limit for Type SL cement in AS 3972.

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

Only Transport and Main Roads registered cementitious materials shall be used. In addition, cementitious materials shall be supplied only by departmental registered suppliers.

Each delivery of cement and SCM shall be accompanied by a delivery document providing traceability by detailing:

1. marking information as required by AS 3972, AS 3582.1 or AS 3582.2 (as relevant), and
2. ATIC registration number.

Within five business days after the start of the Works, deliver to the Administrator a minimum five kilogram representative grab sample (labelled for traceability) of each cement and SCM.

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

Milestone

Submission details:	Documentary evidence of conformance (monthly) and initial sample of each cement and SCM.

For information regarding registered suppliers and products, refer to Product Index for Bridges and Other Structures on the department's website, www.tmr.qld.gov.au.

Cementitious materials and suppliers that are registered to MRTS70 are considered to also be registered to MRTS40.

Bulk cementitious materials shall only be stored in watertight silos.

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

As far as practicable, cement shall be used in order of receipt.

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

6.2.2 Cement

Cement shall comply with ATIC-SPEC SP43 and AS 3972.

Cement more than three months old (from date of manufacture) shall be retested for conformance.

6.2.3 Supplementary cementitious material (SCM)

6.2.3.1 Fly ash

Fly ash shall be fine grade, and shall comply with ATIC-SPEC SP43 and AS 3582.1.

Loss on ignition (LoI) and fineness shall conform to the limits in Table 6.2.3.1 (calculated using the 30 most recent successive test results).

Table 6.2.3.1 – Fly ash uniformity requirements

Property	Formula	Limit
Carbon content (LoI)	$LoI_{average} + 3SD$	≤ 4%
Fineness	$Fineness_{average} + 3SD$	≤ 100%
	$Fineness_{average} - 3SD$	≥ 75%
	CoV	≤ 3%

where:

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

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

SD = standard deviation expressed as a decimal

CoV = coefficient of variation = $SD/Fineness_{average}*100\%$

6.2.3.2 Ground granulated iron blast-furnace slag

GGBFS shall comply with ATIC-SPEC SP43 and AS 3582.2.

Fineness shall conform to the following (calculated 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

6.3 Chemical admixtures

Chemical admixtures shall conform to AS 1478.1, but must not contain calcium chloride, and shall be used in accordance with AS 1379.

Air entraining agents are mandatory in slipform paving mixes.

The following conditions also apply to admixtures:

a) For combinations of two or more admixtures, their compatibility shall be certified in writing by the manufacturer(s). Provide certification with the nominated mix submission. **[refer to Hold Point 1]**

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

c) Provide details in the Construction Procedures of the criteria for initiating changes in admixture type with season. If the same admixture is proposed across seasons, provide (in the Construction Procedures) dose rate charts for temperature change. Additional trial mixes are not required if admixture dose rate changes are based solely on ambient temperature.

Calcium chloride may increase drying shrinkage.

Air entrainment is not mandatory in non-pavement components, such as anchors and subgrade beams, nor in fixed-form 'hand placed' mixes.

For slipform paving, ensure the concrete conforms to the air content of fresh concrete requirements in Table 7.6.

Sodium oxide (Na_2O) equivalent content = sodium oxide content + 0.658 x potassium oxide (K_2O) content.

6.4 Curing compound

Curing compounds shall comply with Appendix C2.

A reference sample for each nominated curing compound shall be tested in accordance with Appendix C2. The Contractor shall certify by written report (accompanied by the test results) that the reference sample conforms to this Technical Specification.

Milestone

Submission details:	Report certifying curing compound conformance and NATA endorsed test results.

6.5 Joint sealant

Joint sealant shall comply with Appendix C3.

Provide a full technical description (as part of the Construction Procedures), including the method of installation recommended by the manufacturer. Certify by written report (accompanied by the test results) that the proposed sealant conforms to this Technical Specification.

Milestone

Submission details:	Report certifying proposed sealant conformance and relevant test results.

6.6 Preformed joint filler

Preformed joint filler shall comply with Appendix C4.

6.7 Steel reinforcement

Steel reinforcement shall conform to MRTS71 *Reinforcing Steel* and the additional and overriding requirements in Appendix E of this Technical Specification.

6.8 Water

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

Water which is drawn solely from a reticulated drinking water supply is deemed to conform. For all other sources of water, comply with Appendix C5.

Limits on soluble salt (chloride ion and sulphate ion) content for the total concrete mix are detailed in Table 7.6.

7 Mix design

7.1 Particle size distribution

Comply with the combined aggregate particle size distribution in Clause 6.1.3.

7.2 Cementitious content

7.2.1 Minimum mass

The minimum mass of cementitious material shall comply with Table 7.2.1.

Table 7.2.1 – Minimum mass of cementitious material

Mix type	Minimum mass (kg/m³)
PCP, JRCP, CRCP	300
SFCP	350

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

7.2.2 Minimum proportion of cement

The minimum proportion of cement, $Cement_{min}$, shall comply with the following requirement:

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

where:

$Cement_{min}$ = minimum SL cement or GP cement (used in a blend) (% by mass)

FA = mass of fly ash (kg/m³)

GGBFS = mass of GGBFS (kg/m³)

7.2.3 Proportion of supplementary cementitious materials (SCM)

Where SCMs are used in blends, the limits on proportion of SCMs shall be as detailed in Table 7.2.3.

Table 7.2.3 – Range of SCM limits

SCM	ASR class	Limits(1)	
		Minimum (%)	Maximum (%)
Fly ash	Non-reactive	15 – (0.5 x *GGBFS*%)	40 – (0.5 x *GGBFS*%)
	Reactive	20 – (0.5 x *GGBFS*%)	
GGBFS	Non-reactive	10 – (2.0 x *FA*%)	65 – (2.0 x *FA*%)
	Reactive	40 – (2.0 x *FA*%)	

Notes:

(1) By mass, relative to total cementitious material.

where:

FA% = percentage of fly ash by mass of total cementitious material

GGBFS% = percentage of GGBFS by mass of total cementitious material

It is acceptable to use mixes without SCMs (unless required for ASR). These limits only apply where SCMs are used. For example, if fly ash is used with non-reactive aggregates, fly ash proportions between 1% and 14% are non-conforming.

A “hot weather mix” is a mix that incorporates a minimum of 30% GGBFS (by mass).

7.3 Strength

Determine the compressive, flexural and indirect tensile strengths for each trial batch in accordance with Appendix P3.

Table 7.3 lists the minimum requirements for compressive and flexural strength at 28 days.

In relation to concrete strengths in this Technical Specification, the leading uppercase “F” refers to results in the trial mix, and the leading lowercase “f” refers to results in the work.

Table 7.3 – Minimum concrete strengths

Description		Compressive strength	Flexural Strength(1)
Mixes without SCM(2)	In the trial mix	45.0 MPa (F_{28Min})	5.0 MPa (F_{f28Min})(3)
	In the works	40.0 MPa (f_{cMin})	4.8 MPa (f_{fMin})(4)
Mixes with SCM(2)	In the trial mix	40.0 MPa (F_{28Min})	4.8 MPa (F_{f28Min})(3)
	In the works	35.0 MPa (f_{cMin})	4.5 MPa (f_{fMin})(4)

Notes:

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

(2) SCM: Mixes containing supplementary cementitious material(s), meeting the requirements of Table 7.2.3.

(3) For CRCP, the flexural strength in the Trial Mix (Ff28Min) shall not exceed 6.5 MPa at 28 days.

(4) Specified only for process control, not specified for sublot compliance.

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

7.4 Consistence (slump)

Determine the consistence of the concrete by measuring the slump in accordance with AS 1012.3.1.

Nominate a slump for each concrete mix that best suits 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, except as provided under (c): 15–50 mm

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

The nominated slump shall be within ± 5 mm of the slump as measured in the trial mix batch.

The slump adopted shall allow the production of a dense, non-segregated base without excessive bleeding.

For slipform concrete mixes, test and report the Vebe reading in the trial mix in accordance with AS 1012.3.3.

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

7.5 Shrinkage

Prepare and test concrete specimens in the Trial Mix in accordance with AS 1012.13. Shrinkage of the concrete specimen after a drying period of either 21 or 56 days shall conform to Table 7.5.

Shrinkage testing is only required in the trial mix. Conformity of the trial mix is required at only one age. If the result at 21 days is nonconforming, the test may be extended to 56 days.

Table 7.5 – Maximum shrinkage strain

Mix type	Maximum shrinkage strain (με) for given drying period	
	21 days	56 days
Mixes with a minimum of 40% GGBFS (by mass)	580	680
Other mixes	500	650

7.6 Other attributes

Limits on other concrete attributes are provided in Table 7.6.

Table 7.6 – Other concrete attributes

Attribute	Test method	Requirement
Chloride ion content	Appendix P2	0.8 kg/m³ maximum per cubic metre of concrete(1)
Sulfate ion content	Appendix P2	5% maximum relative to cement mass(1, 2)
Air content of fresh concrete (with compaction by internal vibration)(3)	Appendix P5	4.5 ± 1.5%
Bleeding (with compaction by internal vibration)(4)	AS 1012.6	3% maximum

Notes:

(1) Total content in the combined mix.

(2) Calculate the sulfate ion content relative to the cement mass (excluding supplementary cementitious materials such as fly ash and slag).

(3) Entrainment is not mandatory in fixed-form (hand placed) mixes nor in non-pavement components, such as anchors and subgrade beams. Testing is only required on entrained mixes.

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

7.7 Nominated concrete mixes

7.7.1 General

Before commencing production, conduct trial mixes to demonstrate that each nominated mix design conforms to this Technical Specification. Submit the details listed in Clause 7.7.3. **[refer to Hold Point 1]**

If the proposed slump for concrete used in transition zones is more than 10 mm greater than the nominated slump for the slipform mix, a full nominated mix submission is required for the transition zone concrete.

7.7.2 Trial batch

Trial mixing shall conform strictly with the Contractor's proposals under Clause 8.4 for batching and mixing, including the dilution and incorporation of admixtures, and the sequence of addition of materials.

The date of testing of both the trial mix and the aggregates shall be within eighteen months before the commencement of paving.

If sufficient production mix results are available from within this period, the Administrator may reduce the scope of the trial mix or waive it.

Advise the Administrator in writing of the time and location of mixing the trial batch.

Witness Point 1

Process witnessed:	Mixing of trial batch.
Submission details:	The submission of notice of time and location of mixing at least two business days before mixing.

Where it is impractical to mould all specimens from a single batch, use two batches in accordance with Appendix P1.

7.7.3 Nominated mix submission

A checklist is available to assist the Administrator in assessing the nominated mix submission(s). The checklist can be downloaded from the specifications page of the Transport and Main Roads website.

Submit, as a single submission, the following details for each nominated mix.

a) A completed verification checklist covering items listed in this clause.

b) Certification that the mix and its constituents meet the requirements of this Technical Specification.

c) NATA endorsed test results for all tests, which include certification that the specimens were prepared and tested in accordance with this Technical Specification.

d) The nominated slump for each mix.

e) Material constituents:

   i. cement: type, supplier, product name, ATIC registration number and source

   ii. supplementary cementitious materials: type, supplier, product name, ATIC registration number and source (for each)

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

   iv. chemical admixtures: proprietary source, type, name, dosage recommended by manufacturer and certification of compatibility if more than one admixture is used

   v. aggregates: source, geological type, moisture condition on which mix design is based (oven dry, saturated surface dry or nominated moisture content), Quarry Registration Certificate (including its Testing Frequency Schedule)

   vi. assessment for alkali-reactive materials, chloride ion content and sulfate ion content

   vii. relevant test results for all constituents

f) Mix design:

   i. constituent quantities, per yielded cubic metre of concrete

ii. nominated particle size distributions for aggregates, including fine, coarse and combined particle size distributions

g) Test results for a laboratory trial batch (or batches) determined at a slump which conforms to Clause 7.4:

i. constituent quantities per yielded cubic metre of concrete

ii. compressive strength at age seven days (F_7)

iii. compressive strength at age 28 days (F_{28})

iv. flexural strength at age seven days (F_{f7})

v. flexural strength at age 28 days (F_{f28})

vi. indirect tensile strength at age 28 days (F_{t28})

vii. drying shrinkage

viii. Vebe reading (for slipform mixes)

ix. air content

x. bleeding

xi. AF factors in accordance with Appendix P3. Derivation of AF is optional but, where adopted, it shall be provided as part of the nominated mix submission. For ages beyond 28 days, report the results progressively as they become available.

xii. unit mass for all compressive, flexural and tensile strength specimens.

Hold Point 1

Process held:	Production of each concrete mix.
Submission details:	Submit the information referred to in Clause 7.7.3 at least five business days before commencing production (including for the trial).
Release of Hold Point:	The Administrator will consider the submitted documents before authorising release of the Hold Point.

After release of Hold Point 1, the nominated mix becomes the authorised mix for use in the Works.

7.7.4 Variations to authorised mixes

The Contractor may vary the authorised mix without submitting a new nominated mix, unless the proposed variations exceed any of the following amounts:

a) cement and other cementitious material: 10 kg/m³ for each material, subject to the requirements of Clause 7.2 being met

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

c) admixture dosages as required, subject to conformity with Clause 6.3

d) water, unspecified.

Notify the Administrator in writing of such variations to an authorised mix before commencing production with the varied quantities.

Milestone

Submission details:	Notification of variations to authorised mix.

If the Contractor wishes 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, submit a new nominated mix in accordance with Clauses 7.7.1 to 7.7.3.

8 Process control

8.1 General

Construct the Works in accordance with the Drawings.

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

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

In SFCP, mesh reinforcement is only used in special slabs, in anchors and in joints (as tiebars and dowels). All slabs contain steel fibre reinforcement, longitudinal joints are typically tied, and transverse joints are not dowelled.

Refer to RMS standard rigid pavement drawings (MD.R83.CP, MD.R83.CJ and MD.R83.CC) for further guidance.

8.2 Survey to determine base invert level

Before placing steel reinforcement and/or the base concrete, determine the base invert level as detailed in Appendix D.

Submit a Survey Report conforming to the Transport and Main Roads Surveying Standards and highlighting all locations where the actual base invert level is higher than the contract level.

Milestone

Submission details:	Survey report comparing actual and contract base invert levels.

Apply Hold Point 2 to base paving if any high levels exist.

Hold Point 2

Process held:	Paving of base, if high invert levels exist.
Submission details:	Schedule of base invert levels and relevant nonconformity report.
Release of Hold Point:	The Administrator will consider the submitted documents before authorising release of the Hold Point.

In the case of nonconforming levels which are high, the Contractor may locally redesign the pavement levels in accordance with Appendix D and submit the redesign to the Administrator for consideration in releasing Hold Point 2.

In the case of low base invert levels, redesign to lower levels will typically not be allowed.

8.3 Placing steel reinforcement

Place steel reinforcement in accordance with Appendix E.

Hold Point 3

Process held:	Placement of concrete around steel reinforcement.
Submission details:	A certificate of compliance signed by the Contractor covering the installation of reinforcement and embedments.
Release of Hold Point:	The Administrator will consider the submitted documents and may inspect the work before authorising release of the Hold Point.

For tiebars which have been inserted (instead of pre-placement) into a formed slab edge (either slipformed or fixed-formed), test for anchorage strength (pull-out testing) in accordance with Appendix E.

Pull-out testing is not required in fixed-form paving if the tiebars are pre-placed and are subjected to internal vibration.

For tiebars which have been inserted (instead of pre-placement) at induced joints, test for location and compaction conformity in accordance with Appendix E.

If a nonconformity is detected at any stage, a hold point applies in accordance with Clause 9.2.2. **[refer to Hold Point 9]**

For tiebars which are located below sawn joints (such as joints type 1), test for vertical cover in accordance with Appendix E. This testing requirement also applies to any steel bar and mesh which is required to function as a tiebar (such as in type 17 joints).

Where dowels are to be used, submit details of the proposed dowel support system and the method of debonding dowels as part of the Construction Procedures. Conduct dowel pull-out testing in accordance with Appendix E.

Confirm the location of reinforcement and dowels within the finished pavement using a metal detector. Do not take cores for this purpose except as required for tiebars in Appendix E or unless approved by the Administrator.

8.4 Production and transport of concrete

The production and transport of concrete shall:

a) prevent segregation or loss of materials

b) supply a homogeneous product

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

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

8.4.1 Production mixes

Always target the authorised mix.

Maintain and monitor a batching record which records the actual masses of each ingredient in every batch, together with departures beyond the allowable tolerances in AS 1379. Do not incorporate nonconforming batches or loads into the Works.

The total batch water, including water contained in the aggregates, shall be within ± 15% of the authorised mix.

In addition, the combined aggregate particle size distribution, determined by the following methods, shall comply with Table 8.4.1:

a) Test Method A – by calculation:

   Determine a separate particle size distribution for each constituent aggregate (AS 1141.11.1), and calculate the combined particle size distribution from the authorised mix proportions.

b) Test Method B – by wet-sieving:

   Determine the combined particle size distribution by wet-sieving of the production mix (RMS T329) for the fractions coarser than the 1.18 mm test sieve.

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

Table 8.4.1 – Concrete production tolerances for combined aggregate particle size distribution

Test sieve (mm)	Tolerance (% by mass)
19.00	± 2
13.20	± 5
9.50	± 5
4.75	± 3
2.36	± 5
1.18	± 5
0.600	± 5
0.300	± 5
0.150	± 2
0.075	± 0.5%

For the purpose of this clause, concrete which is mixed (distinction is intended between the terms "mixed" and "transported") in a mobile mixer is deemed to be of a different mix to that which is mixed in a wet-batch plant.

8.4.1.1 Process control charts

Develop process control charts in accordance with Appendix F for the following:

a) seven day compressive strength

b) 28 day flexural strength

c) cylinder unit mass, and

d) fraction passing 0.075 mm test sieve.

Analysis is to be generally in accordance with Section 5 of AS 3942, except that the decision rules shown in Table F.2 shall be followed for the identification of assignable causes that require corrective action.

Take corrective action also regarding the Contractor's system if:

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

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

Hold Point 4 applies on the use of the relevant concrete mix if:

a) the rolling mean seven day compressive strength falls below the specified minimum (refer Clause 8.4.1.2), or

b) the rolling mean 28 day flexural strength falls below the specified minimum (refer Clause 8.4.1.3), or

c) corrective action is not promptly implemented.

Hold Point 4

Process held:	Use of a concrete mix in a pavement base.
Submission details:	a) Results for compressive and flexural strength, relative compaction and thickness for the same sublot. b) Proposal for corrective action to achieve conformity.
Release of Hold Point:	The Administrator will consider the submitted documents and will release the Hold Point when appropriate Corrective Action has been implemented.

Following release of Hold Point 4, monitor the seven day strength and submit the results to the Administrator with an assessment report within two business days of testing.

8.4.1.2 Assessment of seven day compressive strength

Undertake seven day compressive strength testing (as per Appendix P3) at the same frequency as specified for 28 day compressive testing in accordance with Clause 9.3.1.

The seven day compressive strength requirements will be met if the five-point rolling mean compressive strength is not less than the lower warning limit (LWL), calculated in accordance with Appendix F.

The seven day compressive strength target value shall not be less than $2s_{30}$ above the lower warning limit.

Whenever the seven day compressive strength requirements are not met, submit the results to the Administrator with an assessment report and an assignable cause within two business days of testing.

8.4.1.3 Assessment of 28 day flexural strength

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

Undertake 28 day flexural strength testing in accordance with Appendix P3.

Make a statistical check of the flexural strength of each nominated pavement mix using consecutive 28 day test results.

Calculate the five-point rolling mean for flexural strength and standard deviation for each group.

Assess the results in accordance with Table F.2. Promptly implement corrective action if:

a) 28 day rolling mean flexural strength is less than f_{fMin}, and/or

b) 28 day rolling coefficient of variation is greater than 11.0%.

Apply Hold Point 4 if the 28 day rolling mean flexural strength is less than 0.95 f_{fMin}.

Submit test results to the Administrator within two business days of testing.

Report unit mass results for flexure specimens regularly to the Administrator, but do not use the results in the calculation of the RCUM.

8.4.2 Mixing, transport, consistence and air content

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

a) Do not use aggregates in the Works which have become intermixed or contaminated with foreign matter.

b) Weigh cementitious materials separately from each other.

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

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

See Appendix A for definitions of the terms "batch", “completion of batching”, "load" and for mixer types.

e) Additionally:

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

   ii. For mobile batch mixers: a "batch" is deemed to be the same as a "load". A load shall not comprise more than a single batch.

      - After the completion of batching, discharge the entire batch of concrete from the mixer before any further charging takes place, with the exception of conforming retempering.

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

Detail in the Construction Procedures the proposed methods of handling, storage and batching of materials, and the method of charging the mixer, including the proposed sequence of addition of ingredients. The method and sequence of charging shall be consistent with the recommendations of the suppliers of mix additives.

8.4.2.1 Mixer uniformity testing and mixing time

Undertake mixer uniformity testing in accordance with Appendix G on all central batch mixers and continuous mixers.

Hold Point 5

Process held:	Paving of base (including the Paving Trial).
Submission details:	Results that demonstrate conformity of mixer uniformity, except for CoV_C and $CoV_{MUV,}$ which results will be assessed at a maximum of eight calendar days after the uniformity assessment.
Release of Hold Point:	The Administrator will consider the submitted results, before authorising the release of Hold Point, within two business days of receipt of the results.

Mix the concrete for the required mixing time.

> The term "mixing time" is applicable to batch mixers only. It comprises only that mixing carried out at the specified mixing rate (i.e. excluding agitation).

The minimum mixing time (MT_{min}) is as determined from mixer uniformity testing (refer Appendix G) and the following:

a) Twin-shaft mixers:

   The mixing time after charging shall not be less than 30 seconds plus five seconds for each cubic metre (or part thereof).

b) All other stationary batch mixers:

   The mixing time after charging shall not be less than 54 seconds plus 6 seconds for each cubic metre (or part thereof).

c) Mobile batch mixers:

The mixing time shall not be less than that shown on the mixer identification plate (as required and defined by AS 1379) or 3.0 minutes, whichever is the greater.

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

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

Mixing time is measured as follows:

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

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

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

b) For mobile mixers, mixing time is measured from the time all the ingredients, including the total added water content, are in the mixing drum, until mixing ceases, or after specified revolutions. See Clause 8.4.2.6 for retempering provisions.

Concrete from the mixer uniformity test may be incorporated into the base or into associated works such as anchors, kerbs, subgrade beams or drainage structures on the condition that all concrete from the test conforms to the relevant Technical Specification and is placed in a discrete sublot which shall be removed in total if the mixer fails to meet the criteria as specified in Appendix G.

8.4.2.2 Admixture addition

a) Incorporation during initial batching

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

   i. addition into the water weigh hopper, or

   ii. direct introduction into the water feed line during water batching.

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

b) Addition of admixtures to a mobile mixer after completion of batching.

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

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

The Contractor shall detail in the Construction Procedures how admixtures will be incorporated to conform to this clause.

8.4.2.3 Batch delivery docket

Each batch of concrete shall be accompanied by an identification certificate (delivery docket) which is pre-numbered and which shall be issued sequentially in accordance with the order of batching. The certificate shall record the details required to establish the time of completion of batching.

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

Any addition of water which occurs after the completion of batching shall be in accordance with Clause 8.4.2.6

Any addition of admixture which occurs after the completion of batching shall be in accordance with Clause 8.4.2.2.

No other additions are allowed to a mixed batch before its complete discharge. Do not incorporate recycled concrete into the Works.

Detail in the Construction Procedures how the identification certificate will be monitored for compliance with the requirements of this Technical Specification.

8.4.2.4 Production and transport capacity

For slipform paving, provide sufficient production and transport capacity to enable continuous paving.

8.4.2.5 Consistence (slump)

Test the consistence of concrete by the slump test in accordance with AS 1012.3.1. Sample in accordance with Appendix P6.

Test within 40 minutes of the completion of batching.

The slump shall be within the following limits from the nominated slump:

a) nominated slump < 60: ± 10 mm

b) nominated slump ≥ 60: ± 15 mm.

Record all slump test results, whether conforming or otherwise.

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

Do not incorporate concrete into the Works which is nonconforming in relation to consistence.

If the result from the repeat test falls outside the specified limits:

- For concrete delivered by mobile mixer, 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 within the conditions stated in Clause 8.4.2.6.
- For concrete delivered by tippers, the concrete is deemed to be nonconforming.

8.4.2.6 Retempering

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

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

a) Retempering is allowed only within 40 minutes of the completion of batching.

b) Retempering is allowed only in the presence of the Contractor's representative who has been previously nominated to the Administrator for this purpose.

c) Retempering is only allowed at the batch plant, the testing station, or the point of placement.

d) Immediately after retempering, the Contractor must re-mix the batch at the designated mixing speed for not fewer than 30 revolutions or for such additional time as may be necessary to re-establish uniformity of the mix, except that if assurance is not available regarding the original mixing for 55 revolutions, re-mix the retempered batch for not fewer than 55 revolutions.

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 with Clause 8.4.2.5.

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.

Do not use nonconforming concrete in the Works.

Detail in the Construction Procedures how concrete supply will be monitored for compliance with these retempering provisions.

8.4.2.7 Forming time

Determine a maximum forming time (as defined in Appendix A) for each nominated mix in order to achieve the requirements of Clauses 8.4(c) with consideration of the prevailing weather conditions and concrete temperature.

Monitor the actual forming time and record it for any load exceeding:

a) 90 minutes for air temperatures less than 30ºC

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

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

Include the procedure to determine the maximum forming time in the Construction Procedures.

8.4.2.8 Air content

For mixes that contain an air-entraining agent, test the air content in accordance with Appendix P5 for conformity with Clause 7.6.

Test daily at the following minimum frequency:

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

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

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

Testing under '(b)' and '(c)' shall be on loads of concrete from which cylinders are moulded for 28 day compressive strength under Clause 9.3.

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

The frequency reverts to '(a)' if a nonconforming result is obtained at any stage of testing.

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

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

8.4.2.9 Transport of mixes for fixed-form paving

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

8.5 Paving concrete

8.5.1 General

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

Where practicable, carry out paving by the slipform method using equipment in accordance with this Technical Specification.

Program the paving operations to optimise the ride quality and construction standards of the finished pavement in accordance with this Technical Specification.

Submit details of the equipment and methods to be used for placing, spreading and finishing the concrete base as part of the Construction Procedures.

8.5.2 Concrete paving trials

Before routine concrete base paving, construct a trial section of concrete base using the authorised concrete mix, equipment and methods. Undertake paving trials in accordance with Appendix H.

Give the Administrator a minimum of five business days written notice of the intention to commence:

a) the paving trial, and

b) construction of the concrete base on any section of work.

Provide a written report with the seven day test results which compares all results from the paving trial with those from the laboratory trial mix. Provide the details listed in Table H.2 and a table which shows, as a minimum, the information contained in Table H.3. Also provide an assessment of the

consistency between the mixes in the laboratory trial and the paving trial. Include comment on any notable inconsistencies and any consequential risks.

Hold Point 6

Process held:	Base paving subject to the trial.
Submission details:	Submission of checklists, test results (as listed in Table H.3), requirements of Table H.2 and concrete pavement training records (in accordance with Clause 5.3).
Release of Hold Point:	The Administrator will inspect the trial and consider the submitted documents within five business days of receipt, before authorising the release of the Hold Point.

8.5.3 Placing and paving operations

For slipform paving, comply with Clause J.1. For fixed-form paving, comply with Clause J.2.

Ensure that the subbase at the time of base paving is clean and free of loose or foreign matter including sealing aggregate and that it is not holding ponded water.

Where the subbase is LCS, it shall be treated with debonding agent in accordance with MRTS39 *Lean Mix Concrete Sub-base for Pavements*.

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

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

Place, pave and finish concrete so as to:

a) prevent segregation or loss of materials

b) prevent premature stiffening

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

d) expel entrapped air and closely surround all reinforcement and embedment

e) provide the specified thickness and surface finish.

Bleed water shall not form in sufficient quantity to flow over the slab edge.

Maintain records showing the location of each load of concrete in the finished work in accordance with the provisions for traceability in MRTS50 *Specific Quality System Requirements*. The method of traceability shall be sufficiently accurate to enable subsequent identification of specific loads for examination and/or testing. Submit details of the method of traceability as part of the Quality Plan.

8.5.4 Transition zones

For transition zones, provide the following information in the Construction Procedures:

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

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

c) the size and number of manual vibrators

d) the spacing and duration of vibrator insertions

e) the method of side forming to prevent edge slump

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

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

8.5.5 Temperature

a) Concrete temperature

Measure and record the concrete temperature at the point of placement.

Do not place concrete in the Works if its temperature at the point of discharge from transport vehicles is less than 10ºC or more than 32ºC, except that when the diurnal air temperature changes are greater than or equal to 20ºC, the upper limit of temperature of concrete to be placed in the Works is 30ºC.

b) Air temperature

Measure and record the air temperature outdoors in the shade at the paving site but remote from artificial influences such as machinery.

Monitor the air temperature at intervals not exceeding 30 minutes. Unless agreed otherwise with the Administrator, cease concrete batching when the air temperature reaches 32ºC and is rising.

Do not place concrete in the Works when the air temperature is below 5ºC or above 35ºC.

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 combined with strong dry winds. Precautions may include:

a) At the mixer:

i. shading or irrigating aggregate stockpiles

ii. painting water tanks white

iii. insulating or burying delivery lines, and

iv. chilling the water.

b) At the site

i. cooling the formwork by dampening with water sprays

ii. applying curing compound as early as possible

iii. erecting wind breaks, and

iv. minimising the time for placing and finishing.

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.

8.5.6 Prevention of moisture loss

Detail in the Construction Procedures what meteorological or other data will be collected, how such data will be used and what measures will be taken to restrict the evaporation of water from the concrete surface and to prevent the incidence of plastic shrinkage cracking.

A guide for assessing the rate of evaporation is provided in Appendix J.

If the Contractor chooses to use an evaporation retarder to restrict the evaporation of water, apply it as a fine uniform spray. Carry out any subsequent finishing operations in a way which does not incorporate the evaporation retarder into the surface mortar.

Regularly inspect the plastic concrete to monitor the effectiveness of the adopted procedures.

8.5.7 Texturing of surface

Unless specified otherwise in Clause 1 of Annexure MRTS40.1, texture the surface by both a hessian drag and tining, except that:

a) tining is not required beneath a bituminous surfacing unless specified otherwise in Clause 1 of Annexure MRTS40.1, and

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

Detail as part of the Construction Procedures the procedures and equipment proposed to complete the surface texture.

Produce an average texture depth as given in Table 8.5.7.

Table 8.5.7 – Specified average texture depths

Type	Description	Average texture depth[1]	Test method
1	Hessian drag[2] with no tining or grooving[3]	0.40 mm ± 0.05 mm[3]	RMS T192
		or, alternatively, 0.55 mm ± 0.05 mm[3]	AG:PT/T250[6]
2	Transverse tining[4]	0.60 mm ± 0.10 mm	RMS T192[5]
		or, alternatively, 0.9 mm (-0.30, + 0.20)	AG:PT/T250[6]
3	Longitudinal tining[4]	0.65 mm ± 0.15 mm	RMS T192[5]
		or, alternatively, 0.80 mm ± 0.20 mm	AG:PT/T250[6]
4	Diamond grinding[4]	Minimum 0.65 mm	RMS T192[5]

Notes:

[1] Note that these are average depths over the area of test and are not actual depths.

[2] An alternative to a hessian drag is light brooming which is done to resemble a hessian drag. It may be longitudinal or transverse unless otherwise specified in Clause 1 of Annexure MRTS40.1.

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

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

(5) When testing to T192 for tining, grinding and/or grooving, test orthogonal to the direction of texturing and for a minimum length of 7 m.

(6) For sand patch testing, prepare the surface in accordance with Appendix P8.

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

Areas with less than the specified texture shall be treated with saw-grooving in accordance with Clause 8.5.7.3 or with diamond grinding in accordance with Clause 9.7.

8.5.7.1 Hessian drag and brooming (initial texturing)

Use a hessian drag or broom to produce initial texturing. Adjust the length of the drag or broom type to produce the specified texture. Maintain or replace the equipment as required to produce a uniform consistent texture.

8.5.7.2 Tining

As soon as possible after paving or initial texturing (where specified), apply additional texture to the surface of the freshly placed concrete in accordance with Clause 1 of Annexure MRTS40.1 and by means of a mechanical device for tining plastic concrete.

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

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

a) Transverse tining

For transverse tining, space the tines at a random spacing of between 10 mm and 21 mm, with a mean spacing between 13 mm and 14 mm.

A typical random pattern is shown below:

Tine spacing in mm:	10	14	16	11	10	13	15	16	11	10	21	13	10

The width of the texturing comb shall be at least 750 mm.

Texture at 90º to the direction of linemarking.

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

b) Longitudinal tining

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

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

8.5.7.3 Sawcut grooves

Sawcut grooves shall:

a) be 3 mm wide and 3 mm deep

b) be at a random spacing pattern

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

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

e) be aligned parallel with the tining unless otherwise specified in Clause 1 of Annexure MRTS40.1.

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

8.5.8 Curing

Cure the base and all other structural concrete members, including anchors, kerbs and gutters, in accordance with Appendix J.

Maintain the curing membrane intact in a continuous and unbroken membrane for seven calendar days or until an insitu concrete strength of 25 MPa is achieved, whichever occurs first. Assess the insitu strength (if required) by methods as stated in Clause 8.5.9.4.

Test the first delivery and all subsequent deliveries of curing compound in accordance with Appendix C2. On the basis of these results, provide written certification (accompanied by the test results) that the first delivered batch has the same formulation as that of the reference sample, and that each subsequent delivered batch has the same formulation as that of the first delivery.

Milestone

Submission details:	Report(s) certifying curing compound conformance and NATA endorsed test results.

8.5.9 Protection of work

8.5.9.1 Temperature

If the temperature at the site is forecast by the Bureau of Meteorology (www.bom.gov.au) to fall below 10ºC within 24 hours of paving, record continuous surface temperatures for the first 24 hours after paving to ensure that the temperature of the concrete does not fall below 5ºC. Measure the true surface temperature at two or more locations within each day's paving using purpose-made surface thermometers.

Detail as part of the Construction Procedures the procedures and equipment proposed for the protection of concrete from low air temperatures. Failure to maintain the temperature of the concrete at or above 5ºC constitutes a nonconformity.

The Contractor shall obtain written agreement from the Administrator for the use of subbase protective covers prior to their use.

8.5.9.2 Rain

Do not place concrete in the Works during rain or when rain appears imminent.

Protect the concrete from rain damage. Detail as part of the Construction Procedures the procedures and equipment proposed to protect the concrete from rain damage. Keep the protective equipment on site ready for use at short notice by experienced personnel.

Concrete is nonconforming if:

a) during transport in tippers, it is exposed to rain which creates puddles, or

b) it is exposed on the ground after discharge in a way which creates puddles which will be incorporated into the slab during spreading or paving, or

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

d) Beyond this time, rain-exposed surfaces shall be assessed under the finished surface criteria.

8.5.9.3 Anchor slabs

Regardless of temperature levels, the base above anchors shall be thermally protected for a minimum of 24 hours after placement. The covering shall include vertical edges and shall extend at least 5 metres over adjoining base slab which was cast at the same time. The covers shall be adequately fastened around all edges to prevent air flow under them.

8.5.9.4 Trafficking of the base

Monitor and strictly minimise trafficking of the base (including foot traffic) according to the insitu concrete strength and to minimise damage to the curing compound. Do not allow access to non-essential traffic until an insitu compressive strength of 20 MPa is reached.

Control essential traffic as follows:

a) Do not allow steel implements, such as grader blades and loader buckets, to impact joints or edges of the base.

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

c) Do not allow access to other vehicles until 20 MPa compressive strength is reached and all joints have been permanently sealed, and then the following limits apply:

   i. axle group loads:

      - single: 5.0 t
      - tandem: 8.0 t total
      - triaxle: 9.0 t total

   ii. tracked vehicles:

      - 15 t/m² pressure over the track area, with the concrete protected from surface damage.

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

Hold Point 7

Process held:	Trafficking of base – 20 MPa level.
Submission details:	Insitu strength test results of the base.
Release of Hold Point:	The Administrator will consider the submitted results within two business days of receipt of the results before authorising release of the Hold Point.

e) Higher axle loadings, limited in accordance with Road Transport Regulations, may be applied after 25 MPa compressive strength is reached and all joints have been permanently sealed.

Hold Point 8

Process held:	Trafficking of base – 25 MPa level.
Submission details:	Insitu strength test results of the base.
Release of Hold Point:	The Administrator will consider the submitted results within two business days of receipt of the results before authorising release of the Hold Point.

For trafficking purposes, assess the insitu concrete strength using cylinders which have been moulded for the purpose of Clause 8.4.1.2.

Alternatively, trafficking strength may be assessed from the cores taken for assessment of compaction under Clause 9.2. Use the procedure detailed in Appendix P3.

Rectify any damage caused to any part of the work by the Contractor's operations in a way which produces a dense, homogeneous concrete base with the specified surface finish and texture.

Failure to comply with this clause constitutes a nonconformity on the base concrete.

8.6 Joints and edges

Construct and test joints and edges in accordance with the detailed design drawings and Appendix K.

Witness Point 2

Process witnessed:	Testing of joints and silicone sealants.
Submission details:	The submission of notice of time and location of test at least two business days before testing.

Certify by written report (accompanied by the test results) for each production batch of joint sealant that the sealant conforms to this Technical Specification.

The Contractor is responsible for ensuring that saw cutting of joints is undertaken in a timely manner to prevent unplanned cracking. Refer to Appendix K for specific requirements.

Milestone

Submission details:	Report certifying conformance of each production batch of sealant and relevant test results at least two business days before use of the sealant.

8.7 Kerb and gutter

Construct kerb and gutter in accordance with Appendix L.

8.8 Traffic islands and medians

Do not use sand as a backfill in any location directly abutting the concrete base.

Place a geotextile where shown in the Drawings to prevent the ingress of fines into joints.

Under concrete cappings in traffic islands and medians, only use material which conforms to the requirements for Type 2.3 material in MRTS05 *Unbound Pavements*.

8.9 Slab anchors

Construct slab anchors as shown on the Drawings, and in accordance with the following:

In jointed base:

a) In jointed base:
   i. a Type 12 or 18 is provided at bridge approaches
   ii. a Type 6 or 12 is provided at flexible pavement transverse interfaces
   iii. a Type 12 is provided on steep grades at locations shown on the Drawings.

b) In CRCP base:
   i. multiple Type 12 anchors are provided at bridge approaches and at flexible pavement transverse interfaces
   ii. anchors may be provided at other CRCP slab transitions as shown in the Drawings
   iii. anchors are not provided within continuous lengths of CRCP regardless of the grade

c) Cast the anchor at least 24 hours before the overlying base slab.

d) Trim the trench to neat lines, free of loose soil material, and compact the bottom to at least match the adjacent undisturbed material.

e) Concrete shall conform either with this Technical Specification or with AS 1379 for normal class concrete with strength grade N32 and 20 mm aggregate, and slump at the point of placement between 40 mm and 80 mm.

f) Place and compact the concrete using internal vibration in accordance with Clause J.2

g) Anchor stirrups shall be lapped (as defined) to the base reinforcement.

h) At the junction with an existing flexible pavement, make a straight sawcut to the full depth of any asphalt in the flexible pavement along the joint line. Excavation of the trench shall then take place without disturbance or damage to the existing flexible pavement. Any disturbance or damage to the flexible pavement shall be made good.

Drainage of the interface between flexible and rigid pavements shall be as shown on the Drawings.

Detail in the Construction Procedures how the Contractor will pave over anchors without damaging the stirrup reinforcement.

8.10 Special slabs

8.10.1 Odd-shaped and mismatched slabs

Odd-shaped and mismatched slabs shall:

a) Be reinforced if and as shown on the Drawings.

b) If not shown on the Drawings, be reinforced with SL82 reinforcing fabric, unless transverse construction joints are responsible for the odd shape or mismatch.

c) Be marked by imprint into the surface at the slab edge with the letter “R”, except for anchor slabs which shall be marked in accordance with Clause 8.10.2. The imprint shall be to a depth of 4 mm ± 1 mm below the circular surround.

Omit any stamp that will be covered by an asphalt surfacing.

8.10.2 Anchor slabs

Construct terminal anchor slabs adjoining bridge approach slabs and at changes from rigid to flexible pavement.

Reinforce anchor slabs, as shown on the Drawings, and mark their presence by imprinting the letter “A” into the surface at the slab edge. Place the imprint above the anchor centreline and within 0.5 m of each end of the anchor in a relatively low trafficked area. The imprint shall be to a depth of 4 mm ± 1mm below the circular surround.

Omit any stamp that will be covered by an asphalt surfacing.

9 End product criteria

A sublot is as defined in Appendix A.

9.1 Concrete cracking

Detail in the Quality Plan the inspection schedule for cracking in base slabs.

Cracking is categorised as follows:

a) In jointed bases:

i. Plastic shrinkage cracks:

Discrete cracks of length less than 500 mm and of depth less than 50% of the base thickness which form during the plastic stage and which do not intersect a longitudinal edge or a formed joint.

ii. Drying shrinkage cracks in mesh-reinforced slabs (PCP-R, SFCP-R and JRCP):

Occurring in the central part of the slab, extending full depth and continuous between joints and/or edges. Restraint cracks over anchors are included in this category.

iii. Unplanned structural cracks:

All other cracks, including drying shrinkage cracks in unreinforced slabs.

Slabs will be accepted as conforming according to the following criteria:

- PCP and SFCP slabs: if they contain only plastic shrinkage cracks with a cumulative length of 1.0 m or less in any slab.
- PCP-R, SFCP-R and JRCP slabs: if they contain only plastic shrinkage cracks with a cumulative length of 1.0 m or less in any slab, and drying shrinkage cracks.

Remove and replace all other cracked slabs in accordance with Clause 9.6.

b) In CRCP base:

i. Plastic shrinkage cracks:

Discrete cracks of length less than 500 mm and of depth less than 50% of the base thickness which form during the plastic stage and which do not intersect a longitudinal edge or a formed joint (that is, not an induced joint).

ii. Planned cracks other than induced joints:

Full depth discrete transverse cracks over the full width between longitudinal formed joints or edges. These cracks do not require any treatment. Cracks which divide into two or more braches (for example, Y-cracks) are not discrete.

iii. Restraint cracks over anchors:

Full-depth cracks of a nature that is consistent with restraint (against curling) from the underlying anchor.

Plastic shrinkage cracks with a cumulative length of 1.0 m or less in any 5 m x 5 m square area of base shall be filled with a suitable low viscosity penetrating epoxy resin, within seven calendar days of casting of the concrete. The epoxy resin shall not extend laterally by more than 15 mm beyond the edge of the crack nor completely fill the tining.

Planned cracks forming induced longitudinal joints shall be treated in accordance with Appendix K.

Any cracking beyond that listed above will render that concrete nonconforming.

Within four business days of paving, report in writing to the Administrator all nonconforming cracking and scaled crack maps of all nonconforming cracking, including the Contractor's assessment of the factors likely to have contributed to the unplanned cracking.

The Administrator should consider the Contractor's report, and also make their own determination of the factors likely to have contributed to the unplanned cracking. Such factors should be taken into account in relation to the implementation of corrective action.

9.2 Concrete compaction

9.2.1 Conformity for compaction

A sublot conforms for compaction if:

a) Fixed form paving: It has been internally vibrated by a planned and systematic procedure, followed by a minimum of two passes of a vibrating screed, all in accordance with Clause J.2, and any disturbed areas (such as workers' footprints) in the compacted mix have been reinstated in accordance with Clause J.2, and

Slipformed paving: It has been internally vibrated by a planned and systematic procedure in accordance with Clause J.1, and

b) Vibration was undertaken in such a way as to limit lateral spreading of the mix, and

c) The relative compaction is at least 98.0%, determined in accordance with Appendix P7, as the percentage ratio of the core unit mass of the sublot to the RCUM for the sublot.

Refer to Appendix P7 for testing requirements.

Sublots which do not conform to sub-clauses '(a)' and '(b)' will not be assessed under sub-clause '(c)', and they shall be removed and replaced in accordance with Clause 9.6.

Sublots which conform to sub-clauses '(a)' and '(b)' but which do not conform to sub-clause '(c)' shall be assessed as follows:

i. If the relative compaction is between 97.0% and 98.0%, take cores in accordance with Clause 9.3 and assess the sublot in accordance with Clause 9.3.2.2 on the basis of the 28 day core compressive strength.

ii. If the relative compaction is less than 97.0%, the sublot shall be removed and replaced in accordance with Clause 9.6.

9.2.2 Conformity for within-core variability

Determine within-core variability in accordance with Appendix P7. Proceed as follows:

a) If the within-core variability is between 25 and 40 kg/m³ and/or the relative compaction of either specimen from a divided core is between 97.0 and 97.9%, initiate corrective action before commencement of the next day's paving. The Administrator may, at their discretion, impose Hold Point 9 if the corrective action is insufficient in making satisfactory process improvements.

b) If the with-in core variability is greater than 40 kg/m³ and/or the relative compaction of each specimen is less than 97.0%, Hold Point 9 applies.

Hold Point 9

Process Held:	Slipform paving
Submission details:	a) All test results for compaction from the past five sublots and within-core variability from the past five tests. b) Proposal for Corrective Action to achieve conformity.
Release of Hold Point:	The Administrator will consider the submitted documents and release the Hold Point when appropriate Corrective Action has been implemented.

Following release of Hold Point 9, continue to monitor the cores at the point of extraction and submit an assessment report to the Administrator within three paving days of the resumption.

9.2.3 Conformity for compaction for transition zones

For the purpose of compaction testing, treat Transition Zones as separate sublots of work according to the following rules:

a) At each transverse construction joint in slipformed work, generate one discrete Transition Zone on each side of the joint, each for a length of 3 m or as otherwise nominated under Clause 8.5.4(b).

b) Where a transition point (as defined) is remote from a transverse construction joint, treat the transition point as if it were a joint. That is, generate two transition sublots as in '(a)'.

9.3 Concrete compressive strength

9.3.1 General

For each sublot of base, mould two pairs of cylinder test specimens for compressive strength testing—one pair at seven days and the other pair at 28 days. Seven day testing is covered by Clause 8.4.1.2.

Determine the compressive strength of each pair of cylinders in accordance with Appendix P3.

Where core strength testing is required (for example, to assess strength for trafficking or for non-conforming compaction under Clause 9.2.1), refer to Appendix P3.

9.3.2 Conformity for compressive strength

9.3.2.1 Test cylinders

Assess the concrete within the following discrete categories:

a) slipformed

b) fixed-formed.

If the 28 day compressive strength of test cylinders for any sublot is less than $0.9f_{cMin}$, remove and replace the sublot represented by the test cylinders in accordance with Clause 9.6.

Concrete with 28 day cylinder strength between $0.9f_{cMin}$ and f_{cMin} occurring during progress of the Contract is nonconforming but may be accepted by the Administrator at a reduced level of service, typically only if it represents less than 5% of the area of the applicable base category placed up to and including that sublot.

9.3.2.2 Cores

Where required, to be tested in accordance with Clause 9.2.1(i), the sublot will conform for core strength if the corrected strength is greater than or equal to f_{cMin} for all core specimens from that sublot.

Where this criterion is not met, the sublot is nonconforming but may be accepted by the Administrator at a reduced level of service, typically only if:

a) the mean of all corrected core strength results from the sublot is greater than or equal to f_{cMin}

b) no result is less than 0.9 f_{cMin}

c) the total area of such a sublot is less than 5% of the area of the applicable base category placed up to and including that sublot

d) the deficiency in strength is based on the lowest corrected core strength result from that sublot.

Nonconforming sublots, unless accepted by the Administrator, shall be removed and replaced in accordance with Clause 9.6.

9.4 Geometry and thickness

9.4.1 Horizontal alignment

Within four business days of placing an area of concrete base, survey the alignment and inspect each joint for conformity. Tolerances on horizontal alignment are given in Appendix K for the outer edges of the base and for joints.

If a nonconformity is detected, immediately implement corrective action in accordance with the requirements of MRTS50 *Specific Quality System Requirements*.

9.4.2 Level survey and thickness assessment

Within four business days of placing an area of concrete base, carry out a survey in accordance with Appendix D to determine conformity of the base surface level and thickness.

Assess the base surface levels for conformity on the basis of individual survey points. The level at any point on the top of the base shall not vary by more than 20 mm above or 5 mm below the contract level.

Determine thickness of the base and assess sublots for thickness conformity in accordance with Appendix D.

Milestone

Submission details	Survey data and assessment of levels and thicknesses, including nonconformity report where relevant.

9.5 Surface profile

9.5.1 Transverse profile

Within two business days of paving, test surface deviations in a transverse direction under a 3 m straight edge in accordance with Appendix P9.

Deviations shall not exceed 5 mm, except for areas within 10 m of superelevation transitions where deviations shall not exceed 3 mm.

9.5.2 Longitudinal profile

Within two business days of paving, test the longitudinal profile in accordance with Appendix P9.

The requirements for surface correction are as follows:

a) grind areas with high deviations under a 3 m straightedge that exceed 5 mm

b) grind areas which are high by 20 mm or more

c) grinding may be carried out at the Contractor's discretion for areas which are high by less than 20 mm.

Carry out grinding in accordance with Clause 9.7.

9.5.3 Ride quality

Test and report the ride quality of the finished surface in accordance with Appendix P10. Assess the roughness according to Table 9.5.3.

Table 9.5.3 – Maximum roughness

PRC of pavement section([1])	Maximum roughness (m/km)([2])	Grinding limit roughness (m/km)([3])
1	1.70	2.90
2	1.90	3.30
3	2.10	3.30
4	2.50	3.50
5	2.70	N/A

Notes:

([1]) Pavement roughness category as defined in Appendix P10.

([2]) Segments with roughness exceeding the values in this column are nonconforming.

([3]) Grind segments with roughness exceeding the values in this column.

Milestone

Submission details	Report results from profile testing and ride quality testing, including identification of nonconforming areas and areas to be ground.

9.6 Removal and replacement of concrete base

Where nonconforming base is to be removed and replaced, submit the proposed method with the nonconformity report at least five business days before the work is expected to commence. The proposal shall include precautions to prevent damage to the adjoining base and the underlying subbase.

Remove and replace concrete base in accordance with Appendix M.

Hold Point 10

Process held:	Removal and replacement of concrete base.
Submission details:	A nonconformity report for each location with the proposed method and precautions to prevent damage.
Release of Hold Point:	The Administrator will consider the submitted documents before authorising release of the Hold Point.

9.7 Rectification of finished surface and ride quality

Areas requiring surface rectification shall be diamond ground with purpose-built equipment conforming to RMS R93. Impact methods such as milling or profiling shall not be used.

Carry out the work in accordance with Appendix M.

Within seven calendar days of grinding, re-assess the surface for conformity in accordance with Clauses 9.4 and 9.5.

Restore sealants and surface texture to conform to this Technical Specification.

10 Construction compliance testing

Compliance testing shall be carried out for each lot. Compliance testing of the pavement shall include the testing of all joints relevant to the lot (as required).

The Contractor is responsible for carrying out sufficient testing to ensure compliance with the requirements of this Technical Specification and the Contract. However, the Contractor's testing program shall be such that the testing frequencies and number of tests are not less than those specified in Table 10.

The process requirements shall be checked for compliance with the stated requirements during and after the construction operations, as relevant.

Testing frequencies for the following source rock test properties shall be in accordance with Clause 8.1.1 of MRTS50 *Specific Quality System Requirements*:

- Soundness (sodium sulfate) (fine aggregate)
- MBV (fine aggregate)
- Wet strength (coarse aggregate)
- Wet / dry strength variation (coarse aggregate)
- Degradation factor (coarse aggregate)
- Weak particles (coarse aggregate)
- Particle density and water absorption (fine and coarse aggregate)
- Petrographic analysis (fine and coarse aggregate).

Table 10 – Minimum frequency of testing

Clause	Characteristic analysed	Test method	Minimum frequency of testing
			Normal / Reduced
Fine aggregate			
6.1.4	Particle size distribution (individual)	AS 1141.11.1	Refer to CCAA (2005)
6.1.4	Material passing 75 µm sieve (total fine)	AS 1141.11.1 (by washing) or AS 1141.12	Refer to CCAA (2005)
6.1.4	Material finer than 2 µm (total fine)	AS 1141.13	Refer to CCAA (2005)
6.1.4	MBV (individual)	AS 1141.66	Refer to Clause 8.1.1 of MRTS50
6.1.4	DFI (individual)	AS 1141.11.1 (by washing) and AS 1141.66	As per MBV frequency
6.1.4	Compacted bulk density (individual)	AS 1141.4	Trial mix submission(1)
6.1.4	Particle density	AS 1141.5	Refer to Clause 8.1.1 of MRTS50(2)
6.1.4	Water absorption (individual)	AS 1141.5	Refer to Clause 8.1.1 of MRTS50(2)
6.1.4	Soundness (sodium sulfate) (individual)	AS 1141.24	Refer to Clause 8.1.1 of MRTS50(2)
6.1.4	Light particles (total fine)	AS 1141.31	One per 20,000 t

Clause	Characteristic analysed	Test method	Minimum frequency of testing
			Normal / Reduced
6.1.4	Organic impurities (total fine)	AS 1141.34, and if required AS 1289.4.1.1 (see Table 6.1.4)	Refer to CCAA (2005)
6.1.4	Sugar presence (total fine)	AS 1141.35	One per 5000 t
6.1.4	Acid insoluble residue (total fine)	Tex-612-J	Trial mix submission
6.1.4	Micro-Deval abrasion loss (total fine)	ASTM D7428	Trial mix submission (if required, see Table 6.1.4)
6.1.4	Flow Cone time (total fine)	RMS T279	One per 10,000 t
6.1.4	Alkali-aggregate reactivity (individual)	See Clause 6.1.6	Trial mix submission(1)
6.1.4	Petrographic Analysis (individual)	ASTM C295	Refer to Clause 8.1.1 of MRTS50(2)
Coarse aggregate			
6.1.5	Compacted bulk density (individual)	AS 1141.4	In the trial mix
6.1.5	Particle density on a saturated-surface-dry basis (individual)	AS 1141.6.1	Refer to Clause 8.1.1 of MRTS50
6.1.5	Water absorption (individual)	AS 1141.6.1	Refer to Clause 8.1.1 of MRTS50
6.1.5	Particle size distribution (individual)	AS 1141.11.1	Refer to CCAA (2005)
6.1.5	Material passing 75 µm sieve (total coarse)	AS 1141.11.1 (by washing) or AS 1141.12	One per 5000 t
6.1.5	Material finer than 2 µm (individual)	AS 1141.13	One per 5000 t
6.1.5	Particle shape (individual)	AS 1141.14	Refer to CCAA (2005)
6.1.5	Flakiness index (individual)	AS 1141.15	Refer to CCAA (2005)
6.1.5	Wet strength (individual)	AS 1141.22	Refer to Clause 8.1.1 of MRTS50
6.1.5	Wet/dry strength variation (individual)	AS 1141.22	Refer to Clause 8.1.1 of MRTS50
6.1.5	Degradation factor (individual)	Q208B	Refer to Clause 8.1.1 of MRTS50
6.1.5	Weak particles (individual)	AS 1141.32	Refer to Clause 8.1.1 of MRTS50
6.1.5	Light particles (total coarse)	AS 1141.31	One per 20,000 t

Clause	Characteristic analysed	Test method	Minimum frequency of testing
			Normal / Reduced
6.1.5	Crushed particles (individual)	AS 1141.18	Refer to CCAA (2005) for shape
6.1.5	Foreign materials content (individual)	Q477	One per 4000 t
6.1.5	Alkali-aggregate reactivity (individual)	See Clause 6.1.6	Trial mix submission(1)
6.1.5	Petrographic Analysis (individual)	ASTM C295	Refer to Clause 8.1.1 of MRTS50
Other materials			
6.2	Cementitious materials	See Clause 6.2	Monthly
6.4, 8.5.8	Conformity of curing compound	See Appendix C2	Reference sample plus each delivery
6.5	Joint sealant	See Appendix C3	Each sealant
6.8	Water	See Appendix C5	At the trial mix and thereafter one per 5000 m³ of concrete
Placing concrete in base			
7.5	Shrinkage	AS 1012.13	Trial mix submission(1)
7.6	Chloride ion content	Appendix P2	One per 30,000 m³ of concrete
7.6	Sulfate ion content	Appendix P2	One per 30,000 m³ of concrete
7.6	Bleeding (with compaction by internal vibration)	AS 1012.6	At the trial mix
8.3	Tiebars; pull-out testing	Appendix E	Refer to Appendix E
8.3	Tiebars; location & compaction	Appendix E	Refer to Appendix E
8.3	Tiebars; concrete cover	Appendix E	Refer to Appendix E
8.3	Dowels; pull-out testing	Q474	Three dowels
8.4.1	Particle size distribution of combined aggregate by calculation	AS 1141.11.1	Refer to CCAA (2005)
8.4.1	Particle size distribution of combined aggregate by wet-sieving	RMS T329(3)	In the Paving trial and thereafter one per 1500 m³ of concrete(4)
8.4.1.2	Flexural strength	Appendix P3	Refer to Appendix P3
8.4.1	Water content		In the Paving trial and thereafter one per 500 m³ for the first 5000 m³ and thereafter one per 2500 m³.
8.4.2.5	Concrete consistence (slump)	AS 1012.3.1	Refer to Appendix P6

Clause	Characteristic analysed	Test method	Minimum frequency of testing
			Normal / Reduced
7.6, 8.4.2.8	Air content of fresh concrete (with compaction by internal vibration)	Appendix P5	Refer to Clause 8.4.2.8
8.4.2.1	Mixer Uniformity	Appendix G	Refer to Appendix G
8.5.7	Average texture depth	AG:PT/T250 or T192	One per 2000m² of base
8.5.9.4	Insitu compressive strength (cylinders) (if required for trafficking purposes)	Appendix P3	Refer to Clause 9.3.1 (as per 28 day compressive strength cylinders)
8.5.9.4	Insitu compressive strength (cores) (if required for trafficking purposes)	Appendix P3	Refer to Appendix P3
8.4.1.2	Seven day compressive strength (cylinders)	Appendix P3	Refer to Clause 8.4.1.2
8.4.1.3, 9.3.2.1	28 day compressive strength (cylinders)	Appendix P3	Refer to Clause 9.3.1
8.6, Appendix P	Joint face cleanliness	RMS T379	Refer to Appendix K
8.6, Appendix P	Sealant dimensions	Appendix K	Refer to Appendix K
8.6, Appendix P	Sealant field adhesion	RMS T380	Refer to Appendix K
9.2	Relative compaction of concrete	Appendix P7	Refer to Appendix P7
9.4.1	Horizontal alignment	Various	Refer to Clause 9.4.1
9.4.2	Surface level and thickness	Appendix D	Refer to Clause 9.4.2 and Appendix D
9.5.1	Transverse surface profile	Q712	Refer to Appendix P9
9.5.2	Longitudinal surface profile	Appendix P9	Refer to Appendix P9
9.5.3	Ride quality	Appendix P10	Refer to Appendix P10

Notes:

(1) As tested within 18 months before the commencement of paving and to be included in the trial mix submission.

(²) For materials sourced from natural sand quarries, refer to CCAA (2005).

(³) Only the + 1.18 mm fraction need be tested.

(⁴) Where a plant produces less than 1000 t/day of fine or coarse aggregate for use in the project, the minimum of one test per day is required for grading.

11 Supplementary requirements

The requirements of MRTS40 *Concrete Pavement Base* are varied by the supplementary requirements given in Clause 4 of Annexure MRTS40.1.

Appendix A: Definition of terms, abbreviations and symbols

Table A.1 – Definition of terms

Term	Definition
Agitator	An item of plant or equipment which maintains the plastic concrete in the mixed state. Consistent with common usage, this term is also used (for convenience) in lieu of mobile batch mixer.
Anchor slab	The base slab which lies over an anchor. See also 'Slab anchor'.
Approach sections	Pavement which is located within 30 m of bridges (or other structures) where the concrete base is discontinuous or within 30 m of contract limits.
Authorised mix	A nominated mix which has been authorised for use in accordance with Clause 7.7.3.
Base	The uppermost pavement structural layer.
Batch	A quantity of concrete produced in a discrete operation. See also 'Load'.
Batching	The process of combining the concrete ingredients in fixed proportions by mass or by volume, including charging and mixing.
Cement	Hydraulic cement that is manufactured by inter-grinding of portland cement clinker, calcium sulfate and optional mineral or minor constituents. If blended with supplementary constituents by the manufacturer, it is referred to as 'blended cement'.
Cementitious	Cements and supplementary cementitious materials as defined in Clause 6.2 of this Technical Specification.
Charging	~of a mixer: The introduction of ingredients at the plant, but excluding water which is added at the slump stand in order to establish the desired slump.
Co-efficient of variation	Ratio of the standard deviation of the test values to the mean of test values * 100%. The five-point rolling coefficient of variation is calculated as the ratio of the five-point rolling standard deviation to the five-point rolling mean (* 100%).
Concrete	A thoroughly mixed combination of cement, 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 commences from the mixer. 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 of 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, whichever occurs first. d) For a continuous mixer discharging into a tipper truck, this will be the time at which discharge commences into the truck.

Term	Definition
	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.
Debond / debonding	The application of a material to a surface to prevent the formation of bond.
Dowel	Or dowel bar. A round steel bar intended to allow joint opening, but to minimise relative shear displacements across the joint.
Drill-tie	A deformed tiebar which is fixed by drilling into existing concrete.
Edge, free	This term is used in the context of limiting all restraint against the free movement of joints which intersect that edge or joint. A free edge is provided by an isolation joint or by an outer edge. Untied butt joints and dowelled expansion joints do not constitute free edges.
Edge, outer (~ of base)	An edge against which material other than base concrete or kerb concrete is to be placed (such as granular backfill or no-fines concrete).
Fixed-form paving	Also referred to as 'manual' and 'hand' paving. Paving between fixed formwork and using manually operated equipment, such as internal vibrators and vibrating screeds.
Formed joint	All joints except induced joints. This includes slipformed and fixed-formed joints.
Forming time	The elapsed time measured from the completion of batching to the incorporation of the concrete into the Works, including compaction and final forming, but excluding hand finishing and texturing.
Grooving	A surface treatment to produce specified texturing in accordance with Clauses 8.5.7.3 and M.2.
Joint	A planned discontinuity in the concrete, including an edge, and which conforms to Appendix K.
Joint, mismatched	A joint which terminates at a junction with an adjoining slab. Tied joints may mismatch without restriction. Untied joints are subject to restrictions in accordance with Appendix K.
Jointed base	A group of PCP, JRCP and SFCP. In other words, all base formats covered by this document except for CRCP.
Kerb, extruded	A kerb which is paved with a machine which does not impart internal vibration and which progresses using a piston mechanism.
Kerb, slipformed	A kerb which is paved with a machine which conforms to Clause J.1.
Lap (in reinforcement)	A splice in which the bars are in contact over the full lapped length, with at least two ties located to ensure bar contact in the hardened concrete.
Load	A single truckload of material. For concrete, a load may comprise one or more batches as detailed in Clause 8.4.2.
Lot	For concrete base, a Lot is a continuous portion of end product produced within a single day at a discrete location. Concrete base will be assessed on the basis of sublots, as defined. If the Contractor chooses to define a Lot by a different method, detail the method in the Quality Plan in accordance with MRTS50. See also 'Sublot' and 'Transition sublot'.

Term	Definition
Mixers	a) Stationary mixer: A mixer in a fixed location adjacent to the batching equipment. This category includes stationary batch mixers (such as split-drums and twin-shafts) and stationary continuous mixers. b) Mobile mixer (or agitator): A truck-mounted drum mixer which is used for mixing and delivery, and possibly also agitation. This Technical Specification covers mobile batch mixers but not mobile continuous mixers. c) Batch mixer: A mixer which produces a fixed amount of concrete produced in a discrete operation. This category includes split-drums, twin shafts and "agitators". d) Continuous (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. e) See Section 4.2 of AS 1379 for further information.
Mixing time	See Clause 8.4.2.1. Applicable to batch mixers only.
Nominated mix	A mix which has been nominated for authorised use in accordance with Clause 7.7.
Odd-shaped slab	See ‘Slab, odd-shaped’
Paving run	A single length of pavement placed as one continuous pour without an interruption to paving that requires a transverse construction joint.
Process mean	$\bar{\bar{X}}$ See Table A.3
Re-entrant angle	An angle, formed by joints and/or edges, which points inwards, towards the concrete slab (for example, at a drainage pit).
Relative compaction	The percentage ratio of the core unit mass of the sublot to the representative cylinder unit mass (RCUM) for the sublot. In the case of SFCP, it is the percentage ratio of the core unit mass of the sublot to the representative beam unit mass (RBUM) for the sublot.
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.
Rolling (mean / standard deviation / coefficient of variation)	Calculated using groups of consecutive results, with progression in single increments.
Site	As defined in the Contract.
Skew, road	Applicable at locations such as bridge abutments, it is the complement of the Bridge Skew (i.e. 90º minus the Bridge Skew)
Slab	A portion of concrete bounded by joints and/or edges. In jointed pavements, tied transverse construction joints are ignored for the purpose of measuring slab length.
Slab, odd-shaped	a) A slab containing a blockout (for example, for a drainage structure), or b) A slab whose dimensional limits exceed those specified in the RMS MD.R83 Series of Drawings. If dimensions, measured normal and parallel to longitudinal joints, are variable within a slab, the maximum value of the ratio applies.

Term	Definition
Slab anchor	A restraining beam cast in the ground, on which a base slab is later cast.
Slab anchor, terminal	A slab anchor where the overlying base slab is a terminal slab.
Slab anchor, intermediate	A slab where the overlying base slab is not a terminal slab.
Slipform paving	Also referred to as mechanical and machine paving. Paving by a purpose-built machine with the capacity to spread, compact, screed and finish the concrete in accordance with Clauses 8.5.3 and J.1, and without fixed formwork. Where a slipformer is used over fixed forms, such work is deemed to conform to this definition.
Stitch-bar	A deformed reinforcing bar which is installed by angled drilling from the top surface.
Sublot	A sublot is defined as a continuous pour of volume: a) up to 50 m^3 for slipformed base, and b) up to 30 m^3 for fixed-formed base. In transition zones, generate separate sublots in accordance with Clause 9.2.3. If the Contractor chooses to define a sublot by a method that is different to '(a)' and '(b)', detail the method in the Quality Plan in accordance with MRTS50. The details shall include how the method incorporates the requirements of (a) and (b) above.
Test result	The result from a single test specimen or sample.
Test value	The value calculated from single test results to represent the sublot (in accordance with relevant clauses of this Technical Specification). For example, single cylinder compressive strength results are averaged (after application of correction factors) to derive a test value.
Tiebar	A deformed reinforcing bar intended to hold joints closed while allowing hinge movement. See also 'stitch-bar'.
Tining	A surface texture applied to the plastic concrete in accordance with Clause 8.5.7.
Total coarse aggregates (TC)	The sum of the coarse aggregates from all sources within the mix.
Total fine aggregates (TF)	The sum of the fine aggregates from all sources within the mix.
Trafficked slab	A slab (bounded by longitudinal joints and/or edges) which lies either totally or in part within the trafficked carriageway as defined by lane lines.
Transition sublot	A sublot which falls within a transition zone (as defined).
Transition zone	Hand vibrated concrete which is cast with otherwise machine-paved concrete, such as at transverse construction joints in machine-paved work.
Transition point	The point at which vibration on a paving machine commences or ceases effective compaction. Examples include: a) transition zones b) the boundary of a zone where a vibrator becomes faulty or irregular c) the boundary of a zone where the operation of the paver becomes unsystematic and/or nonconforming d) a periodic interruption to paving (due, for example, to irregular concrete supply) does not necessarily constitute a transition point.

Term	Definition
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 of freshly mixed concrete in accordance with AS 1012.5.

Table A.2 – Definition of abbreviations

Abbreviation	Definition
AF	Age correction factor
AGD	Average Greatest Dimension (of aggregate)
ALD	Average Least Dimension (of aggregate)
ASR	Alkali-silica reactivity
ATIC	Australian Technical Infrastructure Committee
CRCP	Continuously reinforced concrete pavement (base)
DFI	Deleterious fines index
GGBFS	Ground Granulated Iron Blast-Furnace Slag
JAS-ANZ	Joint Accreditation System of Australia and 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)
PCP-R	Discrete reinforced slabs within PCP (base)
PRC	Pavement roughness category
RBUM	Representative beam unit mass
RCUM	Representative cylinder unit mass
RMS	Roads and Maritime Services, New South Wales
SCM	Supplementary cementitious materials
SF	Shape correction factor
SFCP	Steel fibre reinforced concrete pavement (base)
SFCP-R	Discrete mesh-reinforced slabs of steel fibre reinforced concrete pavement (base)
SFRC	Steel fibre reinforced concrete
SSD	Saturated surface dry

Table A.3 – Definition of symbols

Symbol	Definition
F_{28Min}	The specified minimum 28 day (cylinder) compressive strength in the trial mix
F_{28}	The actual 28 day indirect tensile strength in the trial mix

Symbol	Definition
F_7	The actual seven day (cylinder) compressive strength in the trial mix
F_{f28Min}	The specified minimum 28 day flexural strength in the trial mix
F_{f7}, F_{f28}	The actual seven day and 28 day flexural strengths in the trial mix
F_{t28}	The actual 28 day indirect tensile strength in the trial mix
f_{cMin}	The specified minimum 28 day (cylinder) compressive strength in the Work
f_c	The actual 28 day (cylinder) compressive strength in the Work
f_{c7}	The actual seven day (cylinder) compressive strength in the Work
f_{fMin}	The specified minimum 28 day flexural strength in the Work
f_f	The actual 28 day flexural strength in the Work
F_{sf}	Fibre factor for steel fibre reinforcement
K_f	Steel fibre bond coefficient
MT_{min}	Minimum mixing time
SD	Standard deviation
$\bar{X}$	Process mean calculated on a rolling basis using 100 values (i.e. k = 100). Before 100 values becoming available, all available values shall be used.
s_{100}	Process standard deviation calculated on a rolling basis using 100 values (i.e. k = 100). Before 100 values becoming available, all available values shall be used.
s_{30}	Process standard deviation calculated on a rolling basis using 30 values (i.e. k = 30). Before 30 values becoming available, a value of $f_{cMin}/10$ shall be used.
s_5	Five-point rolling standard deviation
V_f	Steel fibre content (per cent volume) of a mix

Appendix B: Referenced documents and standard test methods

Table B.1 – Referenced documents

Reference	Title
AS 1379	*Specification and Supply of Concrete*
AS 1478.1	*Chemical Admixtures for Concrete, Mortar and Grout - Admixtures for Concrete*
AS 2758.1	*Aggregates and Rock for Engineering Purposes - Concrete Aggregates*
AS 2876	*Concrete Kerbs and Channels (Gutters) – Manually or Machine Placed*
AS 3582.1	*Supplementary Cementitious Materials for use with Portland and Blended Cement - Fly Ash*
AS 3582.2	*Supplementary Cementitious Materials for use with Portland and Blended Cement - Slag - Ground Granulated Iron Blast-Furnace*
AS 3600	*Concrete Structures*
AS 3679.1	*Structural Steel - Hot-rolled Bars and Sections*
AS 3799	*Liquid Membrane-forming Curing compounds for Concrete*
AS 3940	*Quality Control - Guide to the use of Control Chart Methods Including Cusum Techniques*
AS 3942	*Quality Control - Variables Charts - Guide*
AS 3972	*General Purpose and Blended Cements*
AS/NZS 4671	*Steel Reinforcing Materials*
AS/NZS 2310	*Glossary of Paint and Painting Terms*
AS/NZS 4680	*Hot-dip Galvanized (Zinc) Coatings on Fabricated Ferrous Articles*
AS/NZS ISO 9001	*Quality Management Systems - Requirements*
ATIC-SPEC SP43	*Cementitious Materials for Concrete*
CCAA (2005)	*Code of Practice – TESTING FREQUENCIES for the Extractive Industry in Queensland (Cement Concrete & Aggregates Australia, September 2005)*
EN 14889-1	*Fibres for Concrete – Part 1: Steel Fibres - Definitions, Specifications and Conformity*
ISO/IEC 17000	*Conformity Assessment – Vocabulary and General Principles*
MD.R83.CC	*RMS standard rigid pavement drawings: Continuously reinforced concrete pavement (CRCP) - construction*
MD.R83.CJ	*RMS standard rigid pavement drawings: Jointed reinforced concrete pavement (JRCP) - construction*
MD.R83.CP	*RMS standard rigid pavement drawings: Plain concrete pavement (PCP) - construction*
NR83	*Guide to QA Specifications R83 and R84 – Concrete Base*
R83	*Concrete Pavement Base*
R93	*Diamond Grinding of Concrete Pavement*
TMR Surveying Standards	*Transport and Main Roads Surveying Standards*

Table B.2 – Standard test methods

Property to be tested	Test method number
Selection of Sampling and Test Locations	Q050
Degradation Factor (Coarse Aggregate)	Q208B
Compressive Stress and Recovery of Preformed Joint Filler	Q460A
Extrusion of Preformed Joint Filler	Q460B
Expansion of Preformed Self-Expanding Joint Filler	Q460C
Accelerated Weathering of Preformed Joint Filler	Q460D
Resistance to Heat Degradation of Closed Cell Foam Joint Filler	Q460E
Resistance to Disintegration of Preformed Cork Joint Filler	Q460F
Durability of Sealant	Q461
Density of Hardened Concrete (Water Displacement)	Q473
Dowel Pull-out Test	Q474
Foreign Materials Content of Recycled Crushed Concrete	Q477
Road Roughness – Surface Evenness (Using a Two Laser Profilometer)	Q708B
Road Roughness – Surface Evenness (Using the ARRB Walking Profiler)	Q708D
Straightedge	Q712
Austroads	
Texture Depth of Road Surfacings (Sand Patch)	AG:PT/T250
Standards Australia	
Sampling of Fresh Concrete	AS 1012.1
Determination of Properties Related to the Consistency of Concrete - Slump Test	AS 1012.3.1
Determination of Properties Related to the Consistency of Concrete - Vebe Test	AS 1012.3.3
Determination of Air content of Freshly Mixed Concrete - Measuring Reduction in Air Pressure in Chamber Above Concrete	AS 1012.4.2
Determination of Mass per Unit Volume of Freshly Mixed Concrete	AS 1012.5
Method for Determination of Bleeding of Concrete	AS 1012.6
Method for Making and Curing Concrete - Compression and Indirect Tensile Test Specimens	AS 1012.8.1
Method for Making and Curing Concrete - Flexure Test Specimens	AS 1012.8.2
Determination of the Compressive Strength of Concrete Specimens	AS 1012.9
Determination of indirect tensile strength of concrete cylinders ('Brazil' or splitting test)	AS 1012.10
Determination of the Modulus of Rupture	AS 1012.11
Determination of Mass per Unit Volume of Hardened Concrete - Water Displacement Method	AS 1012.12.2
Determination of the Drying Shrinkage of Concrete for Samples Prepared in the Field or in the Laboratory	AS 1012.13

Property to be tested	Test method number
Method for Securing and Testing Cores from Hardened Concrete for Compressive Strength	AS 1012.14
Determination of Chloride and Sulfate in Hardened Concrete and Concrete Aggregates	AS 1012.20
Bulk Density of Aggregate	AS 1141.4
Particle Density and Water Absorption of Fine Aggregate	AS 1141.5
Particle Density and Water Absorption of Coarse Aggregate - Weighing -in-Water Method	AS 1141.6.1
Particle Size Distribution - Sieving Method	AS 1141.11.1
Materials Finer than 75 Micrometre in Aggregates (by Washing)	AS 1141.12
Material Finer than 2 Micrometre	AS 1141.13
Particle Shape, by Proportional Calliper	AS 1141.14
Flakiness Index	AS 1141.15
Crushed Particles in Coarse Aggregate derived from Gravel	AS 1141.18
Average Least Dimension - Direct Measurement (Nominal Size 10 mm and Greater)	AS 1141.20.1
Average Least Dimension - Direct Measurement (Nominal Size 5 mm and 7 mm)	AS 1141.20.2
Wet/dry Strength Variation	AS 1141.22
Aggregate Soundness - Evaluation by Exposure to Sodium Sulphate Solution	AS 1141.24
Light Particles	AS 1141.31
Weak Particles (Including Clay Lumps, Soft and Friable Particles) in Coarse Aggregates	AS 1141.32
Organic Impurities other than Sugar	AS 1141.34
Sugar	AS 1141.35
Alkali-silica Reactivity - Accelerated Mortar Bar Method	AS 1141.60.1
Alkali-silica Reactivity - Concrete Prism Method	AS 1141.60.2
Methylene Blue Adsorption Value of Fine Aggregate and Mineral Fillers	AS 1141.66
Determination of the Sulphate Content of a Natural Soil and the Sulphate Content of the Groundwater - Normal Method	AS 1289.4.1.1
Determination of the Organic Matter Content of a Soil - Normal Method	AS 1289.4.2.1
Determination of Softening Point (Ring and Ball Method)	AS 2341.18
Chemical Composition of Cement	AS 2350.2
Determination of Chloride Ion Content of SCM	AS 3583.13
Sampling Cements	AS/NZS 2350.1
ASTM International	
Petrographic Analysis	ASTM C295
Extrusion Rate and Application Life of Elastomeric Sealants	ASTM C603

Property to be tested	Test method number
Indentation Hardness of Elastomeric-type Sealants by Means of a Durometer	ATSM C661
Tack-free Time of Elastomeric Sealants	ASTM C679
Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants	ASTM C793
Adhesion-in-Peel of Elastomeric Joint Sealants	ASTM C794
Length Change of Concrete due to Alkali-Carbonate Rock Reaction	ASTM C1105
Density and Specific Gravity (Relative Density) of Plastics by Displacement	ASTM D792
Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus	ASTM D7428
Texas Department of Transportation	
Acid Insoluble Residue for Fine Aggregate	Tex-612-J
RMS	
Texture Depth by TRL Meter	T192
Flow Time and Voids Content of Fine Aggregate by Flow Cone	T279
Moulding of Concrete Specimens	T304
Wet sieving of concrete	T329
Cleanliness of Sawn Concrete Pavement Joints	T379
Field Adhesion of Joint Sealant to Concrete	T380
Stability of Wax Emulsion Curing Compound	T862
Recording the Infrared Spectrum of Materials	T1005

Appendix C1: Alkali-silica reactivity (ASR) classification and actions

Appendix C1 applies when one or more of the aggregates is slowly reactive or reactive, as required by Clause 6.1.6.1.

Assess as follows:

a) calculate the weighted ASR contribution of all aggregates in the mix on the basis of mass proportions

b) the combined aggregate ASR potential is deemed to be 1.25 times the weighted ASR contribution

c) apply the combined aggregate ASR to AS 1141.60.1 (or AS 1141.60.2) to determine the Aggregate Reactivity Classification (i.e. non-reactive, slowly reactive or reactive)

d) Take action according to the Aggregate Reactivity Classification as provided in Table C1.1.

Table C1.1 – Action for aggregate reactivity classification

Aggregate reactivity classification	Action required
Non-reactive	None
Slowly reactive	Use ASR Reactive Class mix (Table 7.2.3), or
	Limit alkalis in mix to 2.1 kg/m$^{3(1)}$
Reactive	Use ASR Reactive Class mix (Table 7.2.3), or
	Demonstrate as “Non-Reactive” when tested by AS 1141.60.2 using nominated SCM and aggregates.

Note:

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

Appendix C2: Curing compound

C2.1 General

Curing compounds shall comply with AS 3799, subject to the qualifications in Table C2.1.

For water retention testing, provide NATA accredited test results. For all other testing, provide test results endorsed by an ISO 9001 certified laboratory whose Quality Management System is certified by a conformity assessment body (as defined in ISO 17000) or by JAS-ANZ.

Table C2.1 – Curing compound properties

Description	Conform to AS 3799 class	Carbon number	Limitations
Hydrocarbon resin (HCR)	Class B with minimum 30% NV resin content([1],[2])	C5 only	Do not use where a bitumen seal or asphalt will be placed([3]).
Water-borne hydrocarbon resin (WHCR)	Class B with minimum 30% NV resin content([1],[2])	C5 only	Do not use where a bitumen seal or asphalt will be placed([3]).
Styrene butadiene resin (SBR)	Class B([2])	Not applicable	Do not use where a bitumen seal or asphalt will be placed([3]).
Blended bitumen and water-borne hydrocarbon resin (B HCR)	Class Z with minimum 40% bitumen([4])	C5 only (hydrocarbon resin component)	To be compatible with the prime that will be applied later.
Wax emulsion([5]) (WE)	Class A with minimum 30% NV content([6],[7],[8])	Not applicable	Do not use on the top surface. Use only for debonding of joints. Comply with MRTS39.

Notes:

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

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

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

a) where a fugitive dye is used, ensure that it is incorporated by the manufacturer, and

b) do not use permanent dyes or pigments on the finished surface.

([4]) Ensure that bitumen constitutes at least 40% of the total mass as delivered. The bitumen shall conform to the requirements of MRTS17.

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

([6]) When tested for stability in accordance with RMS T862, the rate of separation in seven days shall not exceed 4%.

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

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

The curing compound shall not adversely impact the adhesion of pavement markings, raised pavement markers and audio tactile line markings as detailed in MRTS45 *Road Surface Delineation*.

C2.2 Test requirements

C2.2.1 Reference sample

Test the reference sample for the following properties:

1. non-volatile content
2. the efficiency index
3. density
4. drying time
5. viscosity
6. the infrared spectrum as determined on the material as supplied and in accordance with RMS T1005.

Test in accordance with AS 3799 and ensure that the results conform to both Table C2.1 of this Technical Specification and AS 3799.

The reference sample may be used on more than one project.

C2.2.2 First delivery

From the first delivery to the project, test a random sample for the following properties:

1. non-volatile content
2. density
3. drying time
4. viscosity
5. the infrared spectrum as determined on the material as supplied and in accordance with RMS T1005.

Test in accordance with AS 3799 and ensure that the results conform to both Table C2.1 of this Technical Specification and AS 3799. Assess for consistency with the reference sample in accordance with AS 3799.

C2.2.3 Subsequent deliveries

For all subsequent deliveries, test for the following properties:

1. non-volatile content
2. density
3. viscosity.

Test in accordance with AS 3799 and ensure that the results conform to both Table C2.1 of this Technical Specification and AS 3799.

Appendix C3: Joint sealant

Joint sealant shall be silicone sealant for casting insitu, conforming to the requirements of Table C3.1.

Test results shall be endorsed by an ISO 9001 certified laboratory whose Quality Management System is certified by a conformity assessment body (as defined in ISO 17000) or by JAS-ANZ, except that JAS-ANZ certification is not required for Test Method Q461 Durability of Sealant

Table C3.1 – Silicone joint sealants

Attribute	Requirements	Test method
Specific gravity	1.1–1.55	ASTM-D792 (Method A)
Durometer hardness	Max 25 at -29ºC Max 30 at +23ºC	ASTM-C661 (Standard Curing)
Extrusion rate	90–250 g/minute	ASTM-C603
Tack free time	Tack free at five hours	ASTM-C679
Accelerated weathering	No surface crazing, hardening, chalking or bond loss at 5000 hours	ASTM-C793
Adhesion to concrete	Minimum 35 N average peel strength	ASTM-C794
Accelerated ageing	Condition of specimen after one ageing cycle	Q461
Adhesion to concrete	Conditioning as per Q461. Extension to 70%, compression to 50%. After 500 cycles, not more than 10% failure over the cross-sectional area.	Q461
Colour	Grey, compatible with pavement concrete	N/A

Appendix C4: Preformed joint filler

C4.1 Introduction

This appendix provides the requirements for the selection of preformed joint filler. This appendix is substantially derived from RMS QA Specification 3204 *Preformed Joint Fillers for Concrete Road Pavements and Structures* (2009).

C4.2 General

Strips of preformed joint filler shall be of such a nature as not to be permanently deformed or broken by twisting or bending to the degree that may occur in normal handling.

Non-expanding type fillers shall show no deterioration in properties if exposed to weather conditions for up to one month before installation.

C4.3 Properties

The properties of the joint filler shall conform to the requirements presented in Table C4.3.

Table C4.3 – Joint filler property requirements

Property	Requirements	Test method
Compression (pressure to produce 50% of original thickness)	80 kPa (min): depth ≤ 1.0 m 300 kPa (min): depth > 1.0 m 5000 kPa (max)	Q460A
Extrusion (free edge)	6 mm (max)	Q460B
Recovery (after 50% compression)	90% (min): standard 70% (min): bitumen-impregnated	Q460A
Resistance to accelerated weathering	Nil disintegration	Q460D
Boiling in hydrochloric acid (for cork only)	Nil disintegration, delamination, particle dislodgment, friability, lack of resiliency, change of porosity, damage by rubbing	Q460F
Expansion (for self-expanding cork only)	140% (min)	Q460C
Resistance to heat degradation (for closed cell foam only)	2 mm (max)	Q460E

C4.4 Other requirements

C4.4.1 Closed cell foam type filler

C4.4.1.1 Perforations

Closed cell foam filler shall be perforated parallel to one edge in such a manner that, following installation of the filler and associated concreting operations, the top of the filler can be readily and cleanly torn off to provide a reservoir for joint sealant. The dimension between the line of perforations and the edge of the filler shall be equal to the thickness of the filler or 10 mm, whichever is greater.

This clause is not applicable if material is to be supplied as special shapes for kerb and gutter and for mountable kerbs, etc.

C4.4.1.2 Adhesive

The supplier shall nominate a suitable adhesive for bonding the foam to a concrete surface.

C4.4.2 Self-expanding cork type filler

Self-expanding cork shall be marked in such a manner that any expansion of the material before installation can be easily detected.

C4.4.3 Packaging

The preformed filler material shall be packed in sizes convenient for handling on the job. In addition, self-expanding cork filler shall be wrapped in a waterproof type material and sealed against the entry of moisture.

Pieces of joint filler that have been damaged will be rejected.

C4.4.4 Dimensions

All preformed strips shall conform to the dimensions specified or shown on the Drawings with allowable tolerance as shown in Table C4.4.4.

Table C4.4.4 – Dimensional tolerance for preformed strip joint filler

Dimension	Tolerance
Thickness	± 1 mm
Depth	± 2 mm
Length	± 6 mm

C4.5 Product certification

Provide a certificate of compliance from the supplier verifying that the product complies with the requirements of this Technical Specification together with test results reported on NATA endorsed test documents.

Certification shall relate only to the composition on which the tests were made and shall be valid for not more than three years. New certification will be required whenever changes in product composition are made.

C4.6 Product identification

Clearly mark each delivery with the following information:

- name of the supplier
- product name and/or number
- batch number or date of manufacture.

Appendix C5: Water other than from a reticulated drinking water supply

If the mixing water contains a component from a source other than a reticulated drinking water supply, test all sources. Ensure that the combined mixing water conforms to the following criteria.

The water shall conform to AS 1379 Section 2.4 and Table 2.2, Limits for Impurities in Mixing Water, with the addition of the following:

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

b) sulfate ion: maximum 400 parts per million determined by AS 1289.4.2.1.

Appendix D: Base level surveys

D.1 Base invert level

D.1.1 Survey before placing base

The base invert level is the level at the top of the subbase, including the thickness of any debonding treatment. Determine the base invert level as follows:

a) for LCS where the base and subbase are constructed under the same contract:

   i. in accordance with MRTS39 *Lean Mix Concrete Sub-base for Pavements*

b) for LCS which was constructed by others:

   i. by survey jointly between the Contractor and the Administrator, in accordance with Transport and Main Roads Surveying Standards

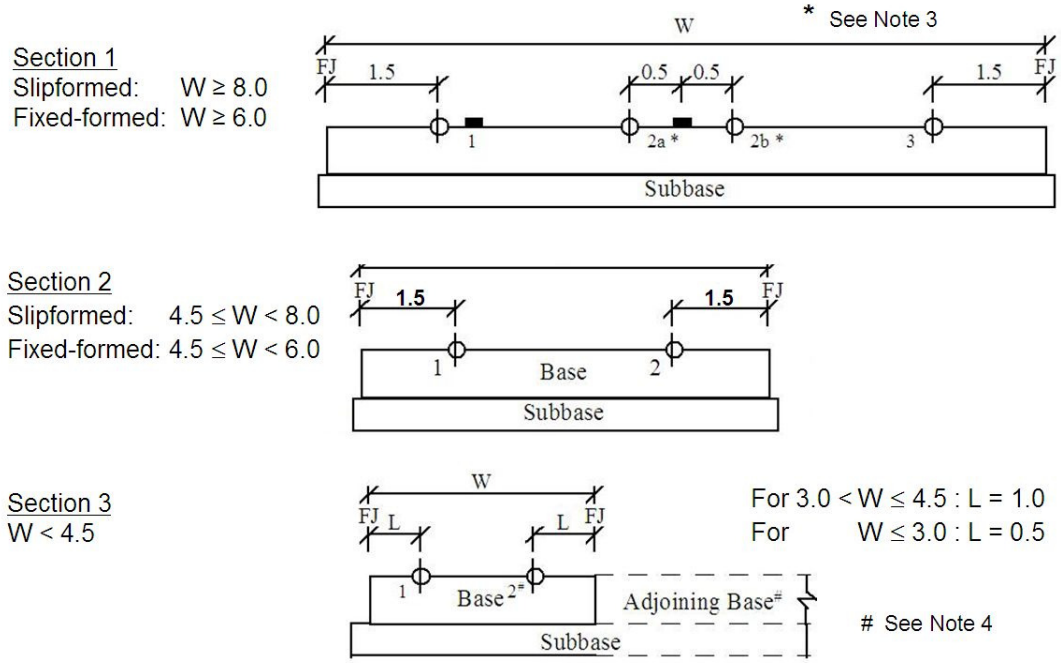
c) for subbase other than LCS:

   i. in a manner consistent with criteria contained in MRTS39 *Lean Mix Concrete Sub-base for Pavements*.

Where the Contractor chooses to undertake additional survey testing on the subbase, this need not be repeated on the base.

Survey the levels using a flat based staff of base area between 300 mm² and 4000 mm², at a spacing of 10.0 m longitudinally and at the cross-section offsets shown in Figure D.1, with a tolerance of 0.5 m. Report the levels to the nearest millimetre.

Figure D.1 – Survey locations (not to scale)



Notes:

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

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

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

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

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

(6) Key:

FJ: Formed joint or edge

W: Paving width between formed joints or edges

■: Lane lines

Φ: Survey points

D.1.2 Thickness of the surface debonding treatment

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

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

Where the surface debonding treatment over LCS comprises a sprayed bituminous seal, the thickness of the treatment is taken as the ALD of the cover aggregate, determined in accordance with MRTS11 *Sprayed Bituminous Surfacing (Excluding Emulsion)*. Add this thickness to the levels determined at the top of LCS. The resultant levels are regarded as the bottom level of the base for the purpose of determining its thickness.

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

D.1.3 Redesign of pavement levels

In the case of nonconforming levels which are high, the Contractor may locally redesign the pavement levels in accordance with the following criteria:

Review the approved contract surface levels in accordance with the following criteria:

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

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

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

Additionally, the revised design shall be such that:

a) water will not pond on the carriageway.

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

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

D.2 Survey after placing base

D.2.1 Survey

Carry out the survey in accordance with Transport and Main Roads Surveying Standards to determine conformity of the base surface level and thickness.

Assess levels within sublots which correspond to those established under Appendix A. Round the departures from the contract level to the nearest 5 mm.

Take levels with a flat based staff of base area between 300 mm² and 4000 mm² at the following locations. Report the levels to the nearest millimetre:

a) (i) At cross-section offsets shown in Figure P7.3.2, and

   (ii) At the same longitudinal plan locations as those surveyed for the base invert levels under Clause D.1,

   both with a tolerance of 0.5 m, and

b) Randomly selected at a minimum frequency of at least half the frequency required to conform to ‘a)’ above.

c) If a survey procedure is adopted which produces an as-built level model of the top of both the subbase and base, each with comparison to the design model, this model may be accepted by the Administrator. A condition of compliance is continued correlation with all pavement thickness results calculated from the model with pavement thickness measured from cores and production of a schedule at locations the same as those for accurately located levels.

The schedules of measured levels shall show actual and contract levels (after applying approved design adjustments) and differences. Highlight all levels and differences that are out of tolerance and locations specially surveyed for apparent nonconformity. Show actual levels that are above contract levels as positive differences and actual levels that are below contract levels as negative differences.

Exclude locations that are nonconforming and then calculate the mean of differences.

D.2.2 Determination of base thickness

a) Assess thickness within sublots which correspond to those established under Appendix A. Calculate base thickness to the nearest 1 mm at individual survey points as the difference between the finished base level and the base invert level.

b) Adjust the calculated thickness to allow for the design surface longitudinal and transverse slopes between the two surveyed points. Include in the Quality Plan the method of determining the thickness adjustment.

c) Measure the base thickness to the nearest 1 mm on the cores taken for compaction testing. Adjust the measured thickness in accordance with Clause D.1.2 to remove the contribution of the interlayer treatment.

d) Wherever a core result differs by 5 mm or more from a survey result located within 1.5 m, or by 10 mm or more in the range 1.5 m to 2.5 m, the core result shall be accepted and the survey result culled from the assessment.

   The surveys are deemed to be nonconforming if the frequency of such occurrences is higher than three in any group of 10 consecutive comparisons.

The Administrator may authorise the drilling of 40 mm diameter cores in areas where the thickness calculated from survey results is nonconforming and no representative cores are available for comparison. Do not take additional cores for the purpose of thickness assessment without the prior approval of the Administrator.

e) Show excess thicknesses as positive values and deficient thicknesses as negative values. Calculate the mean thickness for each sublot using all core results and un-culled survey results (all to the nearest 1 mm). Round the mean to the nearest 5 mm.

Then, for the purpose of assessing thickness conformity, round all individual results to the nearest 5 mm.

D.2.3 Conformity for thickness

Assess sublots for thickness in accordance with Table D.2.3.

Table D.2.3 - Assessment criteria for thickness

Thickness deficiency (mm)				**Status**
Mean of sublot([1])	**Number of individual points([1], [2])**			
	≥ 20 mm	**10–15 mm**	**5 mm**	
≥ 15 mm	U	U	U	Nonconforming, remove and replace
10 mm	2 or more	U	U	Nonconforming, remove and replace
	0–1	U	U	Nonconforming
5 mm	2 or more	U	U	Nonconforming, remove and replace
	0–1	3 or more	U	Nonconforming
		0–2	U	Nonconforming
≤ 0 mm([3])	2 or more	U	U	Nonconforming
	1	3 or more	U	Nonconforming
		0–2	U	Nonconforming
	0	3 or more	U	Nonconforming
		1–2	U	Nonconforming
		0	U	Conforming

Notes:

([1]) All values represent deficiencies except as stated in Note 3.

([2]) In cells labelled "U", there is no limit on the allowable number of under-thick points.

([3]) A value less than zero denotes a mean thickness that exceeds the specified minimum so is conforming.

Appendix E: Placing steel reinforcement

E.1 General

In CRCP, place reinforcement as shown on the Drawings. Longitudinal steel shall be placed on top of transverse steel and shall provide a mass steel ratio within the range 0.65% to 0.70% when calculated in accordance with RMS MD.R83.CC.

In other Base formats, reinforce the concrete as shown on the Drawings, including special slabs (Clause 8.9). Reinforced PCP slabs are designated as PCP-R. Unless shown otherwise on the Drawings, place steel mesh reinforcement as follows:

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

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

Reinforcement shall:

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

b) be bent to an internal bend radius in accordance with Table E.5.

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

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

e) not be heated for purposes of bending.

Ensure that steel reinforcement placed in the Works is free from loose or thick rust, grease, tar, paint, oil, mud, mortar or any other coating, but do not bring it to a smooth polished condition. Ensure that its surface condition does not impair its bond to the concrete or its performance in the member.

Secure reinforcement in place by wiring the bars and/or fabric together with annealed steel wire having a diameter of not less than 1.2 mm.

Support the reinforcement in position using concrete, plastic or wire chairs. Do not use timber or pieces of aggregate to support reinforcement. Do not use a support chair which is likely to impede compaction of the enveloping concrete. Ensure that any enclosed perimeter of the bar chair side elevation has at least 25% voids, with a minimum gap in the chair below the reinforcement of 1.5 times the maximum nominal size aggregate in the concrete mix.

The arrangement and spacing of chairs shall be such that the reinforcement is supported in its proper position with permanent deflection or displacement of the reinforcement of no more than 2 mm during placing and compaction of the concrete. The chairs shall also have sufficient bearing at their base to prevent overturning. Chairs shall be capable of supporting a 200 kg mass without permanent distortion in excess of 2 mm.

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

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

The mass of reinforcing steel supported by any one chair shall not exceed 10 kg.

In CRCP, place the support chairs under the transverse steel using a systematic pattern such that the spacing between any two adjacent chairs does not exceed 0.90 m in both the longitudinal and transverse directions.

Where testing frequencies have not been specified, nominate the Contractor's proposed testing frequency in accordance with MRTS50 *Specific Quality System Requirements*.

E.2 Tiebars

Tiebars (also referred to in some documents as "tie bars") shall be a minimum length of 1.0 m and drill-ties shall be a minimum length of 0.75 m.

The method of insertion of tiebars shall provide for:

a) no disturbance to the finished concrete surface

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

c) in fixed-form paving, vibration of all tiebars in their final position by either internal vibration or by vibrating screed board

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

In longitudinal tied joints, place tiebars:

a) not closer than 300 mm to a transverse untied joint (contraction or isolation joint)

b) not closer than 200 mm to a transverse tied joint

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

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

In transverse tied joints of jointed bases, place tiebars not closer than 300 mm to a longitudinal joint or slab edge.

E.2.1 Pull-out testing

Undertake testing within 30 calendar days of paving.

Tiebars shall be capable of withstanding a tensile pull-out stress equal to 85% of their yield stress. Terminate the testing at the 85% level.

Undertake pull-out testing at the following minimum frequency for each inserter (if tiebars are inserted on both sides of a paving run, test each side at the specified frequency), independent of transverse construction joints, and commencing 5 m from the project start of base paving:

a) one test per 20 m of joint until four consecutive conformities are achieved, and thereafter

b) at a rate of one per 50 m of joint until a further four consecutive conformities are achieved, and thereafter

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

Test a minimum of five bars in any paving trial.

If a nonconformity is encountered at any stage of the test, consecutive bars shall be tested alternately each side of the failed bar until four consecutive tests are performed without failure. Testing then reverts to frequency ‘a)’.

Replace nonconforming bars by using a suitable epoxy or polyester setting system to develop anchorage strength of at least 85% of the yield strength of the bar. Bar replacement shall not disturb the concrete surface. Test the replaced bars at a minimum frequency of one in two.

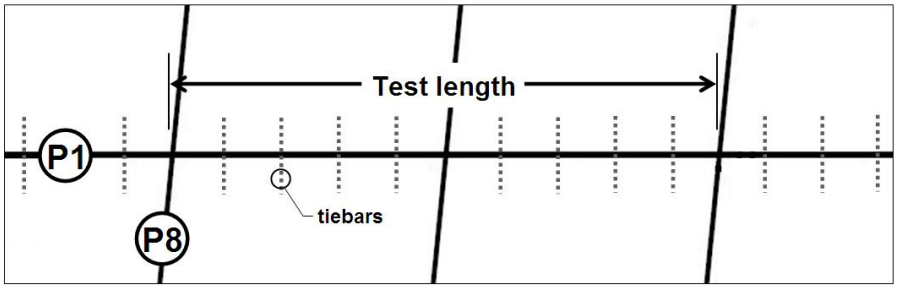
E.2.2 Location and compaction testing of inserted tiebars

Test for location conformity (plan position and depth) using a metal detector, and take cores to ensure that the method of placement provides full compaction of concrete around and above the bars:

1. For location:
    a. in the paving trial: every bar, and thereafter
    b. every bar within a test length comprising two consecutive slabs as shown in Figure E.2.2, and at a minimum frequency as follows:
        i. two test lengths per sublot until 10 consecutive conforming lengths are achieved, and thereafter
        ii. one test length every second sublot.

If a nonconformity is detected, the testing frequency reverts to ‘i.'.

Figure E.2.2 – Test length for inserted tiebars



2. For compaction:
    a. in the paving trial: one core per 40 m of joint, or part thereof, and thereafter
    b. one core per 100 m of joint until five consecutive conformities are obtained, and thereafter
    c. one core per 200 m of joint.

If nonconformity is detected at any stage, the testing frequency reverts to ‘(b)’.

Where two or more inserters are used, the frequencies in ‘(a)’, ‘(b)’ and ‘(c)’ apply to each inserter.

Carry out coring within two calendar days of paving.

Cores shall be located to intersect a tiebar, but shall be offset from the longitudinal joint by 350 mm ± 50 mm and shall not be closer than 1.5 m to a transverse contraction joint nor 3.0 m to a transverse construction joint.

Inspect all cores at the time of extraction. If there is any indication of visual nonhomogeneity, implement Corrective Action within two hours of extraction.

Test each core for with-in core variability in accordance with Clause 9.2.2.

Ground penetrating radar (calibrated with cores) has been used successfully by Contractors to aid in the refinement of tie bar insertion techniques.

E.2.3 Vertical cover below sawn joints

Test for vertical cover between tiebars and the bottom of sawcuts:

a) in the paving trial: one test per 15 m of joint, or part thereof

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

c) thereafter, one test per 50 m of joint.

If a nonconformity is encountered at any stage of testing, consecutive bars shall be tested alternately each side of the failed bar until ten consecutive tests are performed without failure. Testing then reverts to frequency '(a)'.

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

At each nonconformity, provide a drilled stitch-bar in accordance with the RMS standard rigid pavement drawings.

E.3 Dowels

Dowels shall be installed ahead of paving and shall:

a) Comply with AS 3679.1.

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

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

d) When tested in accordance with Q474, have an average bond stress not more than 0.15 MPa.

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

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

g) Be supported so that no part of the assembly, except the dowel, crosses the joint.

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

i) Be equally positioned about the line of the intended joint within a tolerance of ± 25 mm.

j) Be placed not closer than 150 mm to a longitudinal joint or slab corner.

k) Before placing concrete, the alignment tolerance of individual dowels at any location as measured in the dowel assembly is ± 2 mm.

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

E.4 Protective coatings

Do not use protective coated reinforcement unless otherwise specified in the contract documents.

E.5 Bending

Bend the reinforcement in accordance with Section 17.2.3.1 of AS 3600. Bend without impact or damage to the bar either by cold bending around pins or by applying uniform heat not exceeding 450°C to, and beyond, the portion to be bent. Heated bars shall not be cooled by quenching.

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

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

The nominal internal diameter of a reinforcement bend or hook is taken as the external diameter of the pin around which the reinforcement is bent. The diameter of the pin shall not be less than the value determined from Table E.5.

Submit details as part of the Construction Procedures any proposal to bend anchor stirrups to facilitate slipform paving.

Table E.5 – Internal diameter of bend and hooks

Type of bar	Minimum internal diameter of bend
a) Normal bends	
Fitments: bar grade 250 and wire grade 450	$3d_b$
Fitments: bar grade 500	$4d_b$
Mesh and bars other than in ‘b)’ and ‘c)’ below	$5d_b$
b) Bends designed to be straightened or re-bent subsequently	
$d_b < 28$ mm	$5d_b$
$d_b \geq 28$ mm	$6d_b$
c) Bends inreinforcement epoxy coated or galvanised either before or after bending	
$d_b \leq 16$ mm	$5d_b$
$d_b \geq 20$ mm	$8d_b$

Note:

(1) d_b is the nominal diameter of a bar or wire

E.6 Welding

All welding shall conform to the requirements of MRTS71. For grade 500 bars, the welding procedure shall conform to the bar manufacturer's recommendations for control of heat input. In welded splices, bars may only be welded by an electrical method. The welded splice shall meet requirements of tensile and bend tests specified for the parent metal.

E.7 Lapped splices

The minimum length of lapped splices is in accordance with Section 13.2 of AS 3600 unless shown otherwise on the Drawings.

Lapped splices not shown in the Drawings shall have lengths not less than the values listed in Table E.7. The ends of bars forming a lapped splice shall be welded or securely wired together in at least two places.

Table E.7 – Splice lengths

Bar type	Bar diameter (mm)	Splice length (mm)
Deformed	12	360
	16	525
	20	600
	24	900
	28	1050
	32 & 36	1200
Plain (fitment)	d_b < 13 mm	50 d_b or 300 mm whichever is the greater

Note:

(1) Where d_b is the nominal diameter of a bar or wire.

Splices in reinforcing fabric shall conform to Section 13.2.3 of AS 3600 such that the two outermost transverse wires of one sheet overlap the two outermost transverse wires of the lapping sheet. The orientation of the sheets shall be such that they mechanically engage each other (that is, the bottom sheet has transverse wires uppermost and the top sheet has them underneath).

E.8 Mechanical splices

Mechanical splices shall be of the type specified or an approved equivalent and used only at the locations shown in the Drawings. Install the splices in accordance with the manufacturer's recommendations.

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

E.9 Storage

Support reinforcement above the surface of the ground and protect it from damage and deterioration due to exposure.

Appendix F: Process control charts

F.1 General

Develop process control charts in accordance with AS 3940 and AS 3942 for the parameters listed in Table F.2. Chart separately for each nominated pavement mix in use (excluding non-pavement mixes such as anchors and kerbs).

For the purpose of charting under this appendix, the process mean $\bar{X}$ is defined in Appendix A.

F.2 Seven day compressive strength lower warning limit

Calculate the seven day compressive strength lower warning limit (LWL) as follows:

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

where:

F_7 = seven day compressive strength in the trial mix (reference Clause 7.7.3)

F_{28} = 28 day compressive strength in the trial mix

f_{cMin} = as specified in Clause 7.3

s_{30} = standard deviation

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

Before 30 test values becoming available, adopt a value of $f_{cMin}/10$ for s_{30}. Thereafter, calculate s_{30} as the rolling standard deviation for seven day strength of not fewer than 30 test values.

Table F.2 – Control charts

Parameter	Control chart requirements(1)		Decision rules(2)
	Chart types and controls	Specifications and criteria(3)	
Seven day compressive strength	a) Mean chart, showing:	As per AS 3942 Section 4.3.2	
	– target value	See Note (4)	
	– lower warning limit	As per Clause 8.4.1.1	
	– 5-point rolling mean	As per Clause 8.4.1.1	A
28 day flexural strength (5)	a) Mean chart, showing:	As per AS 3942 Section 4.3.2	
	– target value	See Note (4)	
	– lower warning limit	As per AS 3942 Section 4.3.2 and Note (6)	
	– specified limits	As per Clause 8.4.1.3	
	– 5-point rolling mean	As per Clause 8.4.1.3	B

Parameter	Control chart requirements(1)		Decision rules(2)
	Chart types and controls	Specifications and criteria(3)	
28 day flexural strength (5)	b) Coefficient of variation chart, showing:		
	– upper warning limit	9.0%	
	– specified limits	As per Clause 8.4.1.3	
	– 5-point rolling coefficient of variation	As per Clause 8.4.1.3	B
Cylinder unit mass	a) Mean chart, showing:	As per AS 3942 Section 4.3.2	
	– lower warning limit	LWL= RCUM in the paving trial, less 30 kg/m³	
	– RCUM for the paving trial(s)		A
	b) Standard deviation chart, showing:	As per AS 3942 Section 4.3.4	
	– 10-point rolling standard deviation		
	– process standard deviation s100	UWL=15 kg/m³, see Note (7)	E
Fraction passing 75 µm sieve(8)	a) Sample chart, showing:	See Note (9)	
	– specified upper limit	Upper limit = 7.0% (Clause 6.1.4)	D
	– 5-point rolling coefficient of variation		C

Notes:

(1) Abbreviations:

UCL: upper control limit UWL: upper warning limit

LCL: lower control limit L WL: lower warning limit

(2) Key to decision rules:

A: Any values below the lower warning limit (LWL).

B: In accordance with Clause 8.4.1.2.

C: Five consecutive increasing values.

D: Any values above the upper control limit (UCL).

E: Any values above the upper warning limit (UWL).

(3) The individual values to be charted are those calculated to represent the sublot after averaging of pair / group test results in accordance with the relevant clause of this Technical Specification.

(4) At the start of production of a nominated mix, base the target value on the results of the trial mixes. When 25 test values are available, the target value may be revised at the Contractor's discretion and conditional on the results having been conforming. A further revision may be conducted when 100 test values are available. At all times, the target value shall be at least three standard deviations above the minimum specified value.

(5) This parameter is not applicable to SFRC.

(6) The lower warning limit for 28 day flexural strength shall be at least one process standard deviation above the minimum specification limit.

(7) The process mean ($\bar{X}$) and standard deviation (s_{100}) shall be calculated in accordance with Appendix A on a rolling basis using 100 values (that is, k = 100).

(8) The specified limit applies to all concrete mixes but control charting of this parameter is only required where manufactured or unwashed natural sand is used.

(9) Based on the calculated combined grading for all possible stockpile combinations.

Appendix G: Mixer uniformity testing

G.1 Mixer uniformity testing – general

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, the same charging sequence shall be used, and the volume (or throughput) at test shall not be exceeded unless a further uniformity test is conducted.

G.2 Uniformity testing of central batch mixers and continuous mixers

Where concrete is to be produced and mixed by a central batch mixer or a continuous mixer, conduct mixer uniformity tests before production paving is commenced with that mix, and thereafter upon production of each 30,000 m^3 of concrete from that mixer, or as otherwise required by the mixer requirements in AS 1379. Include mixes of all types (including subbase, base and kerbs) and to all clients in this volumetric total.

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

Conduct tests on three batches (as distinct from “loads”) or runs of the same mix which conform to all of the requirements of this Technical Specification. A run from a continuous mixer shall comprise not less than 5 m^3 of mix, with samples from consecutive runs being separated by an interval equivalent to at least 2 m^3 of throughput.

Assess and report mixing speed, batch (or run) volume, duration of charging, total mixing time for central batch mixers, throughput rate for continuous mixers, and mixing time after the last addition of water.

Discharge and sample the whole of a single batch (or run) by one of the following procedures:

a) By discharge into a moving vehicle whose tray length is not less than 8 m. Sampling shall be from the truck 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 work, and then spread evenly over a length of between 6 m and 10 m onto ground which is either sealed or pre-dampened to prevent absorption of water from the mix. Sampling shall be from ground in accordance with AS 1012.1.

In each case, sample the batch (or run) at three 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.

Samples shall be individuals (not composites) in accordance with Section 7.2.2 of AS 1012.1.

Additionally, cast and assess test cylinders for mass per unit volume (MUV) and compressive strength in accordance with Clause G.3. Assess the results in accordance with Clause G.4.

G.3 Mixer uniformity calculations for central batch mixers

As required by Clause G.2, cast a minimum of 24 test cylinders in accordance with RMS T304 from grab samples taken linearly throughout the batch. Obtain sufficient material in each grab sample to cast one cylinder only. Do not mix sub-samples.

Make and cure cylinders in accordance with Clause P3.2.1. Test each cylinder at seven days for MUV and compressive strength as follows:

a) MUV in accordance with Clause P4.1, except that results are to be rounded to the nearest 1 kg/m³, and

b) compressive strength in accordance with Clause P3.2.1, with sampling and moulding in accordance with Clause 9.3.2, except that results are to be rounded to the nearest 0.1 MPa.

Determine the Coefficient of Variation of both result sets as follows:

$$CoV_C = \frac{\sigma_{compressive}}{\mu_{compressive}} \times 100$$

where:

CoV_C = compressive strength Coefficient of Variation, reported to the nearest 0.1%

$\sigma_{compressive}$ = standard deviation of compressive strength, to the nearest 0.1 MPa

$\mu_{compressive}$ = mean of compressive strength, to the nearest 0.1 MPa

$$CoV_{muv} = \frac{\sigma_{MUV}}{\mu_{MUV}} \times 100$$

where:

CoV_{MUV} = MUV Coefficient of Variation, to the nearest 0.1%

σ_{MUV} = Standard Deviation of MUV, to the nearest 1 kg/m³

μ_{MUV} = mean of MUV, to the nearest 1 kg/m³

G.4 Compliance for uniformity

Central batch mixers and continuous mixers will be deemed to have passed the uniformity test if:

a) Three consecutive passes are obtained when batches are tested and assessed under the following criteria. If testing is not carried out on consecutive batches, the test batches shall be selected at random and there shall be three consecutive passes.

b) In each batch, the differences between the highest value and the lowest value for the corresponding properties of the three samples do not exceed the limiting values given in AS 1379 Table A1 for any of the three batches or runs.

c) No slump value is outside the specified range.

d) Coefficient of variation of compressive strength is less than 6.0%, and

e) Coefficient of variation of mass per unit volume is less than 1.0%.

Appendix H: Paving trial

Construct a separate trial for each paver.

Construct trial sections in a continuous operation without intermediate construction joints.

Table H.1 details the requirements for construction and testing of paving trials.

If the trial is conducted at a paving width of less than 70% of the maximum width proposed, the Administrator may call for a new trial section before full-width paving.

Submit the Paving Trial test results at timings in accordance with Table H.2, including an analysis of results that meets the requirements of Table H.3.

The trial shall demonstrate construction of the most common transverse and longitudinal joint types to be used in the Work.

Table H.1 – Concrete paving trial construction and testing requirements

Paving and testing requirements		Paving type	
		Fixed-form	**Slipform**
Length of paving trial	Minimum	15 m	50 m
	Maximum	50 m	100 m
Concrete volume of paving	Minimum	20 m³	–
Cylinders: Minimum testing for UCS(1) and MUV(1). As per Clause 9.2.1, except test MUV at age between two and three days	7 days(2)	4 loads	6 loads
	28 days(2)	4 loads	6 loads
Flexure beams(2) Minimum testing for strength and MUV(1)	7 days(2)	3 loads	4 loads
	28 days(2)	3 loads	4 loads
Fresh concrete: Wash-out test to Clause 8.4.1(b)	at 10%, 50% and 90% of discharge	3 loads	3 loads
Cores: Minimum testing for relative compaction. As per Clause 9.2.1 except: a) extract cores at age between two and three days and b) determine MUV within two days of extraction.	Transition sublots	Not applicable	2 per sublot
	Standard sublots	4(3)	3(3)
	At inserted tiebars at induced joints	NA	See Clause E.2.2
	At inserted tiebars at in formed joints	2(4)	2(5)
Photographs of cores through inserted tiebars (Clauses E.2.1 & E.2.2)(6) a) inspect and photograph within one day of coring b) photograph resolution shall be adequate to show entrapped voids around and above the tiebars.		All(4)	All
Metal detector survey for tiebar location (plan location and depth) in accordance Clauses E.2.2 and E.2.3.		Not applicable	All

Notes:

(1) MUV: mass per unit volume (or "unit mass") determined in accordance with AS 1012.12.2.

UCS: ultimate compressive strength.

(2) See Appendix P1 for conditions on moulding from the same sample or batch (as applicable).

(3) These cores are additional to those taken at tiebars within the same sublot.

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

(5) Inserted tiebars at formed joints are treated in Clause E.2.1. Coring is required only in the paving trial, for advance assessment ahead of 30 day pull-out testing.

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

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

Table H.2 – Paving trial submissions

Item	Timing of submission	Clause reference
Surface profile	Hold Point submission	9.5.1 & 9.5.2
Tiebar location and cover	Hold Point submission	E.2.2 & E.2.3
Texture depth	Hold Point submission	8.5.6
Curing application Row N	Hold Point submission	Table H.3
Table H.3 Rows A to E	Hold Point submission	Table H.3
Class 3 curing calibration results	Hold Point submission	J.4.3
Photographs of cores at inserted tiebars	Within 4 days of the trial	Table H.3
Table H.3 Rows J, K, L, M	Within 5 days of the trial	Table H.3
Table H.3 Row F, H	Within 9 days of the trial	Table H.3
Assessment of paving mix	With the 7 day test results	–
Table H.3 Rows G, I	Within 30 days of the trial	Table H.3
Tiebar pull-out testing	Within 30 days of the trial	E.2.1

The trial section will be accepted as part of the Works if it conforms to the Contract requirements. If the relative compaction of the trial section is less than 98.0%, remove the trial section and construct a new trial section.

In the event of other nonconformity in the trial section, the Administrator may require its removal and a new trial section, which shall be treated as if it was the first trial section.

The Administrator may call for a new trial section at any stage of the work if:

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

b) the concrete base fails substantially to conform to the Technical Specification, or

c) NCRs are not submitted in accordance with the Quality System documents.

To aid in any future discussions between the Contractor and the Administrator in relation to within-core variability, it is recommended the Contractor advise the Administrator of the time of core extraction so that the Administrator can readily inspect extracted cores.

Table H.3 – Paving trial analysis

Row	Item	Laboratory trial mix	Paving trial	Notes
A	Location	Name / suburb of laboratory	Location of the trial	
B	Mix details	Date: Mix No: Mix type: (slip-form or fixed form)	Date: Trial No: Mix variations [a]	a) List any variation to the authorised mix except for admixtures and water.
C	Air content (%)		Min: Max: Mean:	
D	Admixture content	AEA: WRA: Other:	AEA[b]: WRA[b]: Other[b]:	b) Provide the ranges (max & min).
E	Slump (mm), water content[c]			c) In accordance with Clause 8.4.2.
F	Compressive strength 7D	(1)	(3)	
G	Compressive strength 28D	(1)	(3)	
H	Flexural strength 7D	(1)	(3)	
I	Flexural strength 28D	(1)	(3)	
J	Unit mass – cylinders	Mean(1):	Min(1): Max(1): Mean	
K	Unit mass – beams	Mean(1):	Min(1): Max(1): Mean	
L	Core length (mm), excluding any debonding material	NA	Provide all results	
M	Cores[d]: Unit mass (& relative compaction)	NA	Transition sublots Other sublots	d) Record all individual results, e.g. 2360 (99.5%), 2340 (98.5%).
N	Curing application rates	NA	Min[e]: Max[e]: Mean[f]:	e) For Class 3, report min and max for each test. For all Classes

Numbered notes:

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

(2) Record individual specimen results.

(3) Provide all results for cylinder pairs or beam sets, as applicable.

Appendix I: Not used

Appendix J: Placing and paving operations

J.1 Slipform (mechanical) paving

Detail in the Construction Procedures the equipment and methods to be used for placing, spreading and finishing the concrete base, including the following parameters:

a) maximum paving speed (instantaneous, not average)

b) target (optimum) paving speed

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

d) gross operating mass per metre of paving width.

The slipform paver shall be a self-propelled machine and shall 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

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

Regularly inspect and service the paver to ensure that it is maintained at all times in full operating condition consistent with the manufacturer's specifications. Monitor key items, such as vibrators and sensors, throughout the paving process.

Implement a system to indicate the malfunction of each individual vibrator. Document the system in the Construction Procedures.

Maintain the supporting surface for the tracks of the paver, curing machine and any other equipment in the paving and curing trains in a smooth and firm condition.

Plan the work, and coordinate the delivery, spreading and paving activities to optimise the continuous and uniform progress of the paver and to minimise discontinuities in the work.

Record details of any interruptions to the progress of the paver, including the reason, location and duration.

Form a transverse construction joint in accordance with Appendix K if an interruption to paving occurs which is likely to result in a loss of integrity of the concrete mass. Should subsequent testing at the location of an interruption indicate the presence of non-uniform or nonconforming concrete, remove and replace the affected section with conforming concrete in accordance with Clause 9.6.

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

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

At locations where the paver is unable to fully compact and finish the concrete (such as, but not confined to, transition sublots), use supplementary fixed-form paving methods in accordance with Clause J.2.

Limit gaps under side-forms such that the specified systematic vibration and compaction can be achieved throughout the slab with only minimal mortar losses and such that the condition of the formed joint meets the requirements of Clause K.6.1.

J.2 Fixed-form (manual) paving

Detail in the Construction Procedures the equipment and methods to be used for placing, spreading and finishing the concrete base, including the following parameters:

a) the size and number of vibrators

b) the pattern and spacing of vibrator insertions.

Design and construct formwork so that it is braced in a substantial and unyielding manner and is debonded so that it can be removed without damaging the concrete.

Set the formwork to tolerances on the screeding surface equivalent to those specified for the finished base surface.

Limit gaps under side-forms such that the specified systematic vibration and compaction can be achieved throughout the slab with only minimal mortar losses and such that the condition of the formed joint meets the requirements of Clause K.6.1.

Deposit and spread the concrete uniformly in the formwork by means other than vibration and without segregation.

Compact the concrete using internal vibrators. Establish and document suitable vibrator operating parameters for the specific site conditions using systematic spacings and durations which will ensure the achievement of a homogeneous slab with uniform and thorough compaction conforming to Clause 9.2.

Before the demonstration of such conformity, adopt one of the three methods listed in Table J.1 and use operating parameters which are no less thorough than the guidelines provided.

At all times, use internal vibrators with the following operating parameters:

a) a minimum diameter of 50 mm

b) operating at a frequency of between 8000 and 12,000 vibrations / minute (130–200 Hz)

c) by systematic procedures using one of the methods shown in column 1 of Table J.1.

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

Following internal vibration, compact and finish the slab by at least two passes of a hand-guided vibratory screed with the following operating parameters:

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

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

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

d) operating at a frequency of between 3000 and 6000 vibrations / minute (50–100 Hz), and minimum amplitude of 0.3 mm.

Maintain a suitable head of concrete in front of the screed over its whole length to ensure the uniform transmission of vibration into the slab.

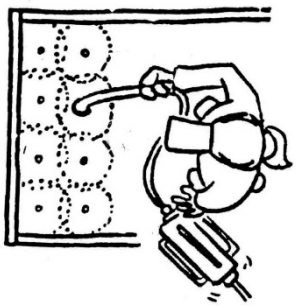
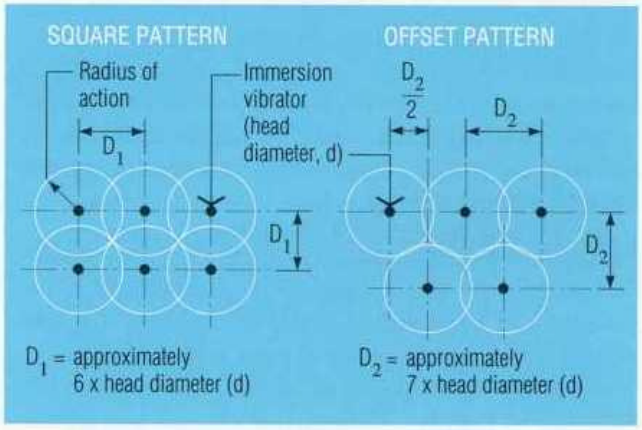
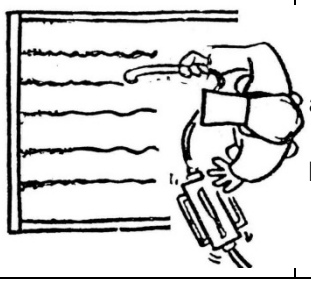
Provide at least two passes of the screed after any significant disturbance of the concrete surface, such as by walking in the mix.

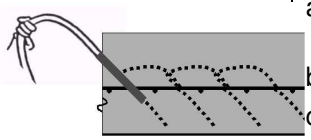
Provide a dense and homogeneous slab with a surface finish which requires a minimum of hand finishing.

Do not use power trowelling on the surface.

Form a transverse construction joint in accordance with Appendix K if an interruption to paving occurs which is likely to result in a loss of integrity of the concrete mass. Should subsequent testing at the location of an interruption indicate the presence of non-uniform or nonconforming concrete, remove and replace the affected section with conforming concrete in accordance with Clause 9.6.

Table J.2 – Internal vibration methods

Method	Diagram	Guideline parameters([1])
1. Dip method		a) The spacing D_1 is not greater than 300 mm, and D_2 is not greater than 350 mm b) Insertion durations are 10 seconds minimum, and c) Withdrawal speed does not exceed 1.5 m/minute.  Source: "*Concrete Practice on Building Sites*". SAA Handbook HB67 – 1995, jointing as Cement & Concrete Association publication C&CAA T43 (1995)
2. Drag method		a) Vibrator paths at spacings not greater than 350 mm, and b) Travel speed not exceeding 1.5 m/minute.

Method	Diagram	Guideline parameters([1])
3. Modified drag method (for reinforced pavement)	 (Section view)	a) Vibrator paths at spacings not greater than 350 mm, and b) Insertion spacings not greater than 350 mm, and c) Net horizontal travel speed not greater than 1.5 m/minute, and d) Withdrawal speed not greater than 1.5 m/minute.

Note:

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

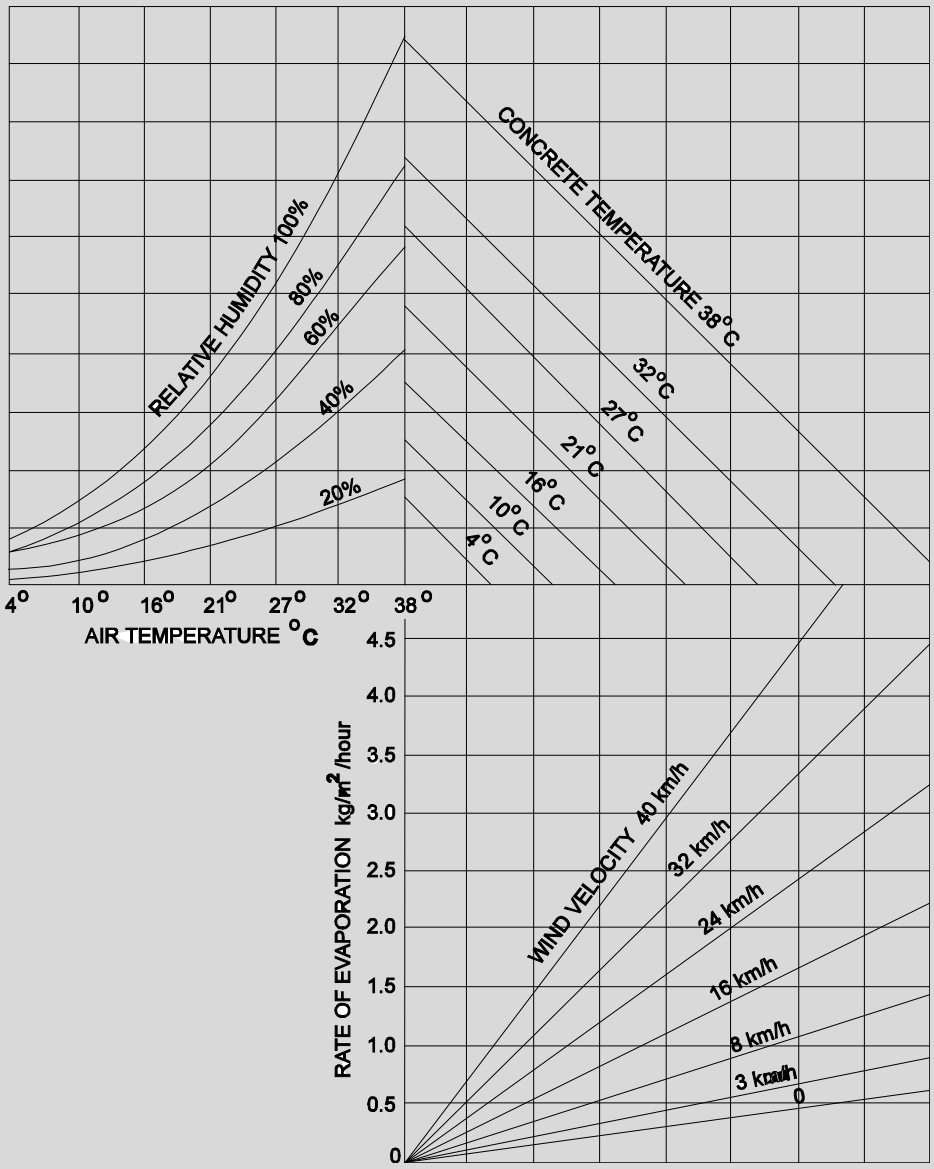
J.3 Guide for assessing the rate of evaporation

Figure J.3 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. For example, 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 would be 1.6 kg/m²/hour.

To determine the evaporation rate, 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 per hour) 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) v5 n4, 19-22).

Figure J.3 – Evaporation from concrete freshly placed on site



J.4 Curing operations

J.4.1 General

Cure the base by the application of a sprayed curing compound, achieving a uniform coverage.

In confined spaces (such as tunnels) where the use of curing compounds is deemed undesirable, cure the base for a minimum of seven calendar days using water or blanket techniques in accordance with Clause J.4.4.

Cure all other structural concrete (including kerbs and gutters) either by application of a compound or by a method included in Clause J.4.4.

Apply the compound in accordance with the following conditions:

a) To form a continuous and unbroken film with two uniform applications as follows:

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

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

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

Spraying equipment and compounds shall conform to Clause J.4.2. Fully operational spraying equipment is a pre-condition for paving to proceed.

J.4.2 Materials and equipment

Provide as part of the Construction Procedures the supplier's recommended procedures for storage and agitation of compounds under varying weather conditions in order to maintain uniformity. Ensure that the compound when sprayed has a uniform consistency and is conforming in all regards.

Spray application methods are categorised as follows:

a) Class 1

i. by hand lance, with either single or multiple nozzles

Use this method (or Classes 2 or 3) for paving widths up to 3.5 m.

b) Class 2

i. by spraybar or hand-lance fitted with a minimum of three nozzles spaced to give a uniform cover over a minimum width of 1.0 m in a single pass

Use this method (or Class 3) for paving widths greater than 3.5 m but less than 4.5 m.

c) Class 3

i. by a 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

Use this method for slipformed paving widths greater than 4.5 m.

Apply curing compound in a fine spray. Fit protective hoods to Class 3 spray bars 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.

J.4.3 Application rate

For Class 3 applications, use a minimum rate in each pass as follows:

a) on tined texture: the higher of 0.30 L/m², or 50% more than the rate stated on the test certificate

b) on surfaces with only hessian-drag or light broom texture: the higher of 0.25 L/m² or 25% more than the rate stated on the test certificate.

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

Make good any damage to the curing membrane by hand spraying the affected area.

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

For Class 3 curing, submit as part of the Construction Procedures the procedures that are proposed for demonstration of the following:

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

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

c) Field trials that are proposed in order to develop operating parameters such as nozzle height, spray pressure and spray overlap factor, and to demonstrate uniform and conforming coverage, including edges. Determine these parameters before any Paving Trial that requires Class 3 curing.

d) During the Paving Trial, verify the operating parameters developed under 'c)'.

Check the curing compound application rate as follows:

a) By calculating the average application rate from the total measured quantity of compound applied within the area specified in Table J.4.3.

b) By testing the local amount of curing compound as measured on test mats placed on the pavement at random locations. Use three 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 J.4.3 – Frequency of testing for application rate

Class of curing([1])	Test Procedures([2])	Frequency
1 and 2	(A)	Each paving area of between 500 m² and 1000 m²([3])
3	(A) and (B)	Each paving area of between 1000 m² and 1500 m²([3]) a) in the Paving Trial, and thereafter b) one in every sixth sublot until three([3]) consecutive conformities are obtained, then c) one every fifty (50) sublots. Testing frequency reverts to 'b)' if a nonconformity is encountered.

Notes:

([1]) See Clause J.4.2.

([2]) See sub-clauses 'a)' and 'b)' above.

([3]) The Contractor may vary this area for each test to suit individual circumstances such as the timing of refilling the curing tank, conditional on the application procedure being homogeneous within each nominated test sublot.

The application rate within a test section is deemed to conform if:

1. the application on the surface is visually uniform and homogeneous, and
2. the losses (by wind or other causes) are insignificant, and
3. all test results obtained in accordance with Table J.4.3 are conforming.

For any section on which the rate does not conform, respray within six hours of testing, at an application rate not less than twice the deficiency in the original application.

J.4.4 Curing of other structural concrete

Cure all structural concrete members, including anchors, kerbs and gutters, for a minimum of seven calendar days from placing.

Use curing compounds in accordance with the principles stated within this appendix, or use wet curing.

For plastic covers, ensure that they form a continuous barrier against loss of moisture and that they are fully secured around all edges such that they maintain a moist environment over the full mass of the concrete as evidenced by the presence of moisture on the underside of the covers.

Appendix K: Joints and edges

K.1 General

Deal with detritus from sawcutting operations in accordance with MRTS51 *Environmental Management*.

Refer to the Drawings and Clause 2 of Annexure MRTS40.1 for project-specific details of treatments required on existing pavements and/or kerbs abutting new Works.

Do not sawcut the pavement for any purposes other than those shown in the Drawings. Traffic presence detector loops shall not be sawn unless specifically approved.

Where scabbling is required, expose coarse aggregate over a large proportion of the scabbled face (avoiding the arrises as shown in the Drawings) and achieve a rough surface with indentations 4 to 6 mm deep. Scabbled joints within the base shall always be subsequently debonded, but do not debond joints in anchors.

K.2 Joint cleaning and sealants

Handle and install sealants in accordance with the manufacturer's written recommendations, which shall include the following items:

a) earliest concrete age at the time of installation

b) minimum temperature of air and concrete at installation

c) requirements for priming of the joint face

d) tooling requirements

e) minimum trafficking age.

Test the dimensions of the cured sealants in accordance with the Drawings and in accordance with the following requirements.

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

Detail as part of the Construction Procedures the procedures and equipment proposed to complete joint sealing.

Test joints and sealants at random locations at the minimum frequency specified in Table K.2.

Table K.2 – Joint and sealant testing

Test type	Joint type		
	Transverse contraction	**Other untied joints([1])**	**Tied sealed joints([2])**
Joint face cleanliness ([5],[7])	Test at two locations per joint, and a) at three joints per sublot commencing with the paving trial, until three consecutive conforming sublots	Include all joint types in the calculation of jointing output, and in the selection of testing location. Test at one location per joint per sublot, and a) at every sublot commencing with the paving trial, until	Test at one location per joint per sublot, and a) at every sublot commencing with the paving trial, until three consecutive conforming lots are obtained, and thereafter

Test type	Joint type		
	Transverse contraction	**Other untied joints([1])**	**Tied sealed joints([2])**
	are obtained, and thereafter b) at one joint in every alternate sublot. If any joint fails, re-clean all joints within the sublot and revert to test frequency 'a)'.	three consecutive conforming sublots are obtained, and thereafter b) at every third sublot. If any test fails, re-clean all joints within the sublot and revert to test frequency 'a)'.	b) at every third sublot. If any test fails, re-clean all joints within the sublot and revert to test frequency 'a)'.
Sealant dimensions([7]) • depth([4]) • width([3]) • recess	Test at one location per joint, and a) three tests per sublot commencing with the paving trial, until six consecutive conforming samples are obtained, and thereafter b) one test per sublot. Testing frequency reverts to 'a)' if a nonconformity is encountered.	Include all joint types in the calculation of jointing output, and in the selection of testing location. Test: a) two locations per 30 m of joint type until six consecutive conforming samples are obtained, and thereafter b) one test per 30 m. Testing frequency reverts to 'a)' if a nonconformity is encountered.	a) two tests per 50 m of joint until six consecutive conforming samples are obtained, and thereafter b) one test per 50 m. Testing frequency reverts to 'a)' if a nonconformity is encountered.
Sealant field adhesion ([6],[7])	a) one test per sublot commencing with the paving trial, until three consecutive conforming samples are obtained, and thereafter b) one test every fifth sublot. Testing frequency reverts to 'a)' if a nonconformity is encountered at any time.	Include all joint types in the calculation of jointing output, and in the selection of testing location. a) One test per sublot commencing with the paving trial, until three consecutive conforming samples are obtained, and thereafter b) One test every third sublot. Testing frequency reverts to 'a)' if a nonconformity is encountered at any time.	a) one test per sublot commencing with the paving trial, until three consecutive conforming samples are obtained, and thereafter b) one test every third sublot. Testing frequency reverts to 'a)' if a nonconformity is encountered at any time.

Notes:

([1]) Examples include isolation and expansion joints, but exclude transverse contractions.

([2]) For example tied longitudinal sawn joints.

([3]) Test at the time of installing the permanent sealant.

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

([5]) Test for cleanliness in accordance with RMS T379. A conforming result is when Grade 1 (None) visual rating category is achieved.

([6]) Test for adhesion in accordance with RMS T380.

([7]) Ignore Transition areas in the selection of sublots for testing.

Reinstate the backer road and sealant at all test locations for sealant dimensions and field adhesion.

K.3 Transverse construction joints

Transverse construction joints shall:

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

b) Be continuous over the paved width without steps or offsets in any axis so that the line of the joint does not deviate by more than 20 mm from a 3 m straightedge.

c) Be constructed at 90° ± 6° to the longitudinal joint, with the joint face corrugated and square (± 6°) to the finished top surface of the base.

d) In jointed bases, have tiebars installed as detailed on the Drawings and in accordance with Clause 8.1 (except for dowelled construction joints, if and where applicable). Where the ties are installed by drilling and fixing in hardened concrete, a suitable epoxy mortar shall be used giving an anchorage strength of at least 85% of the yield strength of the bar.

e) If initially nonconforming or damaged, be reinstated or repaired before the placement of adjoining concrete. The repair material shall not be placed integrally with the adjoining concrete.

f) Have the face of the joint debonded to prevent intimate microtexture bond, and

g) Conform in all regards to the requirements of Clause J.2.

Intimate bond at the microtexture level can induce spalling at arrises and shall be avoided. For this reason, debonding of the joint face is specified including joints between new and existing concrete pavements.

The first-placed face shall be dense and fully compacted and shall be free of honeycombing and re-entrant angles. Where the face is nonconforming or the edge is damaged, reinstate or repair it before the placement of adjoining concrete. Do not place the material used for the repair integrally with the adjoining concrete.

Re-spray the first-placed face with curing compound not more than 10 calendar days before placing the abutting concrete. All aspects of the treatment shall be in accordance with Clause 8.5.8 except that the compound shall be a wax emulsion conforming to MRTS39 *Lean Mix Concrete Sub-base for Pavements* and a single application shall be used at a rate 25% higher than the rate stated on the test certificate for curing efficiency, subject to a minimum value of 0.20 L/m². The coating shall be intact and effective at the time of subsequent concrete placement.

Reinforcement shall not be sprayed with wax or bitumen compounds.

K.4 Transverse contraction joints

Provide transverse contraction joints in jointed pavements as shown on the Drawings.

Contraction joints are not used in CRCP.

Transverse contraction joints shall:

a) be initiated by sawcutting unless the Drawings allow the use of crack inducing inserts outside trafficked areas.

b) be continuous across the full width of the base without steps or offsets in any axis so that the line of the joint does not deviate by more than 10 mm from a 3 m straightedge.

c) be skewed at 1 in 10 unless specified otherwise on the Drawings, or reduced locally to accommodate construction joints and slab anchors.

d) be sawn, where a deflection angle is specified, such that the sawing on any alignment does not extend beyond the intended limit as defined by intersecting joints (typically longitudinal).

e) be sealed in accordance with this Technical Specification.

f) have trafficking controlled in accordance with Clause 8.5.9.4.

g) be maintained at all times free of incompressible and foreign materials and sealed for this purpose at all formed edges including vertical faces, where any underlying induced crack shall also be sealed.

Use sawcutting, except where otherwise shown on the Drawings.

K.4.1 Sawcutting

Transverse contraction joints are sawn using either a two-cut operation (comprising an initial sawcut and a widening sawcut) or a single cut operation.

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

Use the type of blade and equipment and the method of control best suited to the hardness of the concrete being sawn. Have sufficient standby equipment available on site to maintain continuity of sawing.

The surface of the transverse contraction joint shall not show more than 10 mm of vertical or horizontal edge ravelling. The cumulative length of ravelling with a dimension greater than 3 mm shall not exceed 300 mm in any 3 m length of joint edge (that is, assess each side of the joint separately).

The vertical face at the edge of the slab shall not show ravelling greater than 20 mm in any axis at the point of intersection with the sawn joint.

If nonconformity occurs, immediately implement Corrective Action in accordance with the requirements of MRTS50 *Specific Quality System Requirements*.

K.4.2 Cleaning

Clean all debris from the sawcut soon after sawing and before the residue dries or hardens.

Use a liquid or liquid / air oil-free jet combination which:

a) Does not damage the sawcut or arrises.

b) Has a sufficiently high pressure to ensure that the faces are dust-free when dry. Gravity fed liquid from tanks is non-conforming.

c) Does not leave any substance deleterious to the concrete or to the adhesion of the joint sealants to be used.

d) Removes all sawing residue in a way which prevents its entering the joint.

Adjust the timing of cleaning and other variables (such as pressure) to suit the prevailing concrete characteristics.

Do not use grit blasting.

K.4.3 Preliminary sealing

Within two hours of cleaning an initial sawcut, seal the joint against drying and contamination by installing a continuous closed-cell polyethylene backer rod with the top of the seal being neither higher than the concrete surface nor more than 5 mm below it.

Sealing shall include the vertical faces of the slab at the ends of sawcuts.

Maintain the preliminary sealant in a sound and effective condition at the top of the joint until the joint is temporarily or permanently sealed. Replace within one calendar day any backer rod which is damaged or removed before sealing.

In a two-cut operation, the preliminary seal shall remain in position until the commencement of the widening sawcut, at which time it shall be pushed to the bottom of the initial sawcut in a way which is effective in preventing sawcut residue from entering the underlying joint.

In a single-cut operation, the preliminary seal shall remain in position until permanent sealing.

K.4.4 Temporary sealing

a) In two-cut operations

   Ensure that the preliminary seal is effective in preventing sawcut residue from entering the underlying joint.

   After widening, clean the sawcut in accordance with Clause K.4.2. Within two hours of cleaning, seal the joint with a continuous closed-cell polyethylene backer rod of a suitable diameter to prevent the ingress of incompressibles and to maintain moist conditions within the joint.

   Sealing shall include the vertical faces of the slab at the ends of sawcuts.

   The top of the backer rod shall be neither higher than the concrete surface nor more than 5 mm below it. The backer rod shall pass over any longitudinal joint seal already in place.

b) Before diamond grinding and grooving

   Provide a temporary joint seal which is sufficiently robust to withstand the stresses applied during the grinding process. Document the proposed procedure in the Construction Procedures.

c) General

   Maintain the temporary sealant in a sound and effective condition at the top of the joint until the joint is permanently sealed. Replace within one calendar day any temporary sealant which is damaged.

K.4.5 Permanent sealing

The permanent sealant shall be an insitu cast silicone sealant, stored and installed in accordance with the manufacturer's written instructions.

At slab edges and formed joints, the permanent seal shall extend down the vertical faces of joints and any underlying crack.

Place a permanent seal in the joint between 7 and 14 calendar days after initial sawing unless diamond grinding or grooving is proposed, in which case place the permanent seal within 14 calendar days of the completion of that operation within each sublot, except as follows:

a) do not place the permanent sealant within 24 hours of the concrete surface having been wet

b) ensure that, at the time of sealant installation, the joint faces are clean and surface-dry. Assess the cleanliness in accordance with Clause K.2.

Before introducing the silicone sealant into the groove, clean the joint in accordance with Clause K.4.2 to remove all foreign or disturbed material such as dust from the joint and from the top of the backer rod.

Do not use grit blasting.

Use a joint primer if and when recommended by the sealant manufacturer.

Use a continuous closed-cell polyethylene backer rod located at a depth so that the bottom of the silicone sealant is at the planned location and of the correct shape. If the backer rod is damaged in any way it shall be replaced for the full length of the joint.

Unless otherwise stated in the manufacturer's recommendations, tool the sealant to the specified shape before a surface skin forms.

Test adhesion of the sealants at an age of between three and five days in accordance with Clause K.2.

K.5 Isolation and expansion joints

Provide joints as shown in the Drawings to a position tolerance of 25 mm. They shall:

a) Be continuous across the full width of the base without steps or offsets in any axis so that the line of the joint does not deviate by more than 20 mm from a 3 m straightedge.

b) Be constructed with the joint face square (± 5°) to the finished top surface of the base.

c) Be treated with joint filler conforming to Appendix C4 and joint sealant installed in accordance with Clause K.3, except that references to backer rod apply only where shown on the Drawings.

d) Be maintained at all times free of incompressible and foreign materials. At free edges, the permanent sealant shall extend down the full vertical face of the joint. At other edges, the filler shall prevent the ingress of concrete and other foreign materials to the joint space during subsequent work.

Where the joint faces were constructed by methods other than sawing (for example, formed joints), prepare the joint cavity (for permanent sealing) within the sealant area by one of the following methods:

a) By sawing

   Undertake all operations including cleanliness and adhesion testing in accordance with Clauses K.2 and K.3 as if it were the second cut of a two-cut operation.

b) By wire brushing

   Clean the full face area using a mechanised rotary wire brush or similar abrasive contact equipment. Control all residue and arris spalling as if it were from sawcutting. Undertake all

operations, including cleanliness and adhesion testing, in accordance with Clauses K.2 and K.3.

K.6 Longitudinal joints

Provide longitudinal joints as shown on the Drawings to a position tolerance of 25 mm.

Longitudinal joints shall:

a) Be continuous over their full length without steps or offsets in any axis so that the line of the joint does not deviate by more than 20 mm from a 3 m straightedge after due allowance for any planned curvature.

b) For tied joints, have tiebars installed in accordance with Clauses 8.3 and Appendix J.

c) For formed joints (both tied and untied):

   i. Have the face square (± 6°) to the finished top surface of the base, and corrugated unless otherwise specified.

   ii. Have the face of the joint debonded to prevent intimate microtexture bond.

   iii. Where nonconforming or damaged, reinstate or repair the joint before the placement of adjoining concrete. The repair material shall not be placed integrally with the adjoining concrete.

   iv. Prepare the sealant faces in accordance with Clause K.5.

d) For induced joints:

   i. Be provided by sawcutting in accordance with this Technical Specification.

   ii. Exhibit at the surface not more than 10 mm width of vertical or horizontal edge ravelling. The cumulative length of ravelling with a dimension exceeding 3 mm shall not exceed 300 mm in any 3.0 m length of joint edge (that is, assess each side of the joint separately).

   iii. Control all residue and undertake all operations, including cleanliness and adhesion testing, in accordance with Clauses K.2 and K.3.

   iv. Permanently seal the full vertical face at the ends of sawcuts.

K.6.1 Condition of formed joints and debonding

Intimate bond at the microtexture level can induce spalling at arrises and shall be avoided. For this reason, debonding of the joint face is specified including joints between new and existing concrete pavements.

The first-placed face shall be dense and fully compacted and shall be free of honeycombing and re-entrant angles. Where the face is nonconforming or the edge is damaged, reinstatement or repair shall be carried out before the placement of adjoining concrete. Do not place the repair material integrally with the adjoining concrete.

Re-spray the first-placed face with curing compound not more than 10 calendar days before placing the abutting concrete. All aspects of the treatment shall be in accordance with the requirements for curing the concrete, except that the compound shall be a wax emulsion conforming to MRTS39 *Lean Mix Concrete Sub-base for Pavements* and a single application shall be used at the specified rate plus

an increase of 25%. The coating shall be intact and effective at the time of subsequent concrete placement.

Steel tiebars shall not be sprayed with wax or bitumen compounds.

K.6.2 Sawcutting

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

Use the type of blade and equipment and the method of control best suited to the hardness of the concrete being sawn. Ensure that sufficient standby equipment is available on site to maintain continuity of sawing.

K.6.3 Cleaning

Clean joints in accordance with Clause K.4.2.

Do not use grit blasting.

K.6.4 Temporary sealing

Within two hours of cleaning, temporarily seal the joint against drying and contamination by installing a continuous closed-cell polyethylene backer rod.

Sealing shall include the vertical faces of the slab at the ends of sawcuts in order to prevent ingress of materials from subsequent operations.

The top of the backer rod / seal shall not be higher than the concrete surface or more than 5 mm below it.

Maintain the temporary sealant in a sound and effective condition at the top of the joint until permanent sealing. Replace within one calendar day any temporary seal which is damaged or removed before permanent sealing.

K.6.5 Permanent sealing

Install a permanent sealant as for transverse contraction joints except that, if the backer rod is damaged, only the damaged length needs to be replaced.

Ensure that residue from cleaning operations does not enter transverse joints.

Ensure that, at the time of sealant installation, the joint faces are clean and surface-dry. Undertake all operations, including cleanliness and adhesion testing, in accordance with Clauses K.2 and K.3.

K.6.6 Widening of existing concrete base

Where the work involves widening of an existing concrete base, treat the existing edge as follows and in accordance with the Drawings and Clause 2 of Annexure MRTS40.1.

Undertake correction work (such as sawcutting) to the existing face, as and where specified.

Seal the vertical face of all transverse untied joints and underlying induced cracks in accordance with Clause K.4.5 to prevent ingress of mortar. Prepare joints for sealing (regardless of their original method of construction) in accordance with Clause K.5.

Fix drilled tiebars where specified and debond the existing face in accordance with Clause K.6.1.

Fix drilled tiebars where specified and debond the existing face in accordance with Clause K.6.1.

K.7 Mismatched joints and re-entrant angles

Mismatched joints may only be constructed as shown on the Drawings. Do not allow untied joints to form mismatched joints except at a junction with an isolation joint.

Re-entrant angles that exceed 190° shall be reinforced with SL82 reinforcing fabric.

K.8 Outer edges

Outer edges shall:

a) not deviate from the design position at any point by more than 25 mm

b) be continuous over the full length without steps or offsets in any axis so that the line of the edge does not deviate by more than 20 mm from a 3 m straightedge, after due allowance for any planned curvature

c) have face geometry conforming to Clause K.6, but having corrugations and tiebars only if and as specified in the Drawings.

Test each outer edge for alignment conformity at random locations and at a frequency not less than the following, commencing with trial paving and thereafter independent of the boundaries to sublots:

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

b) one test per 50 m of edge.

The testing frequency reverts to ‘a)’ if nonconformity is detected.

Appendix L: Kerb and gutter

Construct kerb and gutter in accordance with MRTS03 *Drainage, Retaining Structures and Protective Treatments* as shown on the Drawings and subject to the following conditions:

- Kerbs of types SA, SB, SC, SE, SO and SL beside concrete base shall not to be extruded unless the Drawings specifically allow extrusion.
- Concrete for the above kerb types shall conform either with this Technical Specification or with AS 1379 for normal class concrete with strength grade N32 and 20 mm aggregate, unless specified otherwise on the Drawings or in MRTS70 *Concrete*.
- Kerb longitudinal joints shall conform to Appendix K (including debonding of formed joints), but the rounding of the kerb or gutter lip shall not be greater than 5 mm, even if a larger rounding is shown on the kerb Drawings.
- Untied joints shall be sealed in accordance with the Drawings.
- At all kerb joints, the first placed joint face shall be reinstated or repaired if initially nonconforming or damaged, before the placement of adjoining concrete. The repair material shall not be placed integrally with the adjoining concrete.
- All inlet pits shall be separated from adjoining base concrete by a Type 15 isolation joint (unbeamed) in accordance with the Drawings.
- Cure all kerbs in accordance with Clause 8.5.8.

Do not undercut the batters of cuttings to allow the construction of kerbs or gutters. Construct kerb and gutters in accordance with AS 2876 modified as shown in Table L.1.

Table L.1 – Modifications to provisions in AS 2876

AS 2876 section description	Modification
Materials	Concrete properties and delivery, placing, compaction, finishing, curing and protection must be in accordance with MRTS70.
Profiles and dimensions	Profiles and dimensions must be as nominated on the Drawings.
Preparation of supporting layers	Compact subgrade, subbase and base layers supporting kerb and gutter to the standard specified for the adjacent pavement.
Tolerances	The minimum frequency of testing is every 10 m. On completion of kerb, gutter and adjacent pavement the gutter lip must not be higher than, nor more than 10 mm lower than, the adjoining pavement surface at any point.
Joints	Provide expansion joints in kerbs and gutters alongside flexible pavements at all locations where kerbs and gutters abut structures, including drainage pits, retaining walls and bridges. Fill these expansion joints with compressible packing complying with MRTS03.

Unless shown otherwise on the Drawings, provide a steel float finish to gutter inverts and faces of kerbs. Where directed by the Administrator, provide a broomed finish to the tops of kerbs.

Where kerbs and gutters are adjacent to a concrete base pavement:

- Construct gutter placed integrally with the base as specified for the base.

- Kerb and gutter alongside the base and tied to the base may be placed using fixed forms or by slip forming. The longitudinal joint shall be continuous over the full length without steps or offsets and shall not deviate from a 3 m straight edge by more than 20 mm after due allowance for planned curvature. The longitudinal joint shall be corrugated and tied as shown on the Drawings and as specified for the base.
- Kerb and gutter alongside, but not tied to, the base may be constructed in fixed forms or by extrusion or slip forming. Seal the longitudinal joint as shown on the Drawings. The joint need not be corrugated unless shown as corrugated on the Drawings.
- Provide kerbs placed on top of a concrete base with ties as shown on the Drawings.

Where kerb and gutter is placed after construction of the concrete base:

- complete the joint sealing in the base before the construction of the kerb and gutter to prevent the ingress of mortar into joints in the base, and
- where the kerb and gutter is to be placed alongside the base, extend the sealant down the full vertical face of transverse base joints and any underlying crack which exceeds 1 mm in width.

Where the kerb and/or gutter is to be constructed before the base and the kerb and gutter lip is to be level with the upper surface of the base (but not when the lip is to be above the upper surface of the base to allow for an asphalt wearing course), the radius of the lip of the gutter adjacent to the base shall not exceed 5 mm notwithstanding any larger radius shown on the Drawings.

Untied joints in the concrete base shall continue across the kerb and gutter in the same joint type and on the same alignment. Tied joints need not continue into the kerb. Only place additional joints in the kerb and gutter where shown on the Drawings. Seal the joints with the same sealant as is used for joints in the base.

Where kerbs are placed on top of the concrete base, align each joint in the kerb with the underlying base joint.

Where kerb and gutter is placed alongside the base, joints in the kerb and gutter shall intersect at the common longitudinal joint (tolerance 15 mm) and their alignment shall be:

- in kerb and gutter which is placed integrally with the base, align joints with those in the base, otherwise
- align joints at an angle of 90° ± 5° to the line of the kerb.

Appendix M: Removal, replacement and rectification

M.1 Remove and replace concrete base

M.1.1 General

Deal with detritus from sawcutting operations in accordance with MRTS51 *Environmental Management*.

Replace the nonconforming base in full slab widths between longitudinal joints and/or external edges.

Carry out paving by the slipform method where practicable.

M.1.2 Jointed base

Make a transverse sawcut at each end of the section to be removed:

a) in a straight line and continuous between adjacent longitudinal joints and at an angle of 90° ± 6° to the longitudinal joint

b) at a location not closer than 1.5 m to a transverse contraction joint in the concrete which is to remain

c) for the full depth of the base without over-sawing into the adjacent base or the underlying subbase.

At each longitudinal edge of the nonconforming base:

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

b) Prepare each longitudinal joint in compliance with the criteria for longitudinal construction joints as defined in this Technical Specification.

Any additional internal sawcuts shall be made without over-sawing into the adjacent base or the underlying subbase. Any base adjoining the removed slabs, which is damaged by the Contractor's operations, shall also be removed and replaced.

Dispose of the removed base slabs in accordance with MRTS51 *Environmental Management*.

Prepare and debond the subbase in accordance with MRTS39 *Lean Mix Concrete Sub-base for Pavements* before construction of the replacement base.

All work involved in the replacement of base shall conform to this Technical Specification, including the following requirements:

a) Seal all joints and cracks which become exposed with silicone sealant to prevent the ingress of mortar and other incompressible matter.

b) At tied joints, the joint faces on the adjoining slabs shall be scabbled (unless the removal has resulted in the exposure of a corrugated face), and assessed and treated in accordance with Clauses K.2 and K.6, including the installation of tiebars as appropriate.

c) Transverse contraction joints shall be continuous across the full width of the base containing the replaced section. Seal the length of the joint across the full width of the base with a silicone sealant that conforms to this Technical Specification.

M.1.3 CRCP base

In CRCP base, the proposed method shall take appropriate account of the daily movements within the adjacent base.

Make a transverse sawcut at each end of the section to be removed:

a) in a straight line and continuous between adjacent longitudinal joints and at an angle of 90° ± 6° to the longitudinal joint

b) to a depth of 50 mm ± 5 mm

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

d) without over-sawing into the adjacent base.

Remove the concrete within these sawcuts in such a way that:

i) The face of the construction joint is left scabbled below, but not within, the depth of the sawcut.

ii) Not less than 0.15 m of every longitudinal bar is left protruding and undamaged beyond those joints. Mechanical couplers shall be used at all of these laps in lieu of tied laps.

At each longitudinal edge of the nonconforming base:

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

b) Prepare each longitudinal joint in accordance with the criteria for longitudinal construction joints.

Any additional internal sawcuts shall be made without over-sawing into the adjacent base or the underlying subbase. Any base adjoining the removed slabs, which is damaged by the Contractor's operations, shall also be removed and replaced.

At the time of casting replacement concrete, the longitudinal steel shall be straight and shall not be in compression.

Dispose of the removed base concrete in accordance with MRTS51 *Environmental Management*.

M.2 Diamond grinding

Carry out the work in accordance with RMS R93 as modified hereunder.

Unless otherwise stated in Clause 1 of Annexure MRTS40.1, grinding equipment shall create a longitudinal texture as follows:

a) grooves shall be uniformly spaced using 3.2 mm wide blades separated by 2.5 mm wide blade spacers, and

b) with a minimum average texture depth in accordance with Clause 8.5.7.

Grinding shall not be carried out until all necessary slab replacements have been completed within the area to be ground.

Where grinding is required, it shall be carried out over the full width of a traffic lane.

Appendix N: Steel fibre reinforced concrete

N.1 General

The requirements for the supply and placement of SFRC and SFCP are the same as for base concrete and concrete base pavement in this Technical Specification, except as provided in this appendix. The requirements of this appendix are in addition to, and where in conflict, in place of, the requirements of the other clauses of this Technical Specification.

The use of SFRC is limited to applications specifically shown in the Drawings. In summary:

a) it is always used in SFCP and SFCP-R

b) it is not used in PCP or JRCP

c) it is not used in CRCP under this Technical Specification.

N.2 Materials

N.2.1 Steel fibres

Steel fibres shall comply with the following properties determined in accordance with EN 14889-1:

a) Ultimate tensile strength equal or exceeding 750 MPa.

b) Aspect ratio (λ) shall be greater than 30 and less than 68.

c) Hardness (Group II fibres only) shall be greater than 84 HRB (Hardness Rockwell; B Scale).

Do not use fibres that are longer than 50 mm.

N.3 Mix design

N.3.1 Strength

Compressive strength testing is only required as follows:

a) in the trial mix and in the paving trial, at both seven and 28 days

b) in the Works at seven days for the purpose of a statistical check on concrete uniformity (in accordance with Clause 8.4.1.1).

Table N.3.1(a) lists the minimum requirements for compressive and flexural strength at 28 days. Compressive and flexural strength specimens shall be of the size listed in Table N.3.1(b).

Table N.3.1(a) – Minimum concrete strengths for SFRC

Description	Compressive strength	Flexural strength
In the trial mix	40.0 MPa (F_{28Min})	5.8 MPa (F_{f28Min})
In the Works	Not applicable	5.5 MPa (f_{fMin})

Take care during sampling and moulding to minimise disturbance to the fibre distribution and orientation in the test specimens.

Table N.3.1(b) – SFCP specimen sizes

Fibre length L_f (mm)	Flexure specimens		Compression specimens
	Specimens size (mm)	Standard reference	Specimen diameter (mm)
$L_f \leq 33$	100 x 100 x 350	AS 1012.8	100
$33 < L_f \leq 50$	150 x 150 x 500	AS 1012.8	150

Key:

L_f = maximum length of steel fibre in the mix.

N.3.2 Consistence

The nominated slump shall be within the ranges as follows:

a) for fixed-form (manual) paving: 50–60 mm

b) for slipform paving: 15–40 mm.

N.3.3 Air content

Do not use air entraining agent in SFRC.

N.3.4 Fibre dose rate

Determine the minimum allowable unit mass of steel fibre (M_f) as follows:

$$M_f = \frac{F \times F_S \times F_D}{F_A \times \lambda \times 100}$$

Or 55 kg/m³, whichever is the higher.

where:

M_f = minimum unit mass of steel fibre (kg/m³)

F = fibre factor (25)

F_S = fibre size factor as per Table N.3.4(a)

F_D = fibre density (7850 kg/m³)

F_A = fibre anchorage performance factor as per Table N.3.4(b)

λ = fibre aspect ratio (refer to EN 14889-1).

Table N.3.4(a) – Steel fibre size factor (FS)

Volume of single fibre (mm³)	Size factor (f_s)
0–5	1.2
6–10	1.3
11–20	1.4
21–30	1.5
31–40	1.6

Volume of single fibre (mm^3)	Size factor (f_s)
41–50	1.7
51–60	1.8

Table N.3.4(b) – Steel fibre anchorage performance factor (FA)

Category	Characteristic fibre shapes		Anchorage performance factory (F_A)
No deformation			0.7
Fully deformed			0.75
Partially deformed (or anchored)([1])		5–20% deformation	0.8
		21–50% deformation	0.9
		51–99% deformation	0.7

Notes:

([1]) For partially deformed fibres, the proportion of deformation is calculated as follows:

Deformation % = $(L_a + L_b)/L * 100$

N.3.5 Nominated concrete mixes

N.3.5.1 Nominated mix submission

Include in the submission details of the source, dimensions and nominated mix quantity of steel fibres.

N.3.5.2 Variations to authorised mix

If the Contractor wishes to vary the quantity of steel fibres in the authorised mix, submit a new nominated mix in accordance with Clauses 7.7.1 to 7.7.3.

N.4 Process control

N.4.1 Mixing and transport

The method of charging the mixer shall be consistent with the recommendations of the supplier of the steel fibre.

The permissible tolerance for weigh batching of steel fibres is +10% and -0%.

N.4.2 Mixer uniformity testing and mixing time

The minimum mixing time for SFRC is:

a) 5.0 minutes for initial mixing

b) as determined from mixer uniformity testing (Appendix G) for subsequent re-mixing.

N.4.3 Texturing of surface

Provide light brooming in lieu of the longitudinal hessian-drag. Brooming may be either longitudinal or transverse.

N.5 End product criteria

Compliance of strength in the Works is based on 28 day flexural strength. The 28 day compressive strength testing is not required in the Work except for the paving trial.

N.5.1 Concrete compaction

The relative compaction of SFCP shall be determined in accordance with the following equation:

Relative Compaction = (MUV_{core} / *RBUM*) * 100%

where:

MUV_{core} = mass per unit volume of the core (kg/m³)

R_{BUM} = representative beam unit mass (kg/m³)

Determine the unit mass of all beams which are moulded for 28 day flexural strength testing. Test in accordance with Appendix P. The unit mass for a set of beams is the average of individual results not more than 20 kg/m³ from the median value. Round the averaged result to the nearest 5 kg/m³.

For the paving trial, the RBUM is the mean of all 28 day sets from that trial of the same concrete mix. Round the mean result to the nearest 5 kg/m³.

Thereafter, take the RBUM for any sublot as the mean of the five consecutive sets of 28 day beams of that mix up to and including that sublot (including the results from the paving trial, where applicable). Where fewer than five sets of a nominated mix are available, take the RBUM as the mean of all available sets from that mix. In each case, round the mean result to the nearest 5 kg/m³.

N.5.2 Concrete flexural strength

For each sublot of base, mould a set of three test specimens to determine the flexural strength at 28 days. Determine the flexural strength of the specimens in accordance with Clause P3.2.4, except specimens shall be standard beams conforming to Table N.3.1(b).

Flexural strength in the Works shall comply with Table N.3.1(a). If the 28 day flexural strength of test beams for any sublot is less than 5.0 MPa, the sublot represented by the test beams shall be removed and replaced in accordance with Clause 9.6.

The Administrator may, based on an engineering risk assessment, accept sublots with flexural strength between 5.0 MPa and 5.5 MPa. Typically, this dispensation would be limited to a maximum of 1 in 20 sublots and be based on appropriate corrective action by the Contractor.

Appendix O: Not used

Appendix P1: Using two batches of the trial mix

Where it is impractical to mould all trial mix specimens from a single batch, use two batches and mould the test specimens as follows:

Batch no.	Specimen grouping
1	a) cementitious content per yielded cubic metre of concrete b) compressive strength at age seven days (F_7) c) compressive strength at age 28 days (F_{28}) d) flexural strength at age seven days (F_{f7}) e) flexural strength at age 28 days (F_{f28}) f) indirect tensile strength at age 28 days (F_{t28}) g) drying shrinkage
2	a) Vebe reading b) air content c) bleeding d) AF factors (optional) e) compressive strength at age 28 days (F_{28})([1])

Notes:

([1]) Repeat compressive strength at age 28 days in order to demonstrate between-batch consistency.

Appendix P2: Chloride and sulfate content testing

P2.1 General

Determine chloride ion content and sulfate ion content by either:

a) testing concrete constituents in accordance with Clause P2.2, or

b) testing hardened concrete in accordance with Clause P2.3.

P2.2 Testing of concrete constituents

Conduct chloride content testing in accordance with:

a) AS 1012.20 for aggregates

   i. AS 2350.2 for cement

   ii. AS 3583.13 for SCMs

   iii. Appendix C of AS 1478.1 for water and admixtures dissolved in water

   iv. then calculate the total content in the mix.

b) Conduct sulfate content testing in accordance with:

   i. AS 1012.20 for aggregates

   ii. AS 1289.4.2.1 for water and admixtures dissolved in water

   iii. AS 2350.2 for cementitious materials

   iv. then calculate the total content and percentage in the mix.

For admixtures, the soluble salt contents may be taken as the values certified in writing by the manufacturer.

For water, test 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 can be used.

P2.3 Testing of hardened concrete

Conduct chloride and sulfate content testing in accordance with AS 1012.20. The water used in the concrete shall be from the source proposed for the Works.

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 0.01 to 0.02 N. Use the Volhard method calibrated using a concrete with known chloride content for the test.

Appendix P3: Concrete strength testing

P3.1 Trial Batch

P3.1.1 Compressive strength (trial batch)

To determine the compressive strengths F_{f7} and F_{f28} for each trial batch:

a) test a minimum of three specimens at age seven days and a minimum of three specimens at age 28 days

b) specimens shall be cylinders of 100 mm diameter

c) make and cure specimens in accordance with AS 1012.8.1, except mould the cylinders in accordance with RMS T304.

RMS T304 requires compressive strength specimens to be compacted using internal electric vibration

d) determine the unit mass of all specimens in accordance with Appendix P4

e) test the specimens for compressive strength (including inspection, capping and crushing) in accordance with AS 1012.9

f) F_{f7} and F_{f28} are the mean of all individual results not more than 2.0 MPa from the median value.

P3.1.2 Flexural strength (trial batch)

To determine the flexural strength for each trial batch:

a) test a minimum of three specimens at age 28 days and a minimum of three specimens at age seven days

b) specimens shall be beams with dimensions 100 x 100 x 350 mm

c) make and cure specimens in accordance with AS 1012.8.2, except mould the beams in accordance with RMS T304.

RMS T304 requires flexural strength specimens to be compacted using either internal electric or table vibration.

d) determine the unit mass of all specimens in accordance with Appendix P4

e) test the specimens for flexural strength in accordance with AS 1012.11

f) the flexural strengths F_{f28} and F_{f7} are the mean of all individual results not more than 0.5 MPa from the median value.

P3.1.3 Indirect tensile strength (trial batch)

To determine the indirect tensile strength for each trial batch:

a) test a minimum of three specimens at age 28 days

b) specimens shall be cylinders of 100 mm diameter

c) make and cure specimens in accordance with the requirements for compressive strength cylinders (refer to Clause P3.1.1)

d) determine the unit mass of all specimens in accordance with Appendix P4

e) test specimens in accordance with AS 1012.10

f) the indirect tensile strength F_{t28} is the mean of all individual results not more than 0.5 MPa from the median value.

P3.2 Production mix

P3.2.1 Compressive strength (cylinders) (production mix)

To determine the seven day compressive strength (f_{c7}) and 28 day compressive strength (f_c) of cylinders from production:

a) Test specimens in pairs, with each specimen of a pair moulded from the same sample of concrete.

b) Sampling shall conform to AS 1012.1.

c) For concrete delivered by mobile mixer, sampling shall occur at the point of discharge or the point of testing, and after final retempering.

d) Specimens shall be cylinders of 100 mm diameter.

e) Make and cure specimens in accordance with AS 1012.8.1, except mould the cylinders in accordance with RMS T304.

RMS T304 requires compressive strength specimens to be compacted using internal electric vibration.

f) Determine the unit mass of all specimens in accordance with Appendix P4.

g) Test the specimens for compressive strength (including inspection, capping and crushing) in accordance with AS 1012.9.

h) For 28 day compressive strength, if the age of the test specimens is greater than 28 days at the time of compressive strength testing, adjust the test results for age in accordance with Clause P3.3.

i) The compressive strength of concrete represented by a pair of cylinders is the average test value, except that the higher result applies if the difference in the results exceeds 10% of the average. However, as soon as 10 pair results become available, the following condition applies:

   i. if the mean of such differences for 10 consecutive pairs (up to and including that in question) is greater than or equal to 5% of the mean strength value for all 20 cylinders, then the compressive strength for a pair is taken as the average of the two results.

P3.2.2 Compressive strength (cores)

Where core strength testing is required, it shall be carried out as follows:

a) take two cores at locations separated by at least one-third of the length of the sublot

b) for transition sublots, take one core

c) wet-condition the cores up to the time of testing and in accordance with AS 1012.14, except that the requirement in AS 1012.14 for submerging cores in water for three days may be amended to be not less than two days nor more than three days

d) adjust the test results for age and shape in accordance with Clause P3.3.

Do not take additional cores for this purpose without the prior approval of the Administrator.

P3.2.3 Compressive strength (cores to assess trafficking strength)

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

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

c) The requirements of Clause 9.3.2.2 apply except that strength assessment for trafficking purposes may be based on a single core per sublot.

d) Assessment of any particular sublot shall be based on not fewer than three core results of equal or lesser age (in days) compared with the sublot under assessment.

e) Upon determination of a compliant insitu strength of any sublot, all concrete placed before that sublot using the same concrete mix may be assumed to have achieved an equivalent trafficking strength.

P3.2.4 Flexural strength (production mix)

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

Specimens for seven day testing are required only from the paving trial (as per Appendix H).

To determine the flexural strength of the production mix:

a) Sampling shall be in accordance with AS 1012.1. For agitator delivered concrete, sampling shall take place at the point of discharge after all retempering.

b) Specimens shall be beams with dimensions 100 x 100 x 350 mm.

c) Mould specimens in sets of three, at the frequencies given in Table P3.2.4.

This means three specimens for each seven day test result (in the paving trial) and three specimens for each 28 day test result.

d) Mould all specimens within a set from the same sample of concrete.

e) In the paving trial, mould the seven day and 28 day flexural specimens from the same batch of concrete.

f) Mould specimens from the same batches of concrete used to make cylinders for assessing conformance of 28 day compressive strength.

Moulding of multiple samples from the same batch requires care in sampling if a load comprises more than one batch.

g) Make and cure specimens in accordance with AS 1012.8.2, except mould the beams in accordance with RMS T304.

RMS T304 requires specimens to be compacted using either internal electric or table vibration.

h) Determine the unit mass of all specimens in accordance with Appendix P4.

i) Test the specimens for flexural strength in accordance with AS 1012.11.

j) For 28 day flexural strength, if the age of the test specimens is greater than 28 days at the time of flexural strength testing, adjust the test results for age in accordance with Clause P3.3.

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

Table P3.2.4 – Minimum frequency of flexural test specimens

Project stage	Minimum frequency (sets)	
	Seven day testing	**28 day testing**
Paving trial	As per Appendix H	
and thereafter		
From the first three sublots using that mix([1])	Nil	One per submot
and thereafter		
For daily outputs ≤ 200 m³ For daily outpus > 200 m³	Nil Nil	One One per 400 m³

Notes:

([1]) The sublots are those determined in accordance with Appendix A.

P3.3 Age and shape correction factors

Correction factors for age (AF) and shape (SF) are given in Table P3.3(a) and Table P3.3(b) respectively. For intermediate ages, determine AF on a pro-rata basis rounded to two decimal places.

Alternatively, the Contractor may derive AF for the mix as follows:

a) derive AF for cylinders and beams as a part of the trial mix or on the basis of standard cylinders cast during the Works, and

b) calculate AF for cores by apportioning the cylinder AF in the ratio used at specific ages in Table P3.3(a).

Multiply the test strength by factor SF and divide by factor AF to derive the factored strength. Apply the correction factors to the unrounded strength.

Table P3.3(a) – Age correction factors

Age of specimen at time of test (days)	Age correction factor (AF)					
	Compressive strength				Flexural strength(2)	
	Cyclinder		Cores		Beams	
	SCM content (%)(1)					
	0	≥ 15	0	≥ 15	0	≥ 15
28(3)	1.00	1.00	0.90	0.90	1.00	1.00
35	1.02	1.03	0.93	0.94	1.01	1.02
42(3)	1.04	1.06	0.96	0.98	1.02	1.03
49	1.06	1.09	0.98	1.01	1.02	1.04
56(3)	1.08	1.12	1.00	1.04	1.03	1.05
70	1.10	1.15	1.02	1.07	1.03	1.07
84	1.12	1.18	1.03	1.09	1.04	1.07
112(3)	1.14	1.21	1.06	1.12	1.05	1.09
140	1.16	1.24	1.07	1.14	1.06	1.11
168	1.18	1.27	1.08	1.16	1.07	1.12
196	1.20	1.30	1.09	1.18	1.07	1.12
224	1.22	1.33	1.09	1.19	1.08	1.13
308	1.24	1.36	1.10	1.20	1.09	1.13

Notes:

(1) Relative to the total cementitious content.

(2) Not specified for sublot compliance.

(3) Where the Contractor elects to derive AF for the mix, data shall be obtained, as a minimum, at these ages, with a tolerance of three days.

Table P3.3(b) – Shape correction factors for cores

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

Appendix P4: Unit mass of cylinders, cores and beams

P4.1 Unit mass of cylinders

Determine the unit mass of cylinders in accordance with AS 1012.12.2, amended as follows:

a) Determine m_1 the initial mass of the specimen before dressing, in accordance with AS 1012.12.2 Section 6(a) and in the SSD condition. This will require wet conditioning for 24 hours in accordance with Section 6(c).

b) Assess the cylinder in accordance with Q473 for excessive voids. Dress and/or seal voids where required.

c) Determine m^2 the immersed mass, including dressing in accordance with AS 1012.12.2.

d) Determine m^3 the SSD mass, including dressing. The dressing shall be fully intact at the time of weighing. It may be simpler to assess the cylinder MUV without dressing.

e) Calculate the volume and mass per unit volume in accordance with AS 1012.12.2.

f) The concrete age at testing shall be at least three days.

g) Report the height and diameter of the core, as tested.

h) Round individual results for unit mass to the nearest even number (in contrast to AS 1012.12.2 which requires rounding to the nearest 10 kg/m^3).

P4.2 Unit mass of cores

Determine the unit mass of cores in accordance with AS 1012.12.2, amended as follows:

a) Test the full core, except:

   i. remove materials such as bitumen, if present

   ii. up to 15 mm of concrete may be removed from each end of the core where it can be demonstrated to constitute planned nonhomogeneity (such as surface texture).

b) Determine the initial mass (m^1) of the specimen, including any steel but before dressing, in accordance with AS 1012.12.2 Section 6(a) and in the SSD condition. This will require wet conditioning for 24 hours in accordance with Section 6(c).

c) Assess the cores in accordance with Q473 for excessive voids. Dress and/or seal voids where required.

d) Determine the immersed mass (m^2), including steel and dressing in accordance with AS 1012.12.2.

e) Determine the SSD mass (m^3), including steel and dressing. The dressing shall be fully intact at the time of weighing.

f) Calculate the volume and mass per unit volume in accordance with AS 1012.12.2.

g) The concrete age at testing shall be at least three days.

h) Adjust the unit mass for the presence of steel reinforcement in accordance with Q473.

i) Report the height and diameter of the core, as tested.

j) Round individual results for unit mass to the nearest even number (in contrast to AS 1012.12.2 which requires rounding to the nearest 10 kg/m³).

P4.3 Unit mass of beams

Determine the unit mass of beams in accordance with AS 1012.12.2, amended as follows:

a) Mass testing shall be in the saturated-surface-dry condition and without dressing of voids; (refer to Q473).

b) The concrete age at testing shall be between four and seven days.

c) Round individual results for unit mass to the nearest even number (in contrast to AS 1012.12.2 which requires rounding to the nearest 10 kg/m³).

Appendix P5: Air content testing

Air content of fresh concrete shall be determined in accordance with AS 1012.4.2 with compaction by internal vibration, except the vibration pattern and duration shall be as per RMS T304.

Appendix P6: Consistence testing (production)

P6.1 Sampling procedure

Sample for consistence testing as follows:

a) For tipper delivery: Obtain a composite test sample in accordance with Section 7.3 of AS 1012.1. Take the sample before discharge from the truck using a shovel or scoop. Exclude the top 100 mm.

b) For agitator delivery: The test sample shall be an individual sample obtained in accordance with Section 7.2.2 of AS 1012.1.

P6.2 Testing frequency

The minimum frequency of routine testing is as follows:

a) For tipper delivery

   i. Initial daily slumping:

      Test every load before discharge until eight consecutive conforming loads are tested. Calculate the SD of these eight loads.

      If SD is less than or equal to 8.0 mm, go to Process Slumping.

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

   ii. Process slumping:

      Slump test every fourth load. Visually check every intermediate load before discharge, and test the slump for any load which appears, in the opinion of either party, to be nonconforming.

      Allow visual assessment only by the testing staff, and only at the testing station.

      Record visual checks as, for example, V30, V40 for Visual 30 mm and 40 mm respectively.

      If a nonconforming slump is measured, slump test all loads thereafter (before discharge) until the SD of six consecutive loads is less than or equal to 8 mm, at which time testing may revert to each fourth load.

      Additionally, slump test every load from which samples are taken for other tests on the concrete or its constituents.

b) For delivery by mobile mixer:

   i. Initial daily slumping:

      Test every load before discharge until four consecutive conforming batches are tested, and thereafter.

      Test every alternate batch for slump.

   ii. Conduct additional slump testing as required in accordance with the provisions for retempering in Clause 8.4.2.6.

Appendix P7: Compaction testing

P7.1 Calculation of relative compaction

The relative compaction of PCP, JRCP and CRCP shall be determined in accordance with the following equation:

$$Relative\ Compaction = (MUV_{core} / RCUM) * 100\%$$

where:

MUV_{core} = mass per unit volume of the core (kg/m³)

R_{CUM} = representative cylinder unit mass (kg/m³)

The relative compaction shall be reported to the nearest 0.1%.

P7.2 Moulding and testing of cylinders

Determine the unit mass reference values for concrete compaction using standard moulded cylinders and in accordance with the following provisions:

a) test cylinders are those which are moulded for 28 day compressive strength testing

b) test at an age of between four and seven days

c) determine the MUV of all cylinders in accordance with Appendix P4

d) the unit mass for a pair of cylinders is the average of the two individual results, unless they differ by more than 20 kg/m³, in which case the higher result represents the unit mass of the pair. Round the averaged result to the nearest 5 kg/m³.

For each nominated mix in use, make a statistical check to determine the RCUM using the pair unit mass as defined under sub-clause ‘d)’.

For the paving trial, the RCUM is the mean of all 28 day pairs from that trial of the same concrete mix. Round the mean result to the nearest 5 kg/m³.

Thereafter, take the RCUM for any sublot as the mean of the five consecutive pairs of 28 day cylinders of that mix up to and including that sublot (including the results from the paving trial, where applicable). Where fewer than five pairs of a nominated mix are available, take the RCUM as the mean of all available pairs from that mix. In each case, round the mean result to the nearest 5 kg/m³.

Do not use the unit mass of beams or seven day compressive strength cylinders in calculations of the RCUM.

P7.3 Core specimens

P7.3.1 General

Specimens for determining the relative compaction of concrete shall be cores of nominal diameter 75–100 mm, cut and extracted from the full depth of the concrete base, in accordance with AS 1012.14. Secure the cores as soon as practicable without causing damage to the cores or the pavement, but no later than two calendar days after paving.

Within two hours of being extracted, place the cores in either a tank of lime saturated water or individual plastic bags that are sealed to prevent water loss and stored in the shade.

Cores shall not be subjected to temperatures:

a) in excess of the ambient temperature or 28°C, whichever is higher, and

b) less than 10°C.

The frequency and location of coring shall conform to Clause P7.3.2.

Test all cores for unit mass in accordance with Clause P7.3.4 and report all results.

P7.3.2 Frequency and location of coring for compaction

The sublots for determining compaction are based on the sublots created in accordance with the definitions in Appendix A. Transition zones generate separate sublots.

a) In slipformed concrete:

   i. take at least one core specimen from each sublot until 10 consecutive conforming sublots (that is, not less than 98.0% compaction) are obtained, and then

   ii. at least one core from each second sublot until a further 10 consecutive conforming sublots are obtained, and then

   iii. one core from each third sublot.

In each case, avoid transition zones and select sampling sublots on the basis of time sequence.

If a nonconforming result is obtained, the frequency of testing, commencing from the nonconforming sublot, reverts to that specified in sub-clause ‘i.’.

b) In manually paved base, take two cores from each sublot. The core locations shall be separated by at least one-third of the length of the sublot.

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

   i. Two cores from each sublot until three consecutive conforming sublots (that is, not less than 98.0% compaction) are obtained; and then

   ii. Two cores from each third sublot, which shall be selected on the basis of time sequence, until four consecutive sublots conform; and then

   iii. One core from each fifth sublot, which shall be selected on the basis of time sequence.

If a nonconforming result is obtained, the frequency of testing, commencing from the nonconforming sublot, reverts to that specified in sub-clause ‘i.’.

Choose the location of coring by random stratified sampling in accordance with Q050, except adjust the lateral coordinate to coincide with the nearest grid line established in accordance with the criteria shown for a dual-lane paving run in Figure P7.3.2. Apply consistent criteria for single-lane paving runs such as shoulders and ramps.

Use a metal detector to locate all bar and mesh reinforcement and locate core holes to maximise the chance of avoiding it.

Adjust the longitudinal coordinate by the minimum extent necessary to:

a) exclude reinforcement and tiebars from the core (except when testing compaction around tiebars) or as otherwise required by the Administrator to assess process uniformity

b) in jointed pavements, to maintain a longitudinal separation of 1.0 m minimum from any transverse untied joint.

In continuously reinforced pavement, adjust the transverse and longitudinal coordinates by the minimum extent necessary to avoid the reinforcement.

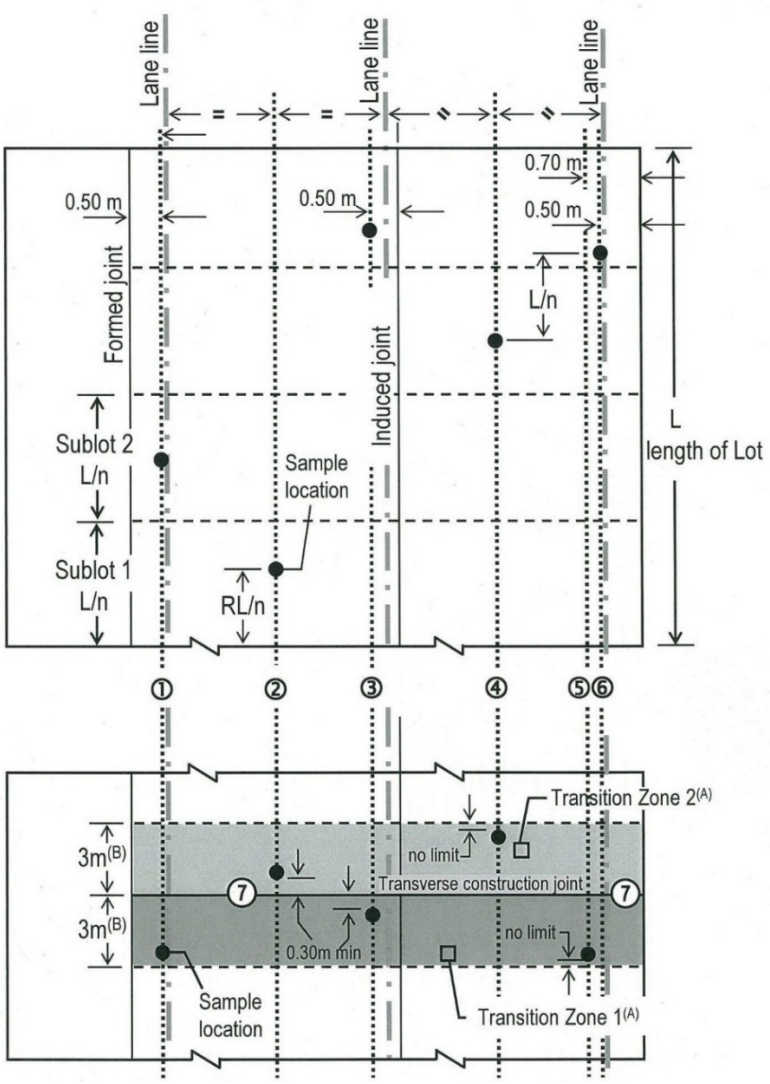
For small and/or odd-shaped slabs in all Base types, avoid coring:

a) within 0.50 m of an edge or longitudinal joint

b) within 0.30 m of a transverse tied joint

c) within 1.5 m of a transverse untied joint.

Figure P7.3.2 – Sampling locations for a dual-lane paving sublot



Notes:

(A) Transition Zones apply to slipform paving only.

(B) ~ or as otherwise nominated under Clause 8.5.4(b).

P7.3.3 Repair of core holes

Clean and restore all core holes taken in the base with low-shrink cementitious concrete having a compressive strength not less than that of the base. The authorised base mix may be used for this purpose.

The surface of the restored hole shall be similar in colour to the surrounding surface. Before trafficking, the concrete in the core shall be cured sufficiently to achieve an expected compressive strength of 10 MPa. Demonstrate the expected strength gain by previous testing or by a technical data sheet.

P7.3.4 Reporting unit mass of cores

Determine the unit mass of cores in accordance with Appendix P4.

Where two cores are available from a sublot, the unit mass of the sublot is the average of the individual test results unless they differ by more than 20 kg/m³, in which case the lower result applies. Round averaged results to the nearest 5 kg/m³.

Where three or more cores are available from a sublot, the unit mass of the sublot is the mean of the individual test results. Round the mean to the nearest 5 kg/m³. However, if the lowest result differs from the mean by more than 30 kg/m³, the lowest result applies.

P7.4 Within-core variability

Test cores for within-core variability at a frequency as follows:

a) for cores taken to assess compaction around tiebars (Appendix E), test all cores

b) for cores extracted to assess compaction conformity (Clause 9.2.1):

   i. at a frequency of one in five commencing at the paving trial until five consecutive conforming results are obtained, and thereafter

   ii. at a minimum frequency of one in 10 unless a nonconformity occurs, in which case the frequency reverts to ‘i.’

   iii. select cores for variability testing on the basis of time sequence of paving

   iv. if fewer than five cores are required in the paving trial, take an additional one core for variability testing.

For cores which will be assessed for within-core variability, do not dress voids before sawcutting. Testing for the unit mass of the full core is optional but if testing is done, the report shall include a description of its void condition and its conformity (or otherwise) with Q473 in terms of voids and steel.

Prepare and test for within-core variability as follows:

a) Divide the cores as follows:

   i. Cores from CRCP, JRCP, PCP-R, SFCP-R and all tiebar cores, saw each core horizontally along the line of the reinforcement.

      If the core contains no reinforcement, sawcut along the line of the reinforcement in the slab from which the core was taken, with a tolerance of ± 15 mm. If the core contains bar or mesh, remove it by sawcutting each side of the steel to a maximum offset of 5 mm

each side as measured orthogonal to the axis of the core. Label and retain the sawn slice until its matching cores are discarded.

ii. Cores from PCP, SFCP, saw each core along the axis of the tiebar, with a tolerance of 5 mm and remove the tiebar.

b) Determine the unit mass of each specimen in accordance with Appendix P4.

c) Calculate the within-core variability which is the difference in unit mass between the upper and lower parts of the core.

d) Calculate the relative compaction of each specimen, as the percentage ratio of the specimen unit mass to the RCUM for the sublot.

Appendix P8: Sand patch texture testing preparation

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

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

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

a) for concrete which is deemed (under Clause 8.5.9.4) to have reached at least 20 MPa, ensure that each part of the target area receives between 15 and 20 passes. Apply a constant down force of approximately 20 kg

b) for concrete less than 20 MPa, cease grinding when the target condition has been achieved uniformly over the test area.

Sweep the test area before testing to completely remove all loose material.

Appendix P9: Surface profile testing

P9.1 Transverse profile

Test surface deviations in a transverse direction under a 3 m straight edge in accordance with Q712. Where the surface deviation is convex, place the straightedge so that the cantilever length does not exceed 0.75 m.

Commencing with trial paving, test for conformity with the straightedge criteria as follows:

a) within each day's paving at random locations at a minimum frequency of:

   i. one test per 15 m of paving run, until four conforming results are recorded, and thereafter

   ii. one test per 50 m of paving run.

b) across longitudinal joints, at a minimum frequency of:

   i. one test per 15 m of joint, until four conforming results are recorded, and thereafter

   ii. one test per 50 m of joint.

   Testing frequency reverts to 'i.' if nonconformity is detected.

c) testing, additional to the above, shall be undertaken at each superelevation transition at three random locations within 10 m, at both mid-slab and longitudinal joints.

P9.2 Longitudinal profile

Test the longitudinal profile by one of the following:

a) measuring deviations under a 3 m straight edge in accordance with Q712

b) testing with a Class 1 Profiler device in accordance with Q708D

c) a California Profilograph.

Test in each trafficked lane and the near-side shoulder in the following areas:

a) within 15 m each side of transverse construction joints.

b) At approach sections (as defined).

   Extend the limit of profile testing beyond the defined 15 m in accordance with Appendix P10 to cover any area paved under the Contract which cannot be tested for roughness. Profile testing shall also extend beyond the limit of the Contract (where an abutting running surface is available at base level) by at least 10 m or whatever lesser length is available.

c) at all slab replacements, including 10 m beyond the replacement in each direction.

Where a Class 1 Profiler or California Profilograph device is used, test using the following procedure:

a) Measure the surface profile along a straight line within 0.3 m of the centre of traffic lane and in accordance with the operating manual for the device in use.

b) A discontinuity in measurement occurs when the data acquisition system is reset during recording. At discontinuities in measurement of a profile, provide an overlap of at least 5.0 m

on a line within 0.01 m offset of the original, and record the chainage (longitudinal location) of the discontinuity to an accuracy of at least 0.2 m.

c) Discontinuities are not permitted in profile measurements of test lengths that are less than 100 m. Captured data shall be discarded and testing recommenced from the start point.

d) At junctions of testing lines at ramps and intersections of road pavement, extend the measurement for a distance of at least 1.0 m beyond the junction, and record the point of intersection to an accuracy of 1.0 m in both measurements series.

e) On road pavement at the approach to a bridge structure, extend the pavement profile testing onto the bridge approach slab or abutment by 15.0 m, or the maximum lesser length available.

f) Report deviations using the simulated straightedge function.

Appendix P10: Ride quality testing

Assess the ride quality of pavement sections nominated in Table P10.1.

Assess the finished surface (after completion of any required grinding and/or base replacement) using either a laser profilometer in accordance with Q708B or, a Class 1 Profiler in accordance with Q708D.

> Some sections may not be assessable. Such sections should be agreed with the Administrator.
>
> Minimum strength limits on trafficking the base (Clause 8.5.9.4) may influence the timing of testing.

Report the longitudinal profile in terms of International Roughness Index (IRI) (m/km).

Report results at intervals as follows:

- for test lengths of 100 m or less, at 10.0 m test intervals
- for test lengths greater than 100 m, at both 10.0 m and 100 m test intervals.

The roughness value for any segment is the average of three survey runs over that segment.

Roughness testing shall extend as close as practicable to approach sections (as defined). Any area not assessed for roughness shall be assessed for profile (using a Class 1 Profiler in accordance with Q708D). No area will be assessed on both tests.

Use the following procedure for testing.

a) Divide each nominated pavement test section into segments 100 m long.

   On multiple lane carriageways, test and assess each traffic lane separately.

   Include any segment less than 100 m with the segment immediately preceding it, and determine an average roughness for the total segment.

b) Include transverse construction joints in the count except where they constitute the limits of contract or where they border an area of pavement which is exempt from assessment for roughness. For the purpose of roughness testing, transverse joints are deemed to include the pavement within 5 m of the joint.

c) Conduct testing within each traffic lane and within the planned wheel paths, except that the testing line shall be adjusted to conform to sub-clause ‘d)’.

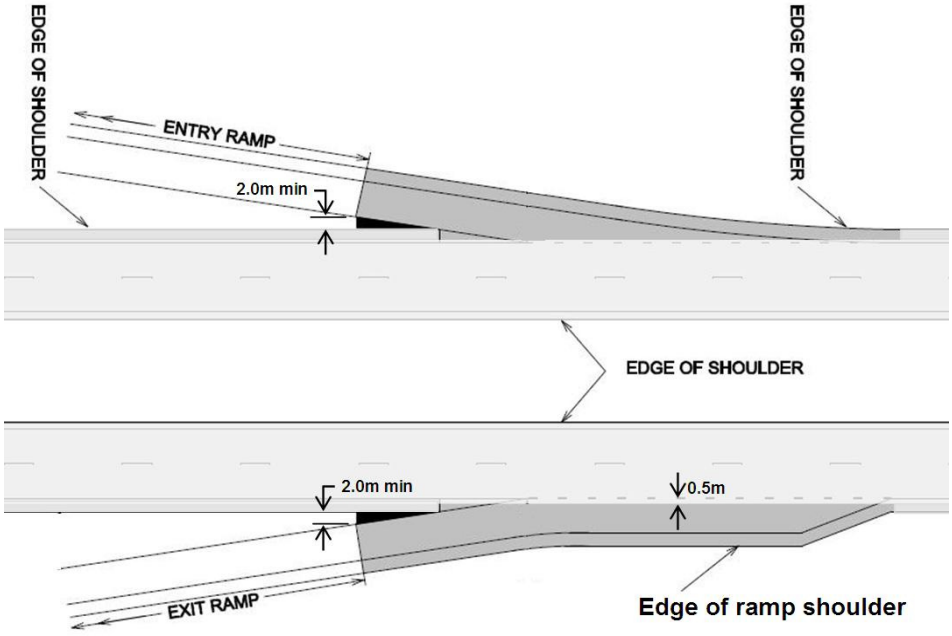
d) The testing wheels shall not run closer than 0.3 m to a formed longitudinal joint except in ramp junction zones as per ‘e)’.

e) Test ramp junction zones (as indicated in Figure P10.1) in the wheel path which a vehicle would typically follow when travelling on or off the through carriageway.

Ignore longitudinal joints within the ramp junction for the purpose of roughness testing.

For ramp junction zones which widen to dual ramp lanes, the roughness result is the average of separate runs along wheel paths leading to each lane.

Figure P10.1 – Ramp junction zones



Assign a Pavement Roughness Category (PRC), as per Table P10.1, for each test segment and report results accordingly.

Table P10.1 – Pavement roughness categories (PRC)

Nominated pavement section		PRC
Through carriageways	Trafficked lanes – longitudinal grade ≤ 4.0%	1
	Trafficked lanes – longitudinal grade > 4.0%	3
	Shoulders	3
Ramps([1])	Within ramp junction zones	3
	Beyond ramp junction zones • speed limit greater than or equal to 80 km/h • speed limit less than 80 km/h	 2 3
Minor roads	Speed limit greater than or equal to 80 km/h	3
	Speed limit less than 80 km/h	4
Project specific areas		Refer Clause 3 of MRTS40.1
Under asphalt surfacing		See Note ([2])

Notes:

([1]) Shoulders on ramps and minor roads are not to be separately assessed.

([2]) Under asphalt surfacing, the PRC will be one category below that applicable for the same pavement section if asphalt were not being added. (For example, a PRC of one would become two under an asphalt surfacing.)

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