Technical Specification

MRTS41 Concrete Pavement Base (Ancillary Works)

July 2023

Copyright

Licence

CC BY licence summary statement

In essence, you are free to copy, communicate and adapt this work, as long as you attribute the work to the State of Queensland (Department of Transport and Main Roads). To view a copy of this licence, visit: https://creativecommons.org/licenses/by/4.0/

Translating and interpreting assistance

The Queensland Government is committed to providing accessible services to Queenslanders from all cultural and linguistic backgrounds. If you have difficulty understanding this publication and need a translator, please call the Translating and Interpreting Service (TIS National) on 13 14 50 and ask them to telephone the Queensland Department of Transport and Main Roads on 13 74 68.

Disclaimer

While every care has been taken in preparing this publication, the State of Queensland accepts no responsibility for decisions or actions taken as a result of any data, information, statement or advice, expressed or implied, contained within. To the best of our knowledge, the content was correct at the time of publishing.

Feedback

Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Contents

1 Introduction

This Technical Specification applies to the construction of concrete pavement base in ancillary works using fixed forms.

Examples of ancillary works are:

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

This Technical Specification is not intended for footpaths, cycle paths, industrial pavements or airports.

Fixed-form paving involves constructing concrete pavement base between fixed formwork and using manually operated equipment, such as internal vibrators and vibrating screeds.

For larger projects and/or placement using a paver, MRTS40 *Concrete Pavement Base* should be used. Where there is doubt on the applicability of this Technical Specification to a particular project, advice should be sought from the department's Principal Engineer (Pavement Design).

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

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

2 Definitions of terms

The terms used in this Technical Specification are as defined in Clause 2 of MRTS01 *Introduction to Technical Specifications* and the referenced documents.

Abbreviations used in this Technical Specification are as defined in Table 2.

Table 2 – Definitions of terms

Term	Definition
CRCP	Continuously reinforced concrete pavement (base)
JRCP	Jointed reinforced concrete pavement (base)
PCP	Plain (jointed unreinforced) concrete pavement (base)
PCP-R	Discrete mesh reinforced slabs within PCP (base)
SFCP	Steel fibre reinforced concrete pavement (base)
SFCP-R	Discrete mesh reinforced slabs within SFCP (base)

3 Referenced documents

The requirements of the referenced documents listed in Table 3 below apply to this Technical Specification. Where there are inconsistencies between this Technical Specification and the referenced documents, the requirements specified in this Technical Specification shall take precedence.

Table 3 – Referenced documents

Reference	Title
AGPT02	*Part 2: Pavement Structural Design* of the *Austroads Guide to Pavement Technology,* Austroads
AS 2425	*Bar chairs in reinforced concrete - Product requirements and test methods*
AS 3799	*Liquid membrane-forming curing compounds for concrete*
ATS 3050	*Supply of Recycled Crushed Glass Sand,* Austroads
EN 14889-1	*Fibres for Concrete – Part 1: Steel Fibres - Definitions, Specifications and Conformity,* European Committee for Standardisation
MRTS01	*Introduction to Technical Specifications*
MRTS03	*Drainage Structures, Retaining Structures and Embankment Slope Protections*
MRTS40	*Concrete Pavement Base*
MRTS45	*Road Surface Delineation*
MRTS50	*Specific Quality System Requirements*
MRTS70	*Concrete*
MRTS71	*Reinforcing Steel*
MRTS77	*Bridge Deck*
SCM-P-015	*Supplier Registration Scheme: Bridges and Other Structures*

4 Standard test methods

The standard test methods given in Table 4 shall be used in this Technical Specification.

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

Table 4 – Standard test methods

Property to be tested	Method No.
Flexural strength of concrete	TfNSW T304, AS 1012.8.2, AS 1012.11
Mass per unit volume of hardened concrete (water displacement method)	AS 1012.12.2
Ride quality (roughness)	Q708B, Q708C, Q708D
Securing and testing cores from hardened concrete	AS 1012.14
Selection of sampling and test locations	AS 1289.1.4.2
Surface evenness (using a three metre straightedge)	Q712

Property to be tested	Method No.
Texture depth of road surfacings (sand patch)	AG:PT/T250

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 (10 business days)
6.5			Curing compound details (seven days)
6.6			Joint sealant details (seven days)
7.5	1. Approval of base mix design	1. Mixing of trial batch	Proposed concrete mix design submission (four weeks)
8.5.2	2. Base paving subject to successful paving trial (if specified)	2. Paving trial (if specified)	
8.5.3	3. Base paving subject to suitable construction procedures 4. Base paving subject to suitable formwork, reinforcement and equipment.	3. Placing and paving	
8.5.7.2	5. Trafficking of base (20 MPa) 6. Trafficking of base (25 MPa)		
9.3.4		4. Extracted cores	
9.9	7. Removal and replacement of nonconforming concrete base		

5.2 Quality Plan

The Contractor shall develop and implement a Quality Plan, including Construction Procedures, for the work in accordance with MRTS50 *Specific Quality System Requirements*. The plan shall also include the documents listed in Table 5.2.

The Quality Plan shall be submitted to the Administrator at least 10 business days before work commences.

Milestone

Submission details:	Quality Plan, including Construction Procedures, in accordance with MRTS50 *Specific Quality System Requirements* and Table 5.2 at least 10 business 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
8.2.4	Construction procedure: dowel support system and method of debonding
8.5.1 and Appendix A	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
8.5.5	Construction procedure: surface texturing
8.5.6	Construction procedure: curing
8.6	Construction procedure: joint construction and sealing
9.8	Inspection schedule for cracking in base slabs

5.3 Concrete paving crew training

The Contractor's representative on site during paving operations who is in charge of the paving crew, and at least one third of the remainder of the paving crew, shall hold a 'Grey Card' for successfully completing the *TfNSW Grey Card: Concrete Pavement Training* course. Details of such training shall be submitted 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 *TfNSW Grey Card: Concrete Pavement 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, tiebars and dowels
- receiving and placing concrete
- operating vibrating screeds
- compaction, finishing, texturing, curing, debonding and/or early age protection of concrete.

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

Grey Card' training is not mandatory for construction of indented bus stops and other similar small low risk Works as agreed with the Administrator. For these situations, details of other relevant training and paving crew experience shall be submitted as part of the Quality Plan.

6 Materials

6.1 General

Materials which are specified by reference to another Technical Specification (such as MRTS70 *Concrete*, MRTS77 *Bridge Deck* or MRTS71 *Reinforcing Steel*) shall conform to all the requirements of the referenced Technical Specification unless stated otherwise. This includes, but is not limited to product registration, material properties, material storage and testing.

Additional requirements for materials used in steel fibre reinforced concrete are detailed in Appendix C.

6.2 Aggregates

Aggregates shall conform to the requirements of MRTS70 *Concrete,* including the percent abrasion (Micro-Deval) loss requirement for fine aggregate.

Recycled crushed glass may be used as a partial replacement of fine aggregate up to 20% (by mass) of the fine aggregate component. The recycled crushed glass shall comply with ATS 3050.

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

6.3 Cementitious materials

Cementitious materials shall conform to the requirements of MRTS70 *Concrete*.

6.4 Chemical admixtures

Chemical admixtures shall conform to the requirements of MRTS70 *Concrete*.

6.5 Curing compounds

Curing compounds shall be registered proprietary products suitable for use in concrete road pavements. Curing compounds shall comply with the requirements of AS 3799 and the additional requirements in Table 6.5.

For registration, the supplier shall provide a certificate of compliance and NATA-endorsed test certificates showing compliance to AS 3799 and this Technical Specification. The certificate of compliance shall relate only to the formulation on which the tests were performed and shall be valid for not more than three years from the date of issue.

Registration of curing compounds for concrete pavements is through the department's *Supplier Registration Scheme: Bridges and Other Structures* (SCM-P-015). Products registered for use in concrete pavements will be designated accordingly in a future update to the registered product list.

Table 6.5 – Curing compound type and additional requirements

Application	Permitted Curing Compound Type	Additional Requirements
Concrete base (not where a bitumen seal or asphalt will be placed)	Hydrocarbon resin (HCR)	AS 3799 Class B Type 1-D, with minimum 30% non-volatile content.
	Water-borne hydrocarbon resin (WHCR)	AS 3799 Class B Type 1-D, with minimum 30% non-volatile content.
Concrete base (where a bitumen seal or asphalt will be placed)	Blended bitumen and water-borne hydrocarbon resin (B-HCR)	AS 3799 Class Z, with minimum 40% bitumen (by mass). To be compatible with the prime that will be applied later.
Joint debonding (not the top surface of the base)	Wax emulsion (WE)	AS 3799 Class A, with minimum 30% non-volatile content.

Curing compound residue shall be removed from areas where pavement marking material is to be applied. Residue removal shall be in accordance with MRTS45 *Road Surface Delineation*.

Milestone

Submission details:	Certification of curing compound conformance, including product name, registration certificate, technical data sheet and evidence of conformance with additional requirements in Table 6.5 at least seven days before used in the Works.

6.6 Joint sealant

Joint sealant shall be a propriety grey silicon sealant suitable for use in concrete road pavement joints. The silicon joint sealant shall conform to the requirements of MRTS77 *Bridge Deck*.

Milestone

Submission details:	Certification of joint sealant conformance, including product name, registration certificate and technical data sheet at least seven days before used in the Works.

6.7 Preformed joint filler

Preformed joint filler shall conform to the requirements of MRTS77 *Bridge Deck* for compressible filler.

6.8 Closed-cell polyethylene foam backing rod

Closed-cell polyethylene foam backing rod shall conform to the requirements of MRTS77 *Bridge Deck.*

6.9 Steel reinforcement

Steel reinforcement shall conform to the requirements of MRTS71 *Reinforcing Steel*.

6.10 Water

Water shall conform to the requirements of MRTS70 *Concrete*.

7 Concrete mix – design and acceptance

7.1 General

Concrete, including mix design and acceptance, shall conform to MRTS70 *Concrete*, and the additional requirements of this Technical Specification. All concrete in the pavement base shall be Special Class.

The concrete mix design adopted shall enable the production of a dense, non-segregated base to the design shape without excessive bleeding.

Additional requirements for design and acceptance of steel fibre reinforced concrete mixes are detailed in Appendix C.

7.2 Concrete class

The concrete class shall be as nominated in the design documentation and shall be either S32/20 or S40/20.

S32/20 or S40/20 concrete is typically used for indented bus stops, car parks and other similar small low risk areas with low volumes of slow-moving traffic.

S40/20 concrete is typically used in other situations such as bus stations, bus parking facilities, floodways, intersections/roundabouts and widenings.

Concrete strength requirements are as per MRTS70 *Concrete* which specifies concrete using compressive strength. For pavement design calculations, the following design flexural strengths should typically be used:

- S32/20 concrete – 4.0 MPa
- S40/20 concrete – 4.5 MPa

These presumptive design flexural strengths are based on the relationship between flexural strength and compressive strength in *Part 2: Pavement Structural Design* of the *Austroads Guide to Pavement Technology* (AGPT02). Results are conservatively rounded down on the basis that this Technical Specification does not require flexural strength checks on specific mixes.

7.3 Nominated slump

The slump nominated by the Contractor for each concrete mix used in the Works shall be a discrete value which is no greater than 100 mm.

Nominated slumps in the range of 50 mm to 80 mm have typically been used successfully for fixed form pavement concrete. Higher values up to 100 mm can be nominated but may introduce additional risks to the Contractor in meeting other aspects of this Technical Specification (including, but not limited to, compaction, homogeneity, bleeding, surface shape/crossfall and finishing). The Contractor remains responsible for ensuring the concrete mix and nominated slump suit the equipment and methods to be used, and for meeting all aspects of this Technical Specification.

Base concrete with a slump of 70 mm has been successfully pumped on Transport and Main Roads projects using a large capacity pump.

7.4 Other mix requirements

Maximum chloride ion content of hardened concrete (whether reinforced or not) shall conform to the requirements for reinforced concrete in MRTS70 *Concrete*.

7.5 Proposed mix design

The Contractor shall nominate the concrete mix to be used in the Works and provide a full mix design submission (in accordance with MRTS70 *Concrete*) not less than four weeks prior to the commencement of concreting operations.

Milestone

Submission details:	Nomination of proposed mix and full mix design submission at least four weeks prior to the commencement of concreting operations.

No concrete shall be placed in the Works until approval of the mix design has been obtained from the Administrator.

Hold Point 1

Process held:	Placement of concrete (including in the paving trial, if specified).
Submission details:	Proposed mix and full mix design submission
Release of Hold Point:	The Administrator will consider the submitted documents before authorising release of the Hold Point.

Mixes previously assessed by the department's Structures Construction Materials team against MRTS70 *Concrete* will need to be further assessed by the Administrator for conformance with the additional requirements of this Technical Specification prior to the release of Hold Point 1.

Mixes which have not been previously assessed by the department's Structures Construction Materials team will need to be assessed by the Administrator against both MRTS70 *Concrete* and the additional requirements of this Technical Specification prior to the release of Hold Point 1.

Where trial mixing is undertaken, each trial mix shall be a witness point with a notice period of three business days.

MRTS70 *Concrete* includes requirements for when trial mixing is necessary.

Witness Point 1

Process witnessed:	Mixing of trial batch.
Submission details:	Notice of time and location of trial mixing at least three business days prior to trial mixing.

8 Process Control

8.1 General

Works shall be constructed in accordance with the drawings.

Additional process control requirements for steel fibre reinforced concrete are detailed in Appendix C.

8.2 Placing steel reinforcement

8.2.1 General

Placement of steel reinforcement shall conform with the drawings, MRTS71 *Reinforcing Steel*, and the additional requirements of this Technical Specification.

8.2.2 Bar chairs

The reinforcement shall be supported in position using concrete, plastic or wire chairs that conform to the requirements of AS 2425 including a minimum strength grade of 200 kg. Bar chairs which are likely to impede compaction of the enveloping concrete shall not be used.

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.

In CRCP, chairs shall be placed 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.

8.2.3 Tiebars

Tiebars shall be pre-placed or drilled.

If requested by the Contractor, the Administrator may approve the use of inserted tiebars rather than pre-placed or drilled tiebars. Use of inserted tiebars will usually require a demonstration trial, in addition to pull-out testing and compaction assessment in accordance with MRTS40 *Concrete Pavement Base*.

8.2.4 Dowels

Dowels shall be pre-placed or drilled and shall:

a) Be straight and free of irregularities, including burrs and protrusions, which could hinder joint movement.

b) Be coated at one end (as shown on the drawings) with a tough, durable debonding agent of thickness 0.75 mm ± 0.25 mm over a minimum length of 275 mm.

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

d) Be aligned parallel with the line joining the centroids of the adjacent slabs, unless otherwise shown on the drawings.

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

f) Have an alignment tolerance on dowel location in the finished slab of ± 2 mm.

Where dowels are to be used, details of the proposed dowel support system and the method of debonding dowels shall be submitted as part of the Construction Procedures.

8.3 Batching, mixing and transport of concrete

Batching, mixing and transport of concrete shall conform to the requirements of MRTS70 *Concrete*.

8.4 Acceptance and rejection of plastic concrete

Acceptance and rejection of plastic concrete shall conform to the requirements of MRTS70 *Concrete*.

8.5 Paving concrete

8.5.1 General

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

Prior to constructing the paving trial (if specified) or commencing paving in the Works, it is good practice for the Contractor to undertake a small offline/yard trial. A small offline/yard trial, while not mandated, can reduce the risks associated with non-conformances in the Works by allowing assessment of mix suitability and refinement of placement operations.

8.5.2 Concrete paving trial

If specified in Clause 1 of Annexure MRTS41.1 and before routine concrete base paving, a paving trial section of concrete base shall be constructed using the approved concrete mix, and the equipment and methods detailed in the Construction Procedures. The paving trial (if specified) shall be placed in a continuous operation without intermediate construction joints. The Contractor shall give the Administrator a minimum of five business days written notice of the intention to commence the paving trial and its location.

Witness Point 2

Process witnessed:	Paving trial (if specified).
Submission details:	Notice of time and location of the paving trial at least five business days prior to trial paving.

The paving trial may be placed in the final project Works, or at another location. The paving trial concrete shall be removed from the final project Works if it does not comply with the specified requirements.

The paving trial length shall be between 10 m and 30 m. The paving trial width shall be equal to the maximum width proposed to be paved in the final project Works.

The Contractor shall demonstrate to the Administrator in the paving trial that the concrete mix, equipment and methods lead to an outcome that complies with this Technical Specification. This includes, but is not limited to:

- Placement of formwork, reinforcement, tiebars and dowels
- Delivery, spreading and compaction
- Texturing
- Curing
- Joint sawing
- End product criteria

The paving trial shall be assessed and conform to the requirements of Clause 9, modified as follows:

- Both seven day and 28 day compressive strength cylinders are required. The frequency for seven day compressive strength shall be the same as specified for 28 day compressive strength in MRTS70 *Concrete*.
- Relative compaction of the concrete base shall be assessed on a minimum of four cores.

The Contractor shall provide a written report with the paving trial details and all test results and calculations, including:

- Mix details, including any variations to the approved mix design
- Slump
- Air content (for air entrained mixes)
- Seven day compressive strength (report only)
- Mass per unit volume of cylinders
- Mass per unit volume of cores
- Relative compaction of cores
- Length of cores
- Texture depth
- Geometrics
- Surface evenness
- Cracking assessment
- Curing compound application rates
- Non-conformance reports (where relevant)

The Contractor shall advise the Administrator in the Hold Point submission if the seven day compressive strength results indicate that the specified 28 day compressive strength may not be achieved.

Hold Point 2

Process held:	Base paving subject to successful paving trial (if specified).
Submission details:	Submission of paving trial test results and non-conformance reports (where relevant).
Release of Hold Point:	The Administrator will inspect the paving trial and consider the submitted documents within five business days of receipt, before authorising the release of the Hold Point.

The Administrator may require further paving trials until all requirements have been successfully demonstrated, or where changes to materials, equipment and methods are proposed.

Within 30 days of the paving trial the Contractor shall provide the 28 day compressive strength results.

8.5.3 Placing and paving operations

Concrete placing and paving operations shall not commence until all relevant procedures listed in Table 5.2 have been approved by the Administrator.

Hold Point 3

Process held:	Base paving subject to Construction Procedures.
Submission details:	Submission of relevant procedures (refer Table 5.2).
Release of Hold Point:	The Administrator will review the submitted documents within five business days of receipt, before authorising the release of the Hold Point.

No concrete shall be placed in the Works until:

a) the formwork and reinforcement have been inspected by the Administrator

b) all foreign material has been completely removed from the forms

c) the mixing, batching, and compaction equipment have been approved by the Administrator.

Hold Point 4

Process held:	Base paving subject to suitable formwork, reinforcement and equipment.
Submission details:	Inspection of formwork, reinforcement and equipment.
Release of Hold Point:	The Administrator will inspect the formwork, reinforcement and equipment, before authorising the release of the Hold Point.

Concrete placement shall use fixed forms and shall comply with Appendix A.

To improve project quality and compliance, it is recommended the Administrator, Contractor and relevant sub-contractors discuss the content of Appendix A in a site meeting prior to paving.

A short instructional video covering use of internal vibrators and vibrating screeds is available from the following link: https://www.youtube.com/watch?v=mxOn5evRZEY. It is recommended this video be viewed and discussed as part of the site meeting.

The subbase at the time of base paving shall be clean and free of loose or foreign matter including sealing aggregate and it shall not be holding ponded water.

Unless agreed otherwise with the Administrator, the placing and paving operations shall be conducted in the presence of the Administrator or Administrator's delegate. The Contractor shall give at least 24 hours notice to the Administrator of the time that placing and paving shall start.

Witness Point 3

Process witnessed:	Placing and paving.
Submission details:	Notice of time and location of placing and paving at least 24 hours prior to placing and paving.

The Contractor shall place, pave and finish concrete 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, shape and surface finish.

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

The Contractor shall 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. Details of the method of traceability shall be submitted as part of the Quality Plan.

8.5.4 Environmental limits for concreting operations

Concreting operations shall conform to the environmental limits and requirements of MRTS70 *Concrete*, except that use of an evaporation retarder is not mandatory.

MRTS70 *Concrete* includes requirements such as:

- temperature limits
- evaporation monitoring and limits
- Protection from rain

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

8.5.5 Texturing of surface

Unless specified otherwise in Clause 2 of Annexure MRTS41.1, the surface shall be textured transversely to the direction of traffic in accordance with Table 8.5.5.

Table 8.5.5 – Texturing type selection and specified average texture depths

Site Description	Texturing Type	Average Texture Depth (AG:PT/T250)
Roads and busways	Light-medium brooming and tining	0.9 mm ±0.2 mm
Areas with slow moving traffic such as indented bus bays, bus interchanges and bus parking facilities	Light-medium brooming (with no tining)	0.6 mm ±0.1 mm
Beneath bituminous surfacing	Heavy brooming (with no tining)	1.0 mm ±0.2 mm

Light-medium brooming is intended to expose the fine aggregate particles and produce a coarse sand-paper-like (gritty) surface finish with only minor bristle grooves (visible as parallel indentations in the surface from the broom's bristles).

Heavy brooming is intended to provide macrotexture which will allow interlocking of an overlying bituminous surfacing. In this case, distinct parallel bristle grooves are expected, however brooming should not be so heavy as to cause fins of surface mortar that could break away.

Heavy brooming is not intended to provide a surface suitable for ongoing trafficking as the surface texture will be prone to wear. Tining (plus light-medium brooming) is necessary where lasting macrotexture is needed.

If the texture is not homogeneous throughout the lot, there are provisions in MRTS50 *Specific Quality System Requirements* for the lot to be divided into separate sublots for assessment.

Initial texturing shall be provided using a broom. The broom type and applied pressure shall be selected to produce the specified texture. The equipment shall be maintained and replaced as required to produce a uniform consistent texture.

Where specified, additional texture shall be applied to the surface of the freshly placed concrete by transverse tining as soon as possible after paving and initial texturing. The tining equipment (for example, a manual tining comb) shall have rectangular shaped tines of flat spring steel, approximately 0.6 mm thick, 3 mm wide and minimum free length of 200 mm. The tines shall be at a random spacing of between 10 mm and 21 mm, with a mean spacing between 13 mm and 14 mm. The width of the tining comb shall be at least 750 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 surface texturing process shall be adjusted to account for the prevailing weather conditions and mix design to limit surface ravelling and to produce a uniform finish.

The procedures and equipment proposed to complete the surface texture shall be detailed in the Construction Procedures.

8.5.6 Curing

The base shall be cured by application of a curing compound. Other concrete members (including anchors, kerbs and channels) shall be cured by application of a curing compound, or by water curing or membrane curing (sheeting) in accordance with MRTS70 *Concrete*.

The curing compound shall be applied by a pressurised sprayer to give a uniform cover. The sprayer shall incorporate a device for continuous agitation and mixing of the compound in its container during spraying.

The curing compound shall be applied using a fine spray. The spray rate in each pass shall be the higher of 0.30 L/m² or 50% more than the rate stated on the certificate of compliance, regardless of the texture type. The application rate shall be checked by measuring the volume of compound applied to a given area.

Two coats shall be applied at the full rate.

The curing compound shall be applied 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, the first application shall be sprayed within 30 minutes of stripping the formwork, and the second between 10 and 30 minutes after the first.

The curing membrane shall be maintained intact in a continuous and unbroken membrane for a minimum period of seven days, or until an insitu concrete strength of 25 MPa is achieved, whichever occurs first.

Any damage to the curing membrane due to the Contractor's or other's activities shall be made good by respraying the affected areas.

The procedures and equipment proposed to be used for curing concrete base and other concrete members shall be detailed in the Construction Procedures.

8.5.7 Protection of work

8.5.7.1 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.

8.5.7.2 Trafficking of the base

The Contractor shall 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.

For trafficking purposes, insitu concrete strength shall be assessed using cylinders (preferred). Alternatively, insitu concrete strength may be assessed in accordance with MRTS40 *Concrete Pavement Base* using the cores taken for assessment of compaction.

Access to non-essential traffic shall not be allowed until an insitu compressive strength of 20 MPa is reached.

Essential traffic shall be controlled as follows:

a) Steel implements, such as grader blades and loader buckets, shall not be allowed 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) Access to other vehicles shall not be allowed 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) Compaction of granular verge material against the edge of the base shall not be allowed until 20 MPa compressive strength is reached and all joints have been permanently sealed, including the vertical faces.

Hold Point 5

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.

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 6

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.

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

8.6 Joints and edges

Joints and edges shall be constructed in accordance with the drawings and Appendix B.

Joint sealant shall be used and installed in accordance with the manufacturer's written requirements.

The procedures and equipment proposed to construct joints and complete joint sealing shall be detailed in the Construction Procedures. The joint sealant manufacturer's written requirements shall also be included in the Construction Procedures.

8.7 Kerb and channel

Kerb and channel (including kerb, channel, kerb and channel, and kerb and tray) shall be constructed in accordance with the drawings, MRTS03 *Drainage Structures, Retaining Structures and Embankment Slope Protections* and the following:

a) If specified in the drawings, kerbs and channels shall be constructed using internal vibration (rather than extrusion without internal vibration).

> In some cases the designer may specify that kerbs and channels are to be placed using internal vibration (rather than being extruded without internal vibration) and using concrete with strength consistent with the base concrete. These requirements are typically specified where the additional edge support from the kerb and channel is assumed to contribute to the 'with shoulder' condition used in pavement design calculations to reduce the concrete base thickness.

b) Unless specified otherwise, concrete for kerbs and channels shall conform either with this Technical Specification for base concrete or with MRTS03 *Drainage Structures, Retaining Structures and Embankment Slope Protections*.

c) Where the kerb and channel is constructed integrally with the concrete base, the kerb and channel shall be constructed to the same requirements as that specified for the base.

d) Where the kerb and channel is constructed after the concrete base (whether constructed on top of or alongside the base), sealing of transverse joints in the base shall be completed prior to placing the kerb and channel (to prevent the ingress of mortar into joints).

e) Where the kerb is placed on top of concrete base, each transverse joint in the kerb shall be aligned exactly (that is, coincident) with the joint in the underlying base.

f) Where the kerb and channel is placed alongside concrete base that has untied transverse joints, such untied transverse joints shall continue across into the kerb and channel (in the same joint type).

8.8 Traffic islands and medians

Sand shall not be used as a backfill in any location directly abutting the concrete base.

Where shown in the drawings, a geotextile shall be placed to prevent the ingress of fines into joints.

8.9 Base anchors

Base anchors shall be constructed as shown on the drawings, and in accordance with the following:

a) Anchors shall be cast at least 24 hours before the overlying base slab.

b) Anchor trenches shall be trimmed to neat lines, free of loose soil material, and trench floors shall be compacted to at least match the adjacent undisturbed material.

c) Concrete shall conform either with this Technical Specification for base concrete, or with N32/20 normal class concrete in MRTS70 *Concrete*, and slump at the point of placement between 50 mm and 100 mm.

d) Concrete shall be placed and compacted using internal vibration in accordance with Appendix A.

9 End product criteria

9.1 General

Additional end product criteria for steel fibre reinforced concrete are detailed in Appendix C.

9.2 Concrete compressive strength

Conformity for compressive strength shall be undertaken and assessed in accordance with the requirements for acceptance and rejection of hardened concrete in MRTS70 *Concrete*, including the requirements for insitu concrete.

9.3 Concrete compaction

9.3.1 General

A lot conforms for compaction if:

a) 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 Appendix A, and any disturbed areas (such as workers' footprints) in the compacted mix have been reinstated in accordance with Appendix A, and

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

c) The relative compaction of the lot is at least 97.0%.

Lots which do not conform for compaction shall be removed and replaced in accordance with Clause 9.9.

While the minimum conformance level for relative compaction is set at 97.0%, the Contractor is encouraged to always target a relative compaction of at least 98.0%. A reduced testing frequency is permitted where relative compaction results are consistently at least 98.0% (refer to Table 10.2 for details).

9.3.2 Relative compaction

The relative compaction of each core shall be determined in accordance with the following equation:

$$Relative\ Compaction = (MUV_{core} / RMUV) * 100\%$$

where:

MUV_{core} = mass per unit volume of the core (kg/m³)

RMUV = representative mass per unit volume (kg/m³)

The relative compaction of each core shall be reported to the nearest 0.1%.

The relative compaction of a lot is the average of all core results for that lot, except if the lowest result differs from the average by more than 1.0% then the lowest result applies.

9.3.3 Representative mass per unit volume

The representative mass per unit volume for each concrete mix shall be determined in accordance with the following:

a) Specimens are the cylinders moulded for 28 day compressive strength testing

b) The mass per unit volume of each specimen shall be determined in a saturated surface dry condition in accordance with AS 1012.12.2 (including storing in water for 24 hours before weighing)

c) The concrete age at testing shall be at least three days.

For the paving trial (if specified), the RMUV is the average of all mass per unit volume results from the trial.

Thereafter, the RMUV for any lot is the average of all mass per unit volume results from the most recent five lots (including the results from the paving trial, where applicable). Where fewer than five lots are available, the RMUV is the average of all available results.

9.3.4 Cores

The location of coring shall be selected by random stratified sampling in accordance with AS 1289.1.4.2, except each location shall be adjusted the minimum amount necessary to avoid reinforcement and joints (including tie bars and dowels).

Cores shall be of nominal diameter 75 to 100 mm, cut and extracted from the full depth of the concrete base, in accordance with AS 1012.14. The cores shall be secured as soon as practicable without causing damage to the cores or the pavement, but no later than two days after paving.

Extracted cores shall be visually inspected for within-core variability (compaction and segregation) at the time of extraction. If within-core variability is perceived, corrective action shall be implemented.

Witness Point 4

Process witnessed:	Extracted cores.
Submission details:	Notice of time of core extraction at least one business day prior to extraction.

Variability may indicate compaction processes require improvement, or the mix may need to be redesigned.

Within two hours of being extracted, the cores shall be placed in either a tank of lime saturated water or individual plastic bags that are sealed to prevent water loss and stored in the shade.

Cores shall not be subjected to temperatures in excess of the ambient temperature or 28°C, whichever is higher, and they shall not be subjected to temperatures less than 10°C.

The mass per unit volume of each core shall be determined in a saturated surface dry condition in accordance with AS 1012.14 and AS 1012.12.2 (including storing in water for 24 hours before weighing) and the following:

a) Test the full core length, except trim (if necessary) surface texture and materials such as bitumen.

b) The concrete age at testing shall be at least three days.

Core holes shall be cleaned and restored with low-shrink cementitious concrete having a compressive strength not less than that of the base. The 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 hole shall be cured sufficiently to achieve an expected compressive strength of 10 MPa.

9.4 Surface texture

The average surface texture depth of the concrete base shall conform to the requirements detailed in Clause 8.5.5.

9.5 Geometrics

9.5.1 Geometrics, horizontal tolerances

The horizontal location of any point on the pavement (including joints and outer edges) shall not differ from the corresponding point shown in the design documentation by more than ± 25 mm.

9.5.2 Geometrics, vertical tolerances

The vertical tolerances specified in Table 9.5.2 shall apply for:

a) The surface level (height) measured at any point on the surface of the base, and

b) The average thickness of the base compared to the specified (designed) thickness.

Table 9.5.2 – Primary vertical tolerances

Property	Value
Surface level / height (individual)	± 10 mm
Thickness (lot average)	- 5 mm / + unspecified

Where the survey of the base invert level is undertaken prior to sealing the subbase, the thickness of the seal (equal to the average least dimension (ALD) of the cover aggregate) shall be added to the surveyed levels to determine the base invert level.

9.6 Surface evenness

9.6.1 General

The surface of any trafficked layer shall not pond water.

Where alignment of the pavement with an existing pavement or piece of fixed infrastructure is necessary, the new work shall be joined neatly to the existing work in a smooth manner as shown on the drawings, or if this is not shown, in a manner approved by the Administrator.

9.6.2 Surface evenness using a three metre straightedge

Within two business days of paving, the surface evenness shall be determined and reported in accordance with Q712. Lots shall be extended to include the adjacent longitudinal joints/edges, transverse joints and tie-ins.

The surface shall not deviate from the bottom of a three metre straightedge laid in any direction by more than the following tolerances with due allowance being made for design shape, where relevant:

a) 3 mm in trafficked lanes with ≥ 70 km/h traffic speed

b) 5 mm elsewhere.

9.7 Ride quality (roughness)

The surface of each trafficked lane of the finished base shall have a smooth longitudinal profile.

If specified in Clause 4 of Annexure MRTS41.1, the ride quality (roughness) of each trafficked lane of the finished base shall be determined from measurements of longitudinal profile in accordance with Q708B, Q708C or Q708D. The ride quality (if specified) shall not exceed the International Roughness Index (IRI) limits given in Clause 4 of Annexure MRTS41.1.

9.8 Concrete cracking

The inspection schedule for cracking in base slabs shall be detailed in the Quality Plan. For the purposes of assessing cracking, a slab is defined as a portion of concrete bounded by joints and/or edges.

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.

   All other cracked slabs shall be removed and replaced in accordance with Clause 9.9.

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.

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.

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.

Any cracking beyond that listed above will render that base 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.

9.9 Removal and replacement of concrete base

Where nonconforming base is to be removed and replaced, the proposed method shall be submitted 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.

Removal and replacement of concrete base shall be in accordance with MRTS40 *Concrete Pavement Base*.

Hold Point 7

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.

9.10 Rectification of finished surface and ride quality

Areas requiring surface rectification shall be mechanically grooved or diamond ground in accordance with MRTS40 *Concrete Pavement Base*. Impact methods such as milling or profiling shall not be used. Sealants shall be restored.

Within seven calendar days of grooving or grinding, the surface shall be reassessed for conformity in accordance with Clauses 9.5 to 9.7.

10 Construction compliance testing

Compliance testing shall be carried out for each lot.

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 lot sizes, testing frequencies and number of tests are not less than those specified in Table 10.1 and Table 10.2.

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

Additional requirements for compliance testing of steel fibre reinforced concrete are detailed in Appendix C.

Table 10.1 – Maximum lot size requirements

Construction activity	Maximum lot size
Supply of constituent materials and concrete	Refer to MRTS70 *Concrete*
Construction of concrete base	Concrete base placed within a single day at a discrete location
Testing of ride quality (roughness) (if specified)	100 m

Table 10.2 – Minimum frequency of testing

Clause	Characteristic analysed	Test method	Minimum frequency of testing
			Normal / Reduced
Constituent Materials			
6.2	Aggregates	Refer to MRTS70	Refer to MRTS70
6.3	Cementitious materials	Refer to MRTS70	Refer to MRTS70
6.10	Water	Refer to MRTS70	Refer to MRTS70
Concrete			
7.4	Chloride content	Refer to MRTS70	Refer to MRTS70
8.4	Consistency (slump)	Refer to MRTS70	Refer to MRTS70
8.4	Air content (for air entrained mix)	Refer to MRTS70	Refer to MRTS70
8.5.2	Compressive strength (seven day) (in the paving trial, if specified)	Refer to MRTS70	Refer to MRTS70 (same frequency as for 28 day testing)

Clause	Characteristic analysed	Test method	Minimum frequency of testing
			Normal / Reduced
8.5.7.2	Compressive strength (early age for trafficking assessment)	Refer to MRTS70	Refer to MRTS70
9.2	Compressive strength (28 day)	Refer to MRTS70	Refer to MRTS70
Concrete Base			
8.5.6	Curing compound application rate	Measure volume applied to a given area	One per lot for each application of curing compound
9.3	Relative compaction of concrete	AS 1012.14 AS 1012.12.2	Normal: One core per 80 m² or part thereof, with a minimum of two cores per lot. Reduced: If relative compaction of three consecutive lots (including the paving trial, if specified) are all at least 98.0%, then testing can be reduced to two cores per 500 m². Testing reverts to the Normal frequency if the relative compaction of any lot is less than 98.0%, or with a change in mix or construction process.
9.4	Surface texture	AG:PT/T250	Three tests per lot
9.5.1	Horizontal tolerances	Survey	Outer edges – One test per 20 lineal metres Longitudinal joints – One test per 20 lineal metres of each joint type Transverse joints – One test every four joints
9.5.2	Vertical tolerances - surface level and thickness	Survey	One test per 20 lineal metres measured at two cross-sectional offsets located 1.0 m ± 0.5 m from the longitudinal edges of each paving run. For paving runs > 6.0 m in width, survey a third cross-sectional offset located mid-slab (± 0.5 m).
9.6.2	Surface evenness (three metre straightedge)	Q712	Within lane – One transverse and one longitudinal test per 20 metres along each paving run Longitudinal joints (including those that adjoin existing pavement) and outer edges – One test per 20 lineal metres of joint/edge Transverse joints that adjoin existing pavements – One test per joint for each paving run
9.7	Ride quality (roughness) (if specified)	Q708B, Q708C or Q708D	As defined in the relevant test method
9.8	Concrete cracking	Inspection	All slabs/areas

11 Supplementary requirements

The requirements of MRTS41 *Concrete Pavement Base (Ancillary Works)* are varied by the supplementary requirements given in Clause 5 of Annexure MRTS41.1.

Appendix A: Placing and paving operations - fixed-form (manual) paving

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

a) the size and number of vibrators

b) the pattern and spacing of vibrator insertions.

Formwork shall be designed and constructed so that it is braced in a substantial and unyielding manner and is debonded so that it can be removed without damaging the concrete.

The formwork shall be set to tolerances on the screeding surface equivalent to those specified for the finished base surface.

Gaps under side-forms shall be limited such that the specified systematic vibration and compaction can be achieved throughout the slab with only minimal mortar losses and such that the condition of the formed joint meets the requirements of Clause B.5.

Concrete shall be deposited and spread uniformly in the formwork by means other than vibration and without segregation.

Concrete shall be compacted using internal vibrators. Vibrator operating parameters shall be established and documented 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 9.3.

One of the three methods listed in Table A.1, with operating parameters no less thorough than the guidelines provided, shall be adopted.

Internal vibrators shall be used and comply with the following operating parameters:

a) minimum diameter of 50 mm

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

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

The number of working internal vibrators in use during a concrete pour shall not be less than one for each 10 m^3 of concrete placed per hour. For paving widths in excess of 2.5 m, a minimum of two vibrators shall be used. The number of standby vibrators shall be not less than one quarter of the number in use, with a minimum of one.

Following internal vibration, the slab shall be compacted and finished 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) screed length 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 between 3000 and 6000 vibrations / minute (50–100 Hz), and minimum amplitude of 0.3 mm.

A suitable head of concrete shall be maintained in front of the screed over its whole length to ensure the uniform transmission of vibration into the slab.

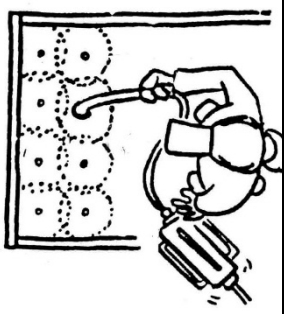
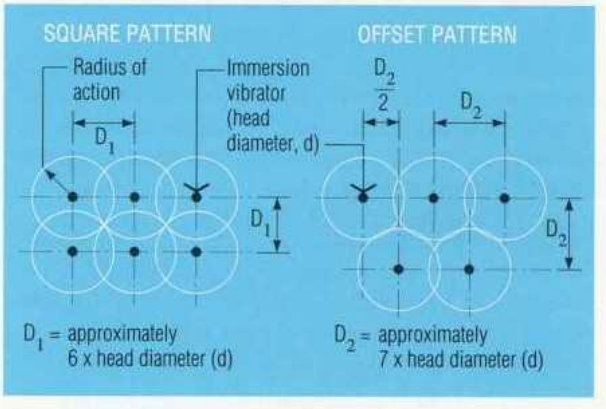
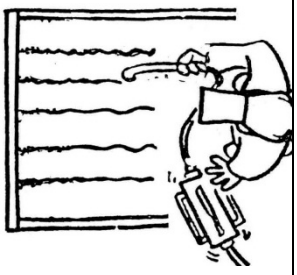
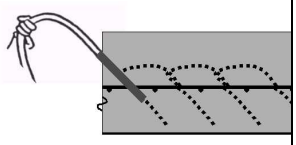
At least two passes of the screed shall be provided after any significant disturbance of the concrete surface, such as by walking in the mix.

A dense and homogeneous slab shall be provided with a surface finish which requires a minimum of hand finishing.

Power trowelling on the surface shall not be used.

A transverse construction joint shall be formed in accordance with Clause B.2 if an interruption to paving occurs which is likely to result in loss of integrity of the concrete mass.

Table A.1 – 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.
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.

Appendix B: Joints and edges

B.1 General

Where scabbling is required, coarse aggregate shall be exposed over a large proportion of the scabbled face (avoiding the arrises as shown in the drawings) and achieving a rough surface with indentations 4 to 6 mm deep. Scabbled joints within the base shall always be subsequently debonded, except joints in anchors shall not be debonded.

B.2 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 8.2 (except for dowelled construction joints, if and where applicable). Where the tiebars 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) Be reinstated or repaired before the placement of adjoining concrete if the face is nonconforming or the edge is damaged. The first-placed face shall be dense and fully compacted and shall be free of honeycombing. 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. The first-placed face shall be resprayed with wax emulsion curing compound not more than 10 calendar days before placing the abutting concrete. 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.

g) Conform in all regards to the requirements of Appendix A.

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.

B.3 Transverse contraction joints

B.3.1 General

Transverse contraction joints 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 10 mm from a 3 m straightedge.

b) not extend sawing beyond the intended limit as defined by intersecting joints (typically longitudinal).

c) have trafficking controlled in accordance with Clause 8.5.7.2.

d) 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.

B.3.2 Sawcutting

Transverse contraction joints shall be 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 to prevent cracking of the base concrete other than at the bottom of the sawcut.

> Delaying sawcutting until the next day will likely be too late and may lead to nonconforming cracking.
>
> A perfectly clean saw cut is also an indicator that saw cutting has been delayed too long. Some ravelling on either side of the joint due to sawcutting is allowed and expected. Sawcutting is usually undertaken at the earliest time such that ravelling is kept within the specified limits.
>
> Sawing needs to proceed regardless of the time of day or night, and regardless of site weather conditions.

The type of blade and equipment, and the method of control best suited to the hardness of the concrete being sawn, shall be used. Sufficient standby equipment shall be 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 3.0 m length of joint edge (that is, each side of the joint is assessed separately).

Where a saw cut terminates through a slab edge, the vertical face of the slab shall not show ravelling greater than 20 mm in any axis at the point of intersection with the sawn joint.

B.3.3 Cleaning

All debris shall be cleaned from the sawcut soon after sawing and before the residue dries or hardens. A liquid or liquid / air oil-free jet combination shall be used 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 shall not be used.

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 it entering the joint.

The timing of cleaning and other variables (such as pressure) shall be adjusted to suit the prevailing concrete characteristics.

Grit blasting shall not be used.

B.3.4 Preliminary sealing with backing rod

Within two hours of cleaning an initial sawcut, the joint shall be sealed against drying and contamination by installing a continuous closed-cell polyethylene backing rod with the top of the backing rod 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.

The backing rod shall be maintained in a sound and effective condition at the top of the joint until the joint is temporarily or permanently sealed. Any backing rod which is damaged or removed before sealing shall be replaced within one calendar day.

In a two-cut operation, the backing rod 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 backing rod shall remain in position until permanent sealing.

B.3.5 Temporary sealing with backing rod for two-cut operations

After widening, the sawcut shall be cleaned in accordance with Clause B.3.3.

Within two hours of cleaning an initial sawcut, the joint shall be sealed against drying and contamination by installing a continuous closed-cell polyethylene backing rod with the top of the backing rod being neither higher than the concrete surface nor more than 5 mm below it. The backing rod shall pass over any longitudinal joint seal already in place.

Sealing shall include the vertical faces of the slab at the ends of sawcuts.

The backing rod shall be maintained in a sound and effective condition at the top of the joint until the joint is permanently sealed. Any backing rod which is damaged or removed before permanent sealing shall be replaced within one calendar day.

B.3.6 Permanent sealing with silicon

The permanent sealant shall be an insitu cast silicone sealant.

At slab edges and formed joints, the silicon sealant shall extend down the vertical faces of joints and any underlying crack.

At the time of sealant installation, the joint faces shall be clean and surface-dry. Silicon sealant shall be placed in the joint between 7 and 14 calendar days after initial sawing, except it shall not be placed within 24 hours of the concrete surface having been wet

Before introducing the silicone sealant into the groove, the joint shall be cleaned in accordance with Clause B.3.3 to remove all foreign or disturbed material such as dust from the joint and from the top of the backing rod.

A joint primer shall be used if and when recommended by the sealant manufacturer.

A continuous closed-cell polyethylene backing rod shall be installed at a depth so that the bottom of the silicone sealant is at the planned location and of the correct shape. If the backing 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, the silicon sealant shall be tooled to the specified shape before a surface skin forms.

B.4 Isolation and expansion joints

Isolation and expansion joints 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) Where the joint faces were constructed by methods other than sawing (for example, formed joints), the joint cavity shall be prepared within the sealant area by either sawing or brushing with a mechanised rotary wire brush or similar abrasive contact equipment.

d) Be cleaned, prior to sealing, in accordance with Clause B.3.3.

e) Be treated with preformed joint filler conforming to Clause 6.6 and joint sealant installed in accordance with Clause B.3.6.

f) Be maintained at all times free of incompressible and foreign materials. At free edges, the silicon sealant shall extend down the full vertical face of the joint. At other edges, the preformed joint filler shall prevent the ingress of concrete and other foreign materials into the joint space during subsequent work.

B.5 Longitudinal joints

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 Clause 8.2. Where the tiebars 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.

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. Be reinstated or repaired before the placement of adjoining concrete if the face is nonconforming or the edge is damaged. The first-placed face shall be dense and fully compacted and shall be free of honeycombing. The repair material shall not be placed integrally with the adjoining concrete.

   iii. Have the face of the joint debonded to prevent intimate microtexture bond. The first-placed face shall be resprayed with wax emulsion curing compound not more than 10 calendar days before placing the abutting concrete. 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. Tiebars shall not be sprayed.

   iv. Sealant faces (for sealed joints) shall be prepared in accordance with Clause B.4, with cleaning and sealing in accordance with Clauses B.3.3 and B.3.6.

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.

d) For induced joints:

   i. Be provided by sawcutting in accordance with Clause B.3.2.

   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. Be cleaned and sealed in accordance with Clauses B.3.3 to B.3.6, including sealing the full vertical face at the ends of sawcuts.

e) If the backing rod is damaged in any way, the damaged section shall be replaced.

f) Residue from cleaning operations shall not enter transverse joints.

g) For widening of existing concrete base

   i. The existing edge shall be treated in accordance with the drawings and Clause 3 of Annexure MRTS41.1.

   ii. The vertical face of all transverse untied joints and underlying induced cracks shall be sealed. Sealant faces shall be prepared in accordance with Clause B.4 (regardless of their original method of construction), with cleaning and sealing in accordance with Clauses B.3.3 and B.3.6.

   iii. The existing face shall be debonded in accordance with Clause B.5 (c).

B.6 Outer edges

Outer edges shall:

a) 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

b) Have the face square (± 6°) to the finished top surface of the base, unless specified otherwise.

Appendix C: Steel fibre reinforced concrete

C.1 General

Additional requirements for steel fibre reinforced concrete are as detailed in this Appendix. These requirements shall take precedence over the other clauses of this Technical Specification.

C.2 Materials

C.2.1 Steel fibres

Steel fibres shall comply with the following properties determined in accordance with EN 14889-1:

a) Ultimate tensile strength equal to or greater than 750 MPa.

b) Aspect ratio (λ) greater than 30 and less than 68.

c) Hardness (Group II fibres only) greater than 84 HRB (Hardness Rockwell; B Scale).

Fibres that are longer than 50 mm shall not be used.

C.2.2 Admixtures

Air entraining agent shall not be used in steel fibre reinforced concrete.

C.3 Concrete mix – design and acceptance

C.3.1 General

A trial mix is required for steel fibre-reinforced concrete mixes. Trial mix testing shall include both compressive strength and flexural strength.

C.3.2 Concrete class and strength

Steel fibre reinforced concrete shall be special class concrete. The minimum requirements for strength are as detailed in Table C.3.2(a). The compressive strength and flexural strength specimens shall be of the size listed in Table C.3.2(b).

Table C.3.2(a) – Minimum concrete strengths for steel fibre reinforced concrete

Description	Compressive strength	Flexural strength
In the trial mix	40.0 MPa (28 day)	5.8 MPa (28 day)
In the Works	Not applicable	5.5 MPa (28 day)

Compliance in the Works is based on flexural strength.

In the trial mix, a minimum of three flexural strength specimens shall be tested at age 28 days and a minimum of three specimens at age seven days. Specimens shall be made and cured in accordance with AS 1012.8.2, except the beams shall be moulded in accordance with TfNSW T304. The specimens shall be tested for flexural strength in accordance with AS 1012.11. The flexural strength of the trial mix is the average of all individual results (at each age) not more than 0.5 MPa from the median value.

TfNSW T304 requires flexural strength specimens for steel fibre reinforced concrete to be compacted using either external (table) vibration or by tamping tee-bar.

Table C.3.2(b) – Flexural beam sizes for steel fibre reinforced concrete

Fibre length L_f (mm)	Flexural strength specimens		Compressive strength specimens
	Specimen 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.

C.3.3 Nominated slump

The nominated slump shall be between 50 mm and 80 mm.

C.3.4 Fibre dose rate

The minimum allowable unit mass of steel fibre (M_f) shall be determined 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 C.3.4(a)

F_D = fibre density (7850 kg/m³)

F_A = fibre anchorage performance factor as per Table C.3.4(b)

λ = fibre aspect ratio (refer to EN 14889-1).

Table C.3.4(a) – Steel fibre size factor (F_S)

Volume of single fibre (mm³)	Size factor (F_S)
0–5	1.2
6–10	1.3
11–20	1.4
21–30	1.5
31–40	1.6
41–50	1.7
51–60	1.8

Table C.3.4(b) – Steel fibre anchorage performance factor (F_A)

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 % = $(L_a + L_b)/L * 100$

C.3.5 Proposed mix design

The submission shall also include:

a) Flexural strength results

b) Source, dimensions and nominated mix quantity of steel fibres

C.4 Process control

C.4.1 Batching, mixing and transport

Fibres shall be batched into concrete in accordance with the fibre manufacturer's instructions, being uniformly distributed and without balling. Fibres shall be added as full bags only and the mass added shall be recorded with the batching records.

C.4.2 Concrete paving trial

In addition to seven and 28 day compressive strength cylinders, both seven and 28 day flexural strength specimens are required in the paving trial (if specified).

A minimum of three flexural strength specimens shall be tested at age 28 days and a minimum of three specimens at age seven days. Specimens shall be made and cured in accordance with AS 1012.8.2, except the beams shall be moulded in accordance with TfNSW T304. The specimens for flexural strength shall be tested in accordance with AS 1012.11. The flexural strength of concrete in the paving trial is the average of all individual results (at each age) not more than 0.5 MPa from the median value.

C.5 End product criteria

C.5.1 Concrete compaction

The specimens for representative mass per unit volume shall be the beams moulded for 28 day flexural strength testing.

C.5.2 Concrete flexural strength

The 28 day flexural strength of concrete in the Works shall comply with Table C.3.2(a).

For each test batch, a minimum of three flexural strength specimens shall be tested at age 28 days. Specimens shall be made and cured in accordance with AS 1012.8.2, except the beams shall be moulded in accordance with TfNSW T304. The specimens for flexural strength shall be tested in accordance with AS 1012.11. The flexural strength of concrete from each batch is the average of all individual results from that batch not more than 0.5 MPa from the median value.

If the 28 day flexural strength for any set of results in the lot is less than 5.0 MPa, the lot shall be removed and replaced in accordance with Clause 9.9.

The Administrator may, based on an engineering risk assessment, accept lots with flexural strength between 5.0 MPa and 5.5 MPa. Typically, this dispensation would be limited to a maximum of one in 20 lots and be based on appropriate corrective action by the Contractor.

C.6 Construction compliance testing

For flexural strength testing, the testing frequencies and number of tests shall not be less than those specified in Table C.6. Compressive strength testing for compliance is not required for steel fibre reinforced concrete.

Table C.6 – Minimum frequency of flexural strength testing

Clause	Characteristic analysed	Test method	Minimum frequency of testing
			Normal / Reduced
Constituent Materials			
C.3.2	Flexural strength (seven day) (in the paving trial, if specified)	AS 1012.11	One set of three specimens
C.5.2	Flexural strength (28 day)	AS 1012.11	Normal: one set of three specimens per 30 m^3 with a minimum of one set per lot Reduced: one set of three specimens per lot