TRANSPORT FOR NSW (TfNSW)

QA SPECIFICATION R83

CONCRETE PAVEMENT BASE

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REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 2/Rev 0		Completely revised. Some requirements transferred to Annexure R83/3.	GM, RNIC (W Ho)	30.01.98
Ed 2/Rev 1	Various	Minor editorial changes	GM, RNIC	15.04.98
	2.2	Natural sand content 75%		
	3.6	Vebe to be ≤ 3 secs in trial mix		
	5.3, 5.4	Rearranged under new clause headings		
	Annexure R83/3	Subclause numbers changed for: A2.1, A2.6, A3.2, A4.1, A4.2.1, A4.3.6, A4.5.2, A4.5.4, A5.2.1, A5.4.2		
	A1.2	Incorporated into Cl 1.2		
	A2.1.1	Table A3.2 & A3.3 renumbered		
	A4.2.1.5, A5.3.4	Age correction factors added for flexural strength		
	A5.3	Paragraphs rearranged.		
	Annexure R83/3	Cl 5.3.3 Subclause numbers added		
Ed 2/Rev 2	5.5.3.2	Table R83.14 deductions changed for PRC 5	GM, RNIC J Woodward	28.09.98
Ed 2/Rev 3	1.2, 2.8	AS 1650 replaced by AS/NZS 4680	GM, RNIC	13.08.99
	2.2	Quartz-chert content changed for base below asphalt		
	2.6, 4.3.8.4, 4.5.3, 4.5.5, A4.2.1.2, A5.3.2,	Minor changes. 5.2.1, 5.3.2, A2.1.2, A4.2.1.1 A4.2.1.3, A4.5.2.5, A5.2.1.1		
	2.9	Reference to AS 1379 changed		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 2/Rev 3 (cont'd)	3.8.1(iii)	Results format specified		
	4.1.1	Clearance to joints changed.		
	4.1.3	Additional dowel requirements		
	4.3.7(g)	Curing required until 30MPa		
	5.4.3	Thickness assessment changed		
	6	Sub items required for P1, P7		
	A2.1.1	Test methods changed		
	A4.1.1.2	Fabric splicing changed		
	A4.5.2	Sawcutting required		
	A4.5.2.1	Single cut permitted generally		
	Annex R83/7	New annexure listing Identified Records		
Ed 2/Rev 4	1.2, 2.4, 3.3, 5.4.2, Annx R83/4:	3.8.1, 4.2.1, 4.5.2, 4.5.5, 5.2.2, Annx R83/2, A4.5.1, A4.5.4.1, A5.2.1.2 Minor changes	GM, RNIC	31.08.00
	2.2	Natural sand content 50%		
		Organic impurities requirement changed		
	2.5	Alkali contribution for fly ash mixes changed		
	2.6	Curing compound types changed		
	3.5	Flexural strength omitted for non-pavement mixes		
	3.6	Slump range changed		
	4.1.3	Additional dowel requirements		
	4.2.1	Control chart requirements for combined aggregate grading changed		
	4.2.2	Forming time recording changed Mixing time for mobile mixer added		
	4.3.4	Concrete temperature range changed		
	4.6	Isolated joints required at pits		
	5.1.4	12% deductions added		
	5.5.1	Longitudinal joint test added		
	5.5.3.2	Assessment of cores changed		
	6	Pay Item R83P1 changed		
	Annex R83/3 - A4.1.2.2	Voids above tiebars to be filled		
	- A4.2.1.2	Minimum frequency for testing flexural specimens changed		
	- A4.2.2	Continuous mixers included		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 2/Rev 4	- A5.2.3	Assessment of cores changed		
(cont'd)	- A5.3.3	Cores must be wet conditioned		
	- A5.4.2	Survey model included		
	Annex R83/4	Particle size distribution testing requirements changed		
Ed 2/Rev 5		Title changed from Plain Concrete Base to Jointed Concrete Base	GM, RNIC	21.08.03
	1.2	Various revisions to Table R83.1		
	3.7, 4.3.4, 4.3.6, 4.4, A4.2.2,	Minor editorial changes. 5.2.1, 5.4.2, A3.8.1, A4.1.2.2 A5.2.1.1, A5.2.4, A5.3.2		
	1.1	Steel fibre reinforcement added		
	1.2, 2.8, Pay Item R83P4	AS/NZS 4671 replaces AS 1302 AS 1303 and AS 1304		
	1.2, 2.4	RTA 3211 replaces detailed cement requirements. RTA requires a cement sample. AS 2349 added.		
	2.4	Flyash requirements changed		
	2.6	Amendments to curing compounds		
	2.7	RTA T1193 and T1192 added to table		
	3.3	40% replaced by 38%; Table R83.5 4.75 mm AS sieve, 36 replaced by 38		
	3.8.1(iii)	Test methods specified		
	4.1.2	Plain tiebar length added		
	4.1.3(a)	As 4680 added		
	4.1.4, 4.1.5, 4.1.6, 4.1.7, 4.1.8, 4.1.9, 4.1.10	New clauses		
	4.2.1, A4.2.1.5	General revision of the use of control charts		
	4.2.2	Headings added and general revision		
	4.3.2	Vibrator requirements added		
	4.3.3	Details required in PQP		
	4.3.8.2	Rain damage to be assessed		
	4.3.6, 4.4	Reference panel deleted		
	4.5	Management of detritus from sawcutting added		
Ed 2/Rev 5	4.5.1	New clause		
(cont'd)	4.5.3	Item (e) added		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
	4.5.5	Item (c) (iii) added		
	4.5.8	Test edge alignment		
	4.6, 4.8	Concrete requirements revised		
	4.8	Slump and compaction requirements changed for slab anchors		
	5.2.1	(i) and (ii) Treatment of Lots in Transition Zones; (a) conformity of Lots; (C) nonconformity of Lots		
	5.4.2	First paragraph revised		
	5.4.4	General revision		
	5.5.2	Incentive payments applicable at minor grinding (iii) clause deleted		
	5.6	Management of detritus from sawcutting added		
	Annexure R83/2	k) batching time added n) general revision and 4.3.3 added o) Training details required		
	A2.6	Viscosity added		
	A4.1.1.1	General revision of paragraphs three and five		
	A4.1.1.2	Grade 500 added		
	A4.1.2.2 (ii) (B)	500 replaced by 400. “All voids … filled.” paragraph revised		
	A4.2.1	Paragraph referring to SFRC added		
	A4.2.1.1	General revision		
	A4.2.1.2	Note added to table		
	A4.2.1.3	Reference to SFRC added; Tolerance on flexural strength changed from 0.3 to 0.5; AS1012.12 amendment changed; (ii) general revision		
	A4.2.1.5	General revision		
	A4.2.2	Paragraph five revised for conforming retempering		
	A4.2.2 (c)	General revision		
Ed 2/Rev 5 (cont’d)	A4.2.2 (f)	(i) mixing time to be determined under Clause 4.2.2(a); (v) 30 replaced by 40 and 20 replaced by 30		
	A4.3.3	Compaction and training requirements added		
	A4.3.7	Hand lances permitted to 4.5 m		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
	A4.4	Second paragraph, reference to Clause A5.2.1.1 added		
	A4.5.1	New clause		
	A4.5.3.5	Second paragraph, 10 replaced by 14; Fourth paragraph, backer rod described; Eighth paragraph, reference to manufacturer's recommendations added		
	A5.2.1.1	General revision		
	A5.2.1.3	Use of Lots redefined		
	A5.2.3	General revision		
	A5.2.4	First paragraph, deleted; Second paragraph, clarification; Third paragraph, added		
	A5.3.2	Last paragraph, "less than" changed to "greater than"		
	Annex R83/4	Clause 3.3, 800 replaced by 1500; AS 1141.12 added; Clause 4.3.6 (a) and (b) amended; Clause 4.5.1 added		
	Annex R83/5	New definitions and symbols added		
	Annex R83/8	New annexure		
Ed 2/Rev 6	2.4	RTA Laboratory details updated	GM, IC	23.03.07
	4.4	Requirement for Concrete Paving Crew Training records added to Hold Point.		
	Annex R83/3, A4.3.3	Training requirements amended to include reference to Concrete Paving Crew Training		
Ed 2/Rev 7	Table R83.1	Reference documents updated.	GM, IC	03.09.10
	2.8	ACRS certification replaced NATA certification.		
	3.2, A3.2.1, A5.4.2.1, Annex R83/6	Reference for survey requirements changed from "RTA Q" to "RTA G71".		
	Annex R83/5	Abbreviation for ACRS added.		
	Annex R83/7	ACRS endorsed test certificate for steel reinforcement inserted in Schedule of Identified Records.		
Ed 2/Rev 8	2.8	Steel reinforcement requirements clarified.	GM, IC	11.10.10
	Annex R84/7	Certification requirement for steel reinforcement amended.		
Ed 3/Rev 0		New edition, content reorganised and rewritten, and incorporating R84.	GM, CPS	07.11.13
		Specification title changed.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 3/Rev 1	4.1.7 Annex M	Reference to “B204” replaced by “B203”. Referenced documents updated.	DCS	27.10.17
Ed 3/Rev 2	Global	References to “Roads and Maritime Services” or “RMS” changed to “Transport for NSW” or “TfNSW” respectively.	DCS	22.06.20
Ed 3/Rev 3	1.1 2.2 2.3 2.4 2.7 4.1.1 4.3 4.4, 4.5 5.2.4 6.3.1.2 Annex C1 Annex C2	Reference to AS 2706 deleted. Approval of alternative combined particle size distribution by Principal instead of based on User Guide NR83. Fine aggregate to comply with AS 2758.1 and Table 2. Other requirements deleted. Table 2: - Fine aggregate requirements updated. - Note (2) – Reference to AS 1141.11 deleted. - Note (9) changed to Note (8). Coarse aggregate to comply with AS 2758.1 and Table 3. Other requirements deleted. Table 3: - Coarse aggregate requirements updated. - Note (7) – Reference to AS 1141.11 deleted. “AS 1478” changed to “AS 1478.1”. Range of mass steel ratio amended. New clause on concreting personnel requirements, including Grey Card Training. Hold Point added. Subsequent clauses renumbered. Reference to G2-C2 on Concrete Paving Crew Training requirement deleted. Acceptable variability in unit mass between upper and lower parts of core increased to 30 kg/m^3. Table 30 – steel fibre length range corresponding to specimen diameter changed. Schedule of Hold Points and Witness Points updated. Schedule of Identified Records updated.	SMCSp	17.02.21
Ed 3/Rev 3 (cont’d)	Annex D Annex L Annex M	Planning Documents updated. Clause references updated. Referenced documents updated.		

GUIDE NOTES

(Not Part of Contract Document)

Specification R83 Ed 3 Rev 0

Specification R83 Ed 3 Rev 0 now incorporates the requirements previously contained in Specification R84 for continuously reinforced concrete pavement (CRCP).

With the publication of this document, R84 is now withdrawn.

CONCRETE PAVEMENT BASE

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VERSION FOR:
DATE:

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FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW R83 Edition 3 Revision 2.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

PROJECT SPECIFIC CHANGES

Any project specific changes are indicated in the following manner:

(a) Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. ***Additional Text***.

(b) Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. ~~Deleted Text~~.

TfNSW QA SPECIFICATION R83

CONCRETE PAVEMENT BASE

1 GENERAL

1.1 SCOPE

This Specification is for the supply of concrete and construction of the base (upper) layer of the following formats:

(a) plain concrete pavement (PCP);

(b) continuously reinforced concrete pavement (CRCP);

(c) jointed reinforced concrete pavement (JRCP);

(d) steel fibre reinforced concrete pavement (SFCP), for which the provisions of Clause 6 apply.

It includes the following items:

(i) concrete materials;

(ii) concrete mix design requirements;

(iii) process control and manufacture of base;

(iv) end product criteria for base;

(v) quality systems, minimum process standards, plant requirements, and sampling and testing requirements.

This specification is intended for the construction of road pavements in applications such as highways which are carrying substantial volumes of commercial road vehicles. It is unlikely to be applicable to other applications (such as industrial, commercial or residential pavements) without suitable modification.

1.2 STRUCTURE OF THE SPECIFICATION

This Specification includes a series of annexures that detail additional requirements.

1.2.1 Details of Work

Details of work are shown in Annexure R83/A.

1.2.2 Measurement and Payment

The method of measurement and payment is detailed in Annexure R83/B.

1.2.3 Schedules of HOLD POINTS, WITNESS POINTS and Identified Records

The schedules in Annexure R83/C list the **HOLD POINTS** and **WITNESS POINTS** that must be observed. Refer to Specification TfNSW Q for the definitions of **HOLD POINTS** and **WITNESS POINTS**.

The records listed in Annexure R83/C are **Identified Records** for the purposes of TfNSW Q Annexure Q/E.

1.2.4 Referenced Documents

Unless specified otherwise, the applicable issue of a referenced document, other than a TfNSW Specification, is the issue current at the date one week before the closing date for tenders, or where no issue is current at that date, the most recent issue.

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 2350). For convenience, the full titles are given in Annexure R83/M.

1.3 DEFINITIONS

The terms "you" and "your" mean "the Contractor" and "the Contractor's" respectively.

The following definitions apply to this Specification:

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.
AF	Age correction factor; see Clause 5.3.5.
AGD	Average Greatest Dimension (of aggregate); see Clause 2.4.
ALD	Average Least Dimension (of aggregate); see Clause 2.4.
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.
Base	The uppermost pavement structural layer.
Batch	A quantity of concrete containing a fixed amount of ingredients and 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.
Blended cement	Material conforming to Specification TfNSW 3211 and this Specification. See also *Cement*.
Cement	A hydraulic cement as defined by TfNSW 3211 that is manufactured by inter-grinding of portland cement clinker, calcium sulphate and optional mineral or minor constituents. If blended with supplementary constituents by the manufacturer, it is referred to as blended cement.
Cementitious	Cements and supplementary cementitious materials as defined by TfNSW 3211:
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.

Coefficient of variation

Ratio of the standard deviation of the test values to the mean of test values *100.

For 28-day flexural strength the coefficient of variation is calculated as the ratio of the 5-point rolling standard deviation to the 5-point rolling mean (*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 Specification.

Completion of batching

(a) For a stationary batch mixer discharging into a storage bin or tipper truck, this will be the time at which discharge from the mixer commences.

(b) For a stationary batch mixer discharging into a mobile mixer, this will be the time at which mixing and slump adjustment ceases at the batching plant, or 10 minutes after the completion of charging of the stationary mixer, whichever occurs first.

(c) For direct charging 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 into the truck commences.

(e) For a continuous mixer discharging into a storage bin, this will be the time of earliest discharge (from the mixer) of that concrete within the bin.

Curing Classes 1, 2 and 3

See Clause 4.4.7.1.

Debond/Debonding

The application of a material to a surface to prevent the formation of bond.

Diamond grinding

A surface treatment which conforms to Clause 5.7 and Specification TfNSW R93.

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).

Edge, relief

See *Relief edge*.

Fixed-form paving

Also referred to as “manual paving” and “hand paving”. Paving between fixed formwork and using manually operated equipment such as internal vibrators and vibrating screeds.

Fly ash	A pozzolanic material conforming to TfNSW 3211 and this Specification.
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 using equipment which conforms to Clause 5.7 and TfNSW R93.
Haul Time	The elapsed time measured between the completion of batching and the completion of discharge of the mix from the delivery vehicle.
Joint	A planned discontinuity in the concrete, including an edge, and which conforms to Clause 4.6.
Joint, mismatched	A joint which terminates at a junction with an adjoining slab. Tied joints may mismatch without restriction. Untied joints are subject to restrictions in accordance with Clause 4.6.6
Jointed base	A grouping of PCP, PCP-R, JRCP, SFCP and SFCP-R. 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 4.4.1.
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 concrete comprising one or more batches; see also Clause 4.2.2.
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 sub-Lots, as defined. If you choose to define a Lot by a different method, detail the method in the PROJECT QUALITY PLAN in accordance with Clause 7.5.3 of TfNSW Q. See also Sub-Lot and Transition sub-Lot.
MBV	Methylene Blue Adsorption Value
MBV75 value	The product of the MBV and the passing 75µ fraction.
Microfines	The fraction of aggregate which passes the 300 µm sieve but is retained on the 75 µm sieve.

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.

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".

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.

(b) **Mobile mixer** (or **agitator**): a truck-mounted drum mixer which is used for mixing and delivery, and possibly also agitation. This specification covers mobile batch mixers but not mobile continuous mixers.

See AS 1379 Clauses 4.2 and 4.3 for further information.

Mixing Time — See Clause 4.2.2.1. Applicable to batch mixers only.

Monolithic — Constituting a single uniform homogeneous element of concrete between planned joints and/or edges; a section of concrete of uniform composition and properties which will act as a single structural element.

MUV — Mass per Unit Volume; see Clause 5.2.

Odd-shaped slab — See *Slab, odd-shaped*.

Paving run — A single length of pavement placed as one continuous pour without an interruption to paving that requires a transverse construction joint.

Process mean — $\overline{\overline{X}}$; see Clause 1.5 “Symbols”.

Ramp junction zones — See Figure R83.7.

Re-entrant angle — An angle, formed by joints and/or edges, which point inwards, towards the concrete slab (for example, at a drainage pit).

Relative compaction — The percentage ratio of the core unit mass of the sub-Lot to the representative cylinder unit mass (RCUM) for the sub-Lot.

In the case of SFCP, it is the percentage ratio of the core unit mass of the sub-Lot to the representative beam unit mass (RBUM) for the sub-Lot.

Relief edge — An edge or joint which relieves contraction stresses in joints and/or sections which are aligned approximately parallel with the joint (or section) under design. A relief edge is provided by an untied joint or by a free edge or by an expansion or isolation joint.

Relief-edge distance (RED) — The distance measured from the joint (or section) under design to the nearest relief edge which is aligned in such a way that it will limit the design stress. The value for RED must take into account all stress contributors such as connected kerbs and barriers. Allowance may also need to be made for likely future widenings.

Representative beam unit mass (RBUM)	See Clause 6.9.
Representative cylinder unit mass (RCUM)	See Clause 5.2.1.1.
Retemper	The addition of water to a batch after *completion of batching* to restore consistence. See also *Temper*. The addition of an admixture (such as a high range water reducer) is not considered to constitute retempering. Clauses 4.2.2.3 and 4.2.2.7 refer.
Rolling statistical results	Calculated using groups of consecutive results, with progression in single increments.
SCM	Supplementary cementitious materials include fly ash, ground granulated iron blast furnace slag and amorphous silica, as defined by TfNSW 3211.
SF	Shape correction factor; see Clause 5.3.5.
Skew, Road	Applicable at locations such as bridge abutments, it is the complement of the Bridge Skew (i.e. 90° minus the Bridge Skew).
Slab	A portion of concrete bounded by joints and/or edges. In jointed pavements, tied transverse construction joints are ignored for the purpose of measuring *slab length*.
Slab, odd-shaped	(a) A slab containing a blockout (for example, for a drainage structure); or (b) A slab whose dimensional limits exceed those specified in the 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.
Slab anchor	A restraining beam cast in the ground, on which a base slab is later cast.
Slab anchor, terminal	A slab anchor where the overlying base slab is a terminal slab.
Slab anchor, intermediate	A slab anchor where the overlying base slab is not a terminal slab.
Slipform paving	Also referred to as “mechanical paving” and “machine paving”. Paving by a purpose-built machine with the capacity to spread, compact, screed and finish the concrete in accordance with Clause 4.4.1 and without fixed formwork. Where a slipformer is used over fixed forms, such work is deemed to conform to this definition.
Squared standard deviation	s^2; see Clause 1.5 “Symbols”
Stitch-bar	A deformed reinforcing bar which is installed by angled drilling from the top surface.

Sub-Lot

Concrete base will be assessed on the basis of sub-Lots.

A sub-Lot is defined as a continuous pour of volume:

(a) up to 50 m^3 for slipformed base;

(b) up to 30 m^3 for fixed-formed base.

In transition zones, generate separate sub-Lots in accordance with Clause 5.2.1.

If you choose to define a sub-Lot by a method that is different to (a) and (b), detail the method in the PROJECT QUALITY PLAN in accordance with Clause 7.5.3 of TfNSW Q. The details must include how the method incorporates the requirements of (a) and (b).

Temper

The addition of water, and mixing of concrete (or mortar), to bring it initially to the required consistency. See also *Retemper*.

Test result

The result from a single test specimen or sample.

Test value

The value calculated from single test results to represent the sub-Lot (in accordance with relevant clauses of this Specification). For example, single cylinder compressive strength results are averaged (after application of correction factors) to derive a test value.

Tiebar

A deformed reinforcing bar intended to hold joints closed whilst allowing hinge movement. See also *stitch-bar*.

Tining

A surface texture applied to the plastic concrete in accordance with Clause 4.4.6.

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 sub-Lot

A sub-Lot 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. Clause 5.2.1 refers.

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.

A periodic interruption to paving (due, for example, to irregular concrete supply) does not necessarily constitute a transition point.

Vebe test

A flow test on a vibrating table, used as a measure of workability in stiff mixes.

Wet curing Curing in which the concrete surface is maintained in a wet condition. For test specimens, this can be achieved by placing in a fog room/chamber with a relative humidity exceeding 98%.

Yielded cubic metre As per the determination of mass per unit volume in accordance with AS 1012.5.

1.4 ABBREVIATIONS

ACRS	Australian Certification Authority for Reinforcing and Structural Steels
ATIC	Australian Technical Infrastructure Committee (formerly Cement and Concrete User Review Group - CCURG)
CMRS	Cementitious Materials Registration Scheme
CRCP	Continuously reinforced concrete pavement (base)
CSIRO	Commonwealth Scientific and Industrial Research Organisation, Australia
GGBFS	Ground granulated (iron) blast-furnace slag
JRCP	Jointed reinforced concrete pavement (base) - dowelled
LCS	Lean-mix concrete subbase
MBV	Methylene Blue Adsorption Value
NATA	National Association of Testing Authorities, Australia
PCP	Plain concrete pavement (base)
PCP-R	Discrete reinforced slabs within PCP (base)
TfNSW	Transport for NSW
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
SMZ	Selected Material Zone

1.5 SYMBOLS

Symbol (1)	**Definition**
F_{28Min}	The specified minimum 28-day (cylinder) compressive strength in the trial mix
F_{28}	The actual 28-day (cylinder) compressive strength in the trial mix
F_7	The actual 7-day (cylinder) compressive strength in the trial mix
F_{f28Min}	The specified minimum 28-day flexural strength in the trial mix
F_{f7}, F_{f28}	The actual 7-day & 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 7-day (cylinder) compressive strength in the Work

Symbol (1)	**Definition**
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 determined in accordance with Clause 4.2.2.1
S	Standard deviation
$\overline{\overline{X}}$	Process mean calculated on a rolling basis using 100 values (i.e. k = 100). Prior to 100 values becoming available, all available values must be used.
s_{100}	See Clause 4.2.1. Process standard deviation calculated on a rolling basis using 100 values (i.e. k = 100). Prior to 100 values becoming available, all available values must be used.
s_{30}	See Clause 4.2.1.1. Process standard deviation calculated on a rolling basis using 30 values (i.e. k = 30). Prior to 30 values becoming available, a value of $f_{cMin}/10$ must be used.
s_5	Five-point rolling standard deviation
V_f	Steel fibre content (per cent volume) of a mix

Note:

(1) In relation to concrete strengths, the leading uppercase "F" refers to results in the trial mix. The leading lowercase "f" refers to results in the work.

2 MATERIALS

2.1 AGGREGATE - GENERAL

Aggregates for base concrete must consist of clean, durable materials sourced from natural gravel, crushed stone, air-cooled iron blast furnace slag and sand. Basic Oxygen and Electric Arc Furnace Steel slag aggregates are not acceptable.

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

Form stockpiles on clear, even, well-drained, firm ground or constructed floor, and construct them separated from each other in such a way as to prevent cross-contamination and segregation.

Do not exceed a Lot size of 4000 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.

Assess each aggregate source individually for potential alkali-aggregate reactivity in accordance with Clause 2.5.1.

Further requirements for the total combined aggregates are located in Clause 2.2.

Further requirements for fine aggregates are located in Clause 2.3.

Further requirements for coarse aggregates are located in Clause 2.4.

2.2 COMBINED AGGREGATES

Ensure that the particle size distribution of combined aggregates conforms to Table R83.1.

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

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

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

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

Provide the aggregate particle size distribution with the nominated mix submission.

Table R83.1 - Combined Aggregate Particle Size Distribution

AS sieve (mm/μm)	Percent passing by mass
19.00	95 – 100
13.20	75 – 90
9.50	55 – 75
6.70	(45 – 62) (1)
4.75	38 – 50
2.36	30 – 42
1.18	22 – 34
600 μm	16 – 30
300 μm	5 – 15
150 μm	0 – 7
75 μm (2)	0 – 4 (3)
2 μm (3)	0 – 1.0 (3)

Notes:

(1) Values in brackets are for guidance only. Provide actual values for research purposes but do not apply them for acceptance purposes.

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

(3) Assess acceptance in accordance with Clause 2.3.

2.3 FINE AGGREGATE

Fine aggregate must conform to AS 2758.1, except as qualified in Table R83.2.

Table R83.2 - Fine Aggregate Properties

Property	Test: Individual (Ind) or Total fine (TF) (1)	Requirement	Test Method
Material finer than 75 μm	Total fine	As per Fig R83.1	AS 1141.11.1 (2) or AS 1141.12
Material finer than 2 μm	Total fine	As per Fig R83.1	AS 1141.13
Methylene Blue Adsorption Value (MBV)	Individual (7)	As per Fig R83.1	TfNSW T659
MBV75 (3) value	Individual (7)	As per Fig R83.1	NA
Bulk Density (compacted)	Individual	1200 kg/m^3 minimum	AS 1141.4 (Clause 7.2)
Water Absorption	Individual	5.0% maximum	AS 1141.5
Soundness (sodium sulphate)	Individual	6.0% max weighted average loss	AS 1141.24
Organic impurities	Total fine	Pass/Fail (AS 1141) and 0.5% maximum (AS 1289) (4)	AS 1141.34 and AS 1289.4.1.1 (4)
Sugar content	Total fine	less than 1 part in 10,000	AS 1141.35
Acid insoluble residue (6)	Total fine	60% minimum	Texas DOT test Tex-612-J
Micro-Deval loss (6)	Total fine	15% maximum	ASTM D7428 (8)
Flow Cone time (5)	Total fine	27 seconds maximum	TfNSW T279 (8)
Glass content (6)	Total fine	15% maximum	TfNSW 3154

Notes:

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

(2) Determined by washing.

(3) MBV75 is the product of the MBV and the passing 75 μm value.

(4) Test initially under AS 1141. If the presence of organic impurities is indicated, test under AS 1289.

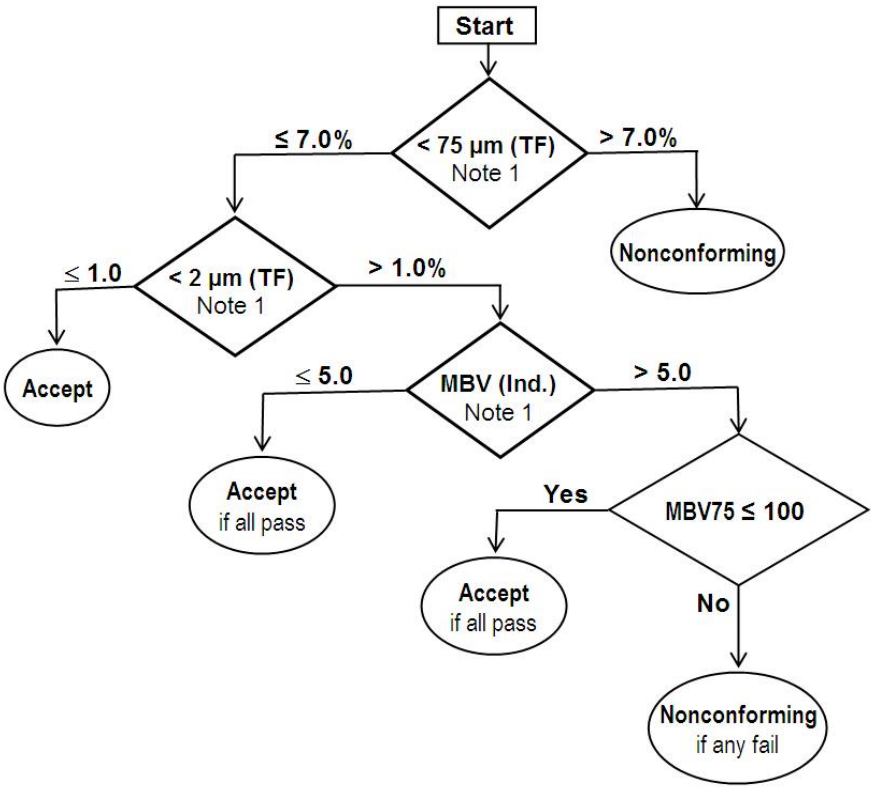
(5) Flow Cone testing is not mandatory if the manufactured fine aggregate content is less than 20% by mass of the total fine aggregate.

(6) As a proportion of the total fine aggregate component.

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

(8) Where NATA registration is unavailable, provide test results endorsed by an ISO 9001 certified laboratory whose Quality Management System is certified by a conformity assessment body (i) or by JAS-ANZ.

(i) ~ as defined in ISO 17000.



Notes:

1. Test in accordance with Table R83.2.
   Do not include the contribution from the coarse aggregates.
2. TF: Total fine aggregate Ind: Individual fine aggregates

Figure R83.1 - Fine aggregate testing

2.4 COARSE AGGREGATE

Coarse aggregate must conform to AS 2758.1, except as qualified in Table R83.3.

Table R83.3 - Coarse Aggregate Properties

Property	Test: Individual (Ind) or Total coarse (TC) (1)	Requirement	Test Method
Bulk Density	Individual	minimum 1200 kg/m^3	AS 1141.4 (Clause 7.2)
Particle Density	Individual	minimum 2100 kg/m^3	AS 1141.6, SSD (8) method
Water Absorption	Individual	2.5% maximum	AS 1141.6.1 or AS 1141.6.2
Material finer than 75 μm	Total coarse	maximum 1.0%	AS 1141.11.1 (7) or AS 1141.12
For material > 9.50 mm: Particle shape, 2:1 and 3:1 ratios	Individual	maximum 25% and 10%	AS 1141.14
For material ≤ 9.50 mm: The ratio AGD/ALD (3) for all fractions 2 mm to 9 mm (4)	Individual	Maximum 2.25	TfNSW T275 and T278
Wet Strength	Individual (6)	minimum 80 kN	TfNSW T215
Wet/Dry variation	Individual (6)	maximum 35%	TfNSW T215
Weak particles	Individual	maximum 0.3%	AS 1141.32
Light particles	Individual	maximum 1.0%	AS 1141.31
Fractured faces (2 or more) (2)	Individual	minimum 80%	TfNSW T239 (2)
Alkali reactivity	Individual (6)	see Clause 2.5.1	TfNSW T363
Foreign materials content	Individual (5)	maximum 0.1% (5)	TfNSW T276

Notes:

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

(2) Test Method TfNSW T239 Clauses 6(a) to 6(c) and 7(b) to 7(d)(ii) may be ignored. Testing can be waived for aggregate which has been extracted from mineral rock quarries by drilling and blasting.

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

(4) In accordance with Test Method TfNSW T278, carry out the test only where the number of aggregate particles in the group is ≥ 15% of the minimum 100 particle sample used to determine ALD.

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

(6) You need only test a single nominal size from each rock source.

(7) Determined by washing.

(8) SSD: saturated surface dry.

2.5 AGGREGATE TESTS

2.5.1 Alkali-Aggregate Reactivity (AAR)

Assess each aggregate individually for potential alkali-aggregate reactivity within 12 months prior to the date of closing of tenders, as follows:

(a) assess using the accelerated mortar bar test TfNSW T363;

(b) calculate the weighted AAR contribution of all aggregates in the mix on the basis of mass proportions;

(c) the Combined Aggregate AAR potential is deemed to be 1.25 times the weighted AAR contribution;

(d) apply the Combined Aggregate AAR to TfNSW T363 Table T363/A to determine the Aggregate Reactivity Classification (i.e. non-reactive, slowly reactive or reactive);

(e) take action according to the Aggregate Reactivity Classification when applied to Table R83.4.

Table R83.4 - Action for Aggregate Reactivity Classification

Aggregate Reactivity Classification	Action Required
Non-reactive	None
Slowly reactive	Use AAR Reactive Class mix (TfNSW 3211 Annexure 3211/D); or Limit alkalis in mix to 2.1 kg/m^3 (1)
Reactive	Use AAR Reactive Class mix (TfNSW 3211 Annexure 3211/D); or Demonstrate as "Non-Reactive" when tested by TfNSW T364 using nominated supplementary cementitious materials (SCM) and aggregates.

Note:

(1) Total alkali must 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.

2.6 CEMENTITIOUS MATERIALS

Comply with TfNSW 3211.

2.7 ADMIXTURES

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

(a) For combinations of two or more admixtures, their compatibility must be certified in writing by the manufacturers.

(b) For mixes with less than 50 kg/m^3 fly ash, the total alkali contribution (measured as Na_2O equivalent) from all admixtures used in any mix must not exceed 0.20 kg/m^3.

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

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

Air entraining agents are mandatory in slipform paving mixes [ii] and must ensure that the concrete conforms to Clause 3.7.

2.8 CURING COMPOUND

See also Clause 4.4.7 regarding curing operations.

Comply with AS 3799, subject to the qualifications in Table R83.5.

For water retention testing, provide test results from a laboratory with NATA accreditation. For all other testing, provide test results endorsed by an AS/NZS ISO 9001 certified laboratory whose Quality Management System is certified by a conformity assessment body [iii] or by JAS-ANZ.

Table R83.5 – Curing Compound Properties

Description	Conform to AS 3799 class	Carbon Number	Limitations
Hydrocarbon resin (HCR)	Class B with minimum 30% NV resin content [2,7]	C5 only	Do not use where a bitumen seal or asphalt will be placed [8]
Water-borne hydrocarbon resin (WHCR)	Class B with minimum 30% NV resin content [2,7]	C5 only	Do not use where a bitumen seal or asphalt will be placed [8]
Styrene butadiene resin (SBR)	Class B [7]	Not applicable	Do not use where a bitumen seal or asphalt will be placed [8]
Blended bitumen and water-borne hydrocarbon resin (B-HCR)	Class Z with minimum 40% bitumen [6]	C_5 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 [1, 3, 4]	Not applicable	Do not use on the top surface. Use only for debonding of joints. Comply with Specification TfNSW R82.

Notes:

(1) When tested for stability in accordance with TfNSW T862, the rate of separation in seven days must not exceed 4%.

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

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

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

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

[ii] Entrainment is not mandatory in non-pavement components such as anchors and subgrade beams, nor in fixed-form (hand placed) mixes.

[iii] ~ as defined in ISO 17000.

(6) Ensure that bitumen constitutes at least 40% of the total mass as delivered. The bitumen is to be Class C170 conforming to Specification TfNSW 3253.

(7) For summer paving, use a Type 1-D compound incorporating a light-colored fugitive dye.

(8) The Principal 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.

For each nominated curing compound, certify by written report that the compound conforms to this Specification and submit relevant test results with the report.

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

Attention is drawn to Specification TfNSW R145 Clause 3.1 regarding adhesion of line marking.

2.8.1 Reference Sample

Test the reference sample for the following properties:

(a) non-volatile content;

(b) the efficiency index;

(c) density;

(d) drying time;

(e) viscosity;

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

Test in accordance with AS 3799 and ensure that the results conform to Table R83.5 and AS 3799.

On the basis of these results, provide written certification (accompanied by the test results) that the reference sample conforms to this Specification.

2.8.2 Initial Delivery

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

(a) non-volatile content;

(b) density;

(c) drying time;

(d) viscosity;

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

Test in accordance with AS 3799 and ensure that the results conform to Table R83.5 and AS 3799. Assess for consistency with the Reference Sample in accordance with AS 3799.

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

2.8.3 Subsequent Deliveries

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

(a) non-volatile content;

(b) density;

(c) viscosity.

2.9 JOINT SEALANT

Joint sealant must be silicone sealant for casting insitu, conforming to the requirements of Table R83.6.

You must:

(a) certify that the proposed sealant conforms to this Specification;

(b) provide all relevant test results endorsed by an AS/NZS ISO 9001 certified laboratory whose Quality Management System is certified by a conformity assessment body [iv] or by JAS-ANZ, except that JAS-ANZ certification is not required for Test Methods TfNSW T1192 and T1193;

(c) provide a full technical description (as part of the PROJECT QUALITY PLAN), including the method of installation recommended by the manufacturer.

Table R83.6 - Silicone Joint Sealants

Test Method	Attribute	Requirements
ASTM-D792 (Method A)	Specific gravity	1.1 – 1.55
ASTM-C661 (Standard Curing)	Durometer hardness	Max 25 at –29ºC Max 30 at +23ºC
ASTM-C603	Extrusion rate	90 – 250 g/minute
ASTM-C679	Tack free time	Tack free at 5 hours
ASTM-C793	Accelerated weathering	No surface crazing, hardening, chalking or bond loss at 5000 hours
ASTM-C794	Adhesion to concrete	Minimum 35 N average peel strength
TfNSW T1193	Accelerated ageing	Condition of specimen after one aging cycle
TfNSW T1192	Adhesion to concrete	Conditioning as per TfNSW T1193. Extension to 70%, compression to 50%. After 500 cycles, not more than 10% failure over the cross-sectional area.
	Colour	Grey, compatible with pavement concrete

[iv] ~ as defined in ISO 17000.

2.10 STEEL REINFORCEMENT

The reinforcement material supplier must be certified by the Australian Certification Authority for Reinforcing and Structural Steels (ACRS) for the supply of reinforcement material.

The reinforcement fabricator must be certified by the Australian Certification Authority for Reinforcing and Structural Steels (ACRS) for fabricating reinforcement and must implement and maintain a quality management system in accordance with AS/NZS ISO 9001 as a means of ensuring that the product conforms to this Specification.

Steel reinforcement must conform to AS/NZS 4671. Reinforcement must be readily identified as to its grade and origin.

When galvanized bars are specified, the bars must be hot dipped in accordance with AS/NZS 4680.

2.11 WATER

Water used in the production of concrete must be free from materials harmful to concrete and reinforcement, and be neither salty nor brackish. The water must conform to AS 1379 Clause 2.7 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 AS 1478.1 Appendix C;

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

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

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 above criteria.

Limits on soluble salt content for the total concrete mix are detailed in Clause 3.7.

3 DESIGN

3.1 GENERAL

Construct the Works in accordance with the Drawings.

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

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

In steel-fibre reinforced concrete pavement (SFCP), mesh reinforcement is only used in special slabs, in anchors and in joints (as tiebars and dowels). All slabs contain steel fibre reinforcement, longitudinal joints are typically tied, and transverse joints are not dowelled. Refer to Clause 6 for additional SFCP requirements.

The Principal may alter the base thickness and levels by up to 30 mm before the commencement of each section of work. Such variations in the scope of work will be covered by the schedule rate, and you are not entitled to any additional payment over and above payment at the scheduled rate.

3.2 SURVEY AT THE TOP OF THE UNDERLYING LAYER

3.2.1 Survey Prior to 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:

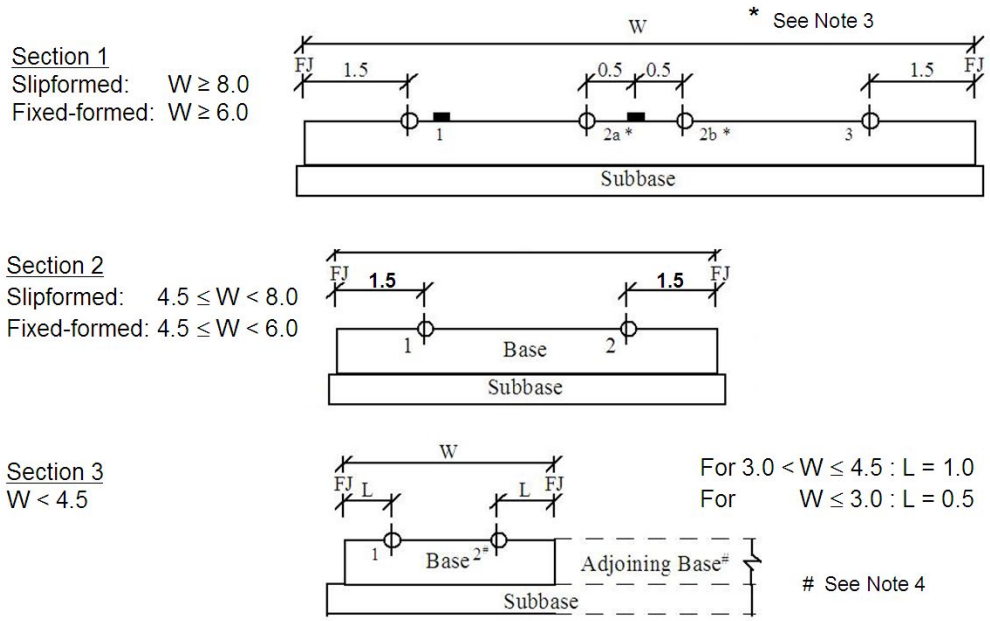
(a) for lean-mix concrete subbase (LCS) where the base and subbase are constructed under the same contract:
- in accordance with Specification TfNSW R82;

(b) for LCS which was constructed by others:
- by survey jointly between you and the Principal, in accordance with Specification TfNSW G71;

(c) for subbases other than LCS:
- in a manner consistent with criteria contained in TfNSW R82.

Where you choose 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 mm^2 and 4000 mm^2, at a spacing of 10.0 m longitudinally and at the cross-section offsets shown in Figure R83.2, with a tolerance of 0.5 m. Report the levels to the nearest millimetre.



Notes:

1. All dimensions are in metres (m).
2. Induced longitudinal joints are ignored for the purpose of locating survey points and so are not marked.
3. In Section 1, survey either at point 2a or 2b.
4. In Section 3, delete survey point 2 adjoining previously placed base.
5. Unless otherwise specified or agreed, in locations where the distance between a formed edge and the adjacent lane line is variable (tapered), the survey point must be altered to a location which is offset by 0.5 m from that lane line.
6. Key:
   FJ - Formed joint or edge
   W - Paving width between formed joints or edges
   ■ - Lane lines
   ϕ - Survey points

Figure R83.2 - Survey locations (not to scale)

3.2.2 Survey Report Prior to Placing Base

Prior to base paving, submit a Survey Report conforming to Specification TfNSW G71 and highlighting all locations where the actual level is higher than the contract level.

Apply a Hold Point to base paving if any high levels exist within the schedule.

HOLD POINT

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 Principal will consider the submitted documents prior to authorising release of the Hold Point.

3.2.3 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 Average Least Dimension (ALD) of the cover aggregate, determined in accordance with Specification TfNSW R106. 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 mm^2 and 4000 mm^2 on the surface over which base will be paved.

3.2.4 Redesign of Pavement Levels

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

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

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, must not be greater than 0.1% (1.0 mm per metre);

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

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

Additionally, the revised design must be such that:

(i) water will not pond on the carriageway;

(ii) 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);

(iii) 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.

Where the base and subbase are constructed under the same contract, you are not entitled to additional payment as a consequence of local redesign.

3.3 MIX PARTICLE SIZE DISTRIBUTION

Comply with Clauses 2.1 to 2.5.

3.4 CEMENTITIOUS CONTENT

Comply with TfNSW 3211 Annexure 3211/D.

3.5 STRENGTH

Table R83.7 lists the minimum requirements for compressive and flexural strength at 28 days, together with qualifying requirements for moulding and testing.

For CRCP mixes, the flexural strength in the Trial Mix must not exceed 6.5 MPa at 28 days.

Table R83.7 - Minimum Concrete Strengths

Description		Compressive Strength	Flexural Strength (1)
Non-SCM Mixes (2)	**In the Trial Mix**	45.0 MPa (F_{28Min})	5.0 MPa (F_{f28Min})
	In the Works	40.0 MPa (f_{cMin})	4.8 MPa (f_{fMin}) (3)
SCM Mixes (2)	**In the Trial Mix**	40.0 MPa (F_{28Min})	4.8 MPa (F_{f28Min})
	In the Works	35.0 MPa (f_{cMin})	4.5 MPa (f_{fMin}) (3)
Test specimen size		cylinder 100 mm diameter	beam 100 × 100 × 350 mm
Test methods		AS 1012.8 except: TfNSW T304 for moulding; AS 1012.9 for testing	AS 1012.8 except: TfNSW T304 for moulding; AS 1012.11 for testing

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). See TfNSW 3211 Annexure 3211/D.

(3) Specified only for process control, not specified for sub-Lot acceptance. For SFCP, refer to Clause 6.6.

3.6 CONSISTENCE

Determine the consistence of the concrete by measuring the slump in accordance with AS 1012.3 Method 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 must be within ± 5 mm of the slump as measured in the trial mix batch under Clause 3.8.1.

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

For slipform concrete mixes, test and report the Vebe reading in the trial mix in accordance with AS 1012.3 Method 3.

3.7 OTHER ATTRIBUTES

3.7.1 Shrinkage

Prepare and test concrete specimens in the Trial Mix in accordance with AS 1012.13.

Shrinkage of the concrete specimen after either of the 21 or 56 days' drying periods must conform to Table R83.8. Conformity is required at only one age. If the result at 21 days is nonconforming, the test may be extended to 56 days.

Table R83.8 - Maximum Shrinkage Strain

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

Notes

(1) To be tested only in the trial mixes.

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

3.7.2 Other

Limits on other concrete attributes apply in accordance with Table R83.9.

Determine the total contents for chloride and sulphate ions in the combined mix by one of the methods in Clause 3.7.3.

Limits on mixing water are detailed in Clause 2.11.

Table R83.9 - Other Concrete Attributes

Attribute	Test Method	Requirement
Compaction	Clause 5.2	Relative compaction 98.0% minimum [1]
Chloride ion content	Clause 3.7.3	0.8 kg/m^3 maximum per cubic metre of concrete
Sulphate ion content	Clause 3.7.3	5% maximum relative to cement mass [2]
Air content of fresh concrete [3]	AS 1012.4.2, with compaction by internal vibration [4]	4.5 ± 1.5 %
Bleeding [5]	AS 1012.6, with compaction by internal vibration	3% maximum
Coefficient of Thermal Expansion (CTE) [5]	AASHTO T336: Standard Method for the Coefficient of Thermal Expansion of Hydraulic Cement Concrete	Report only [6]

Notes:

(1) Not applicable in the Trial Mix.

(2) Calculate the sulphate ion content relative to the cement mass, i.e. 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) Use the same vibration pattern and durations as for cylinders in accordance with TfNSW T304.

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

(6) Test at least one slipform mix and one fixed-form mix. This value is for research purposes only and is not an acceptance criterion. See Clause 3.8.1(iii)(l) regarding delayed submission of results.

3.7.3 Chloride and Sulfate Content Testing

The two methods for testing chloride and sulfate ion contents are as follows. Testing is required by only one method.

(a) Testing of concrete constituents:

(i) Conduct chloride testing in accordance with:

- AS 1012 Part 20 for aggregates;
- AS 1478.1 Appendix C for water and admixtures dissolved in water;

then calculate the total content in the mix.

(ii) Conduct sulfate testing in accordance with:

- AS 1012 Part 20 for aggregates;
- AS 1289.4.1.2 for water and admixtures dissolved in water;
- AS 2350.2 for cementitious materials;

then calculate the total content and percentage in the mix.

(iii) Notes:

(A) For admixtures, the soluble salt contents may be taken as the values certified in writing by the manufacturer.

(B) 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.

(b) Testing of hardened concrete:

Conduct chloride and sulfate testing in accordance with AS 1012 Part 20. The water used in the concrete must 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.

3.8 NOMINATED CONCRETE MIXES

3.8.1 Submission of Nominated Mixes

Before commencing production of each base concrete mix, you must:

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

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

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

(d) submit a copy of a verification checklist covering items listed below;

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

Where a higher slump mix is proposed under Clause 3.6(c) for use in transition zones, it may be considered to be covered by the slipform trial mix.

Trial mixing must conform strictly with your proposals under Clause 4.2 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 must be within eighteen months prior to the commencement of paving. If sufficient production mix results are available from within this period, the Principal may reduce the scope of the trial mix or waive it.

To determine the compressive strengths F_7 and F_{28} for each trial batch, test a minimum of three specimens at age seven days and a minimum of three specimens at age 28 days. Specimens must conform to Clause 3.5, with compaction by internal electric vibration. F_7 and F_{28} are the average of all individual results not more than 2.0 MPa from the median value.

Inspect, cap and crush the cylinders in accordance with AS 1012.9. Determine their unit mass in accordance with AS 1012.12.2 as amended by Clause 5.2.1.1.

To determine the flexural strength for each trial batch, test a minimum of three specimens at age 28 days and a minimum of three specimens at age seven days. Specimens must conform to Clause 3.5, with compaction by either internal electric or table vibration. The flexural strengths F_{f28} and F_{f7} are the average of all individual results not more than 0.5 MPa from the median value.

To determine the indirect tensile strength for each trial batch of base, test a minimum of three specimens at age 28 days. Notwithstanding the requirement of AS 1012.8 Clause 1.5.2(b)(iii), specimens must be 100 mm diameter cylinders which conform to the requirements for compressive strength specimens under Clause 3.5, with compaction by internal electric vibration. The indirect tensile strength F_{t28} is the average of all individual results not more than 0.5 MPa from the median value. The indirect tensile strength will not be used for conformity purposes.

HOLD POINT

Process Held:	Production of each concrete mix.
Submission Details:	Submit the statement and attachments referred to in Clause 3.8.1 at least five working days before commencing production.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising release of the Hold Point.

WITNESS POINT

Process Witnessed:	Trial mix.
Submission Details:	Submission of notice of time and location of mixing at least two working days before mixing.

The following details are required for each nominated mix:

(i) Material Constituents:

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

(b) Supplementary cementitious materials: supplier, product name, ATIC registration number and source (for each).

(c) Water: source.

(d) Admixtures: proprietary source, type, name and dosage recommended by manufacturer.

(e) Aggregates: source, geological type, moisture condition on which mix design is based (oven dry, saturated surface dry or nominated moisture content).

(f) Relevant test results for all constituents.

(g) Test results for alkali-reactive materials in accordance with Clause 2.5.1, and soluble salt content in accordance with Clause 3.7.3.

(ii) Mix Design:

(a) Constituent quantities, per yielded cubic metre of concrete.

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

(iii) Test Results for a laboratory trial batch (or batches): for each nominated mix (Clauses 3.3 to 3.7), determined at a slump which conforms to Clause 3.6. Demonstrate conformity (where required) for:

(a) cementitious content per yielded cubic metre of concrete;

(b) compressive strength at age seven days (F_7);

(c) compressive strength at age twenty eight days (F_{28});

(d) flexural strength at age seven days (F_{f7});

(e) flexural strength at age twenty eight days (F_{f28});

(f) indirect tensile strength at age twenty eight days (F_{t28});

(g) drying shrinkage;

(h) Vebe reading;

(i) air content;

(j) bleeding;

(k) Factors AF in accordance with Clause 5.3.5. Derivation of AF is optional but, where adopted, it must be notified as part of the trial mix submission. For ages beyond 28 days, report the results progressively as they become available;

(l) Coefficient of Thermal Expansion. Results may be submitted up to 3 months after the trial mix.

Mould all test specimens using test methods in accordance with Clauses 3.5, 3.6 and 3.7.

Where it is impractical to mould all specimens from a single batch, prepare two batches of the trial mix, and mould the test specimens as follows:

Batch No	Specimen grouping from item sub-clauses above
1	(a) to (g) inclusive
2	(h) to (k) inclusive, and (c) [(1)]

Note:

(1) Repeat item (c) in order to demonstrate between-batch consistency.

Report the unit mass for all specimens tested under items (b), (c), (d), (e) and (f), using test methods specified in Clauses 4.2.1 and 5.2.1.

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

3.8.2 Variations to Authorised Nominated Mixes

You may vary the authorised nominated mix without submitting a new 'nominated mix', unless the proposed variations exceed the following amounts:

(a) cement and other cementitious material: 10 kilograms per cubic metre for each material, subject to the requirements of Clause 3.4 being met;

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

(c) admixture dosages as required, subject to conformity with Clause 2.7;

(d) water, unspecified.

Notify the Principal of such variations to an authorised nominated mix before commencing production with the varied quantities.

If you wish 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 Clause 3.8.1.

Tolerances on the particle size distribution of aggregates are specified in Clause 4.2.1.

4 PROCESS CONTROL

4.1 PLACING STEEL REINFORCEMENT

4.1.1 General

In CRCP, place reinforcement as shown on the Drawings. Longitudinal steel must be placed on top of transverse steel and must provide a mass steel ratio within the range 0.67% to 0.72% when calculated in accordance with Drawing DS2012/001190.

In other Base formats, reinforce the concrete as shown on the Drawings, including special slabs (Clause 4.8). 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 must:

(i) be formed to the dimensions and shapes shown on the Drawings;

(ii) be bent to an internal bend radius in accordance with Table R83.10;

(iii) not be bent or straightened in a manner that will damage the material;

(iv) not be used with kinks or bends not shown on the Drawings; and

(v) not be heated for purposes of bending.

Steel reinforcement placed in the Works must be free from loose or thick rust, grease, tar, paint, oil, mud, mortar or any other coating; however, do not bring it to a smooth polished condition. Its surface condition must 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. Any enclosed perimeter of the bar chair side elevation must have at least 25% voids, with a minimum gap in the chair below the reinforcement of 1.5 times the maximum nominal size aggregate in the concrete mix.

The arrangement and spacing of chairs must 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 must also have sufficient bearing at their base to prevent overturning. Chairs must be capable of supporting a 200 kg mass without permanent distortion in excess of 2 mm.

The ends of bars forming a lapped splice must 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 must not be less than the pitch of the transverse wires plus 25 mm.

The mass of reinforcing steel supported by any one chair must 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.

HOLD POINT

Process Held:	Placement of concrete around steel reinforcement.
Submission Details:	A certificate of compliance signed by you covering the installation of reinforcement and embedments.
Release of Hold Point:	The Principal will consider the submitted documents and may inspect the work prior to authorising release of the Hold Point.

4.1.2 Tiebars [v]

Tiebars must be a minimum length of 1.0 m. Drill-ties must be a minimum length of 0.75 m.

The method of insertion of tiebars must 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) an anchorage strength of at least 85% of the bar's yield strength;

In longitudinal tied joints, place tiebars:

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

(ii) not closer than 200 mm to a transverse tied joint;

(iii) 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.

(iv) within the central third of the slab depth but with a minimum vertical clearance of 30 mm to any crack inducer or sawcut. This clearance also applies 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.

Conduct testing for tiebar location, anchorage and concrete compaction, as follows:

4.1.2.1 Pull-out Testing

For tiebars which have been inserted (in lieu of pre-placement) into a formed slab edge (either slipformed or fixed-formed [vi], test for anchorage strength.

Undertake testing within 30 days of paving.

Tiebars must 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[vii], 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 1 per 50 m of joint until a further four consecutive conformities are achieved; and thereafter

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

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[v] Also referred to in some documents as "tie bars".

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

[vii] If tiebars are inserted on both sides of a paving run, test each side at the specified frequency.

Test a minimum of five bars in any paving trial.

If a nonconformity is encountered at any stage of the test, consecutive bars must 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 an anchorage strength of at least 85% of the yield strength of the bar. Bar replacement must not disturb the concrete surface. Test the replaced bars at a minimum frequency of 1 in 2.

4.1.2.2 Location and Compaction Testing of Inserted Tiebars

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

(a) For location:

(i) in the paving trial: every bar; and thereafter

(ii) every bar within a test length comprising two consecutive slabs as shown in Figure R83.3, and at a minimum frequency as follows:

(A) two test lengths per sub-Lot until ten consecutive conforming lengths are achieved; and thereafter

(B) one test length every second sub-Lot.

If a nonconformity is detected, the testing frequency reverts to (A).

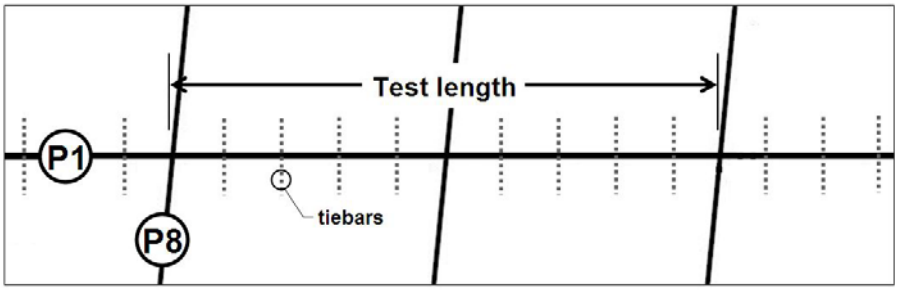


Figure R83.3 - Test Length for Inserted Tiebars

(b) For compaction:

(i) in the paving trial: one core per 40 m of joint, or part thereof; and thereafter

(ii) one core per 100 m of joint until five consecutive conformities are obtained; and thereafter

(iii) one core per 200 m of joint.

If a nonconformity is detected at any stage, a Hold Point applies in accordance with Clause 5.2.4 and the testing frequency reverts to (ii).

Where two or more inserters are used, the frequencies in (i), (ii) and (iii) apply to each inserter.

Carry out coring within two days of paving.

Cores must be located to intersect a tiebar but must be offset from the longitudinal joint by 350 mm ± 50 mm and must 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 5.2.4.

4.1.2.3 Concrete Cover below Sawn aoints

For tiebars which are located below sawn joints (such as joints type 1), test for vertical cover to the bottom of sawcut:

(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, test consecutive bars 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.

This testing requirement also applies to any steel bar and mesh which is required to function as a tiebar (such as in joints type 17).

At each nonconformity, provide a drilled stitch-bar in accordance with the TfNSW maintenance drawings.

4.1.3 Dowels

Dowels must be installed ahead of paving and must:

(a) comply with AS 3679.1 and be galvanized in accordance with AS/NZS 4680.

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

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

(d) when tested in accordance with TfNSW T366, 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. Submit details of the proposed dowel support system and the method of debonding as part of the PROJECT QUALITY PLAN.

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

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

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

Prior to 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.

4.1.4 Testing General

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 under Clause 4.1.2.2 or unless approved by the Principal.

Where testing frequencies have not been specified, nominate your proposed testing frequency in accordance with TfNSW Q.

4.1.5 Protective Coatings

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

4.1.6 Bending

Bend the reinforcement in accordance with Clause 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. Do not cool heated bars by quenching.

Reinforcement already bent and straightened or bent in reverse must 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 must be not less than the value determined from Table R83.10.

Submit details as part of the PROJECT QUALITY PLAN any proposal to bend anchor stirrups to facilitate slipform paving.

Table R83.10 - 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 in reinforcement epoxy coated or galvanized 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

4.1.7 Welding

All welding must conform to the requirements of Specification TfNSW B203. For Grade 500 bars the welding procedure must 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 must meet the requirements of tensile and bend tests specified for the parent metal.

4.1.8 Lapped Splices

The minimum length of lapped splices is in accordance with Clause 13.2 of AS 3600, unless shown otherwise on the Drawings:

Lapped bars splices not shown on the Drawings must have lengths not less than the values listed in Table R83.11. The ends of bars forming a lapped splice must be welded or securely wired together in at least two places.

Table R83.11 - 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 must conform to Clause 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 must be such that they mechanically engage each other (that is, the bottom sheet has transverse wires uppermost and the top sheet has them underneath).

4.1.9 Mechanical Splices

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

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

4.1.10 Storage

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

4.2 PRODUCTION AND TRANSPORT OF CONCRETE

The production and transport of concrete must:

(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 must have an operational capacity which allows continuous paving at the target paving speed. In no case must the capacity be less than that required to maintain continuous paving with adequate allowance for mixer efficiency and control testing.

4.2.1 Production Mixes

For producing a concrete mix, always target the nominated mix. Table R83.12 shows the allowable tolerances on individual batches.

The mean content of each cementitious material within a sub-Lot must be not less than that of the authorised nominated mix (after compliant variations in accordance with Clause 3.8.2).

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

Determine the combined aggregate particle size distribution by the following methods:

(a) **Test Method A** - by calculation:

Determine a separate particle size distribution for each constituent aggregate, and calculate the combined particle size distribution from the nominated mix proportions.

(b) **Test Method B** - by wet-sieving:

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

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

Table R83.12 - Concrete Production Tolerances

Description	Tolerance (% by mass)
Aggregate Particle Size Distribution: (AS sieve)	
19.00 mm	± 2
13.20 mm	± 5
9.50 mm	± 5
4.75 mm	± 3
2.36 mm	± 5
1.18 mm	± 5
600 µm	± 5
300 µm	± 5
150 µm	± 2
75 µm	± 0.5%
Cement:	± 2.0 (1)
SCM:	± 4.0 (1)
Admixtures:	unspecified
Water: (2)	± 15.0%

Notes:

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

(2) Monitor the total batch water relative to the Trial Mix. Measure the water contained in the aggregates at least once per day. This value may be used for the full day.

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

Clauses 4.2.1.2, 4.2.1.3 and 4.2.1.5 do not apply to SFRC. For SFRC, refer to Clause 6.6.

4.2.1.1 7-Day Compressive Strength

Undertake 7-day compressive strength testing at the same frequency as specified for 28-day compressive testing in accordance with Clause 5.3.

Whenever the 7-day compressive strength requirements are not met, submit the results to the Principal with an assessment report and an assignable cause within two working days of testing.

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

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

(viii) A distinction is intended between the terms "mixed" and "transported".

where:

F_7 is the 7-day compressive strength in the trial mix (reference Clause 3.8.1)

F_{28} is the 28-day compressive strength in the trial mix

f_{cMin} is as specified in Clause 3.5

s_{30} is the 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 must be done initially on receipt of 30 test values and thereafter at your discretion, but no less frequently than with each group of 30 new values.

Prior to 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 7-day strength of not fewer than 30 test values.

Your target value must not be less than $2s_{30}$ above the lower warning limit.

4.2.1.2 Frequency of Moulding of Flexural Test Specimens

For SFRC, refer to Clause 6.6.

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.

Mould 28-day specimens at the minimum frequencies given in Table R83.13. Specimens for 7-day testing are required only from the Paving Trial.

Mould specimens in accordance with Table R83.7.

Mould flexural test specimens in sets of three (three for each of 7-day and 28-day testing). Mould all specimens within a set from the same sample of concrete, and mould flexure specimens from batches[ix] of concrete from which cylinders are moulded for 28-day compressive strength under Clause 5.3.2.

In the Paving Trial, mould the 7-day and 28-day flexure sets from the same batch[ix].

Table R83.13 - Minimum Frequency of Flexural Test Specimens

	Minimum Frequency (Sets)	
	7-day testing	**28-day testing**
Paving Trial	As per Clause 4.4	
and thereafter		
from the first three sub-Lots using that mix [1]	Nil	1 per sub-Lot
and thereafter		
for daily outputs ≤ 200 m^3 for daily outputs > 200 m^3	Nil Nil	1 1 per 400 m^3

Note:

[1] The sub-Lots are those determined in accordance with Clause 1.3.

[ix] This will require care in sampling if a load comprises more than one batch.

4.2.1.3 Flexural Test Specimens

For SFRC, refer to Clause 6.6.

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.

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

Test specimens for determining the flexural strength of concrete must be standard beams of nominal size 100 mm × 100 mm × 350 mm conforming to Clause 3.5.

Mould all specimens within a set from the same sample of concrete, with compaction by internal or table vibration.

Specimens must be moulded in accordance with Table R83.7 and inspected, conditioned and tested in accordance with AS 1012.11.

Determine the unit mass of all 28-day flexure test specimens at age not less than 7 days in accordance with AS 1012.12 Method 2, amended as follows:

(a) Mass testing must be in the saturated-surface-dry condition and without dressing of voids; (reference TfNSW T368).

(b) The unit mass for a set of beams is the average of results not more than 20 kg/m^3 from the median value. Round the average to the nearest 10 kg/m^3.

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

4.2.1.4 Assessment of 28-day Flexural Strength

For SFRC, refer to Clause 6.6.

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

Should any specimen be tested more than 28 days after moulding, the equivalent 28-day flexural strength is the flexural strength divided by the relevant factor AF applicable to the age of the specimen at the time of test as specified in Clause 5.3.5.

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

Assess the results in accordance with Table R83.14. Take action as follows if the rolling mean flexural strength falls below f_{fMin} or the rolling standard deviation exceeds 0.5 MPa:

(a) 0.95 f_{fMin} less than or equal to 28-day rolling mean flexural strength less than f_{fMin}:

Promptly implement corrective action to ensure conformity as specified.

(b) 28-day rolling mean flexural strength less than 0.95 f_{fMin}:

Observe the Hold Point specified.

(c) 28-day rolling coefficient of variation greater than 11.0%:

Promptly implement corrective action to ensure conformity as specified.

Submit test results to the Principal within two working days of testing.

4.2.1.5 Process Control Charts

Develop process control charts in accordance with AS 3940 and AS 3942 for the parameters listed in Table R83.14 for each nominated pavement mix in use (excluding non-pavement mixes such as anchors and kerbs).

For the purpose of charting under this clause, the process mean $\overline{\overline{X}}$ is defined in Clause 1.5.

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

Take corrective action also regarding your 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.

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

(i) the rolling mean 7-day compressive strength falls below the specified minimum; or

(ii) the rolling mean 28-day flexural strength falls below the specified minimum; or

(iii) corrective action is not promptly implemented.

HOLD POINT	(Where specified above)
Process Held:	Use of a concrete mix in pavement base.
Submission Details:	(a) Results for compressive and flexural strength, relative compaction and thickness for the same sub-Lot. (b) Proposal for corrective action to achieve conformity.
Release of Hold Point:	The Principal will consider the submitted documents and will release the Hold Point when appropriate Corrective Action has been implemented.

Following release of the Hold Point, monitor the 7-day strength and submit the results to the Principal with an assessment report within two working days of testing.

Table R83.14 - Control Charts

Parameter	Control chart requirements		Decision rules (2)
	Chart types and controls	Specifications and criteria	
7-day compressive strength	(a) Mean chart, showing:	As per AS 3942 Clause 4.3.2	
	- target value	See Note 5	
	- Lower warning limit	As per Clause 4.2.1.1	
	- 5-point rolling mean	As per Clause 4.2.1.1	A
28-day flexural strength (8)	(a) Mean chart, showing:	As per AS 3942 Clause 4.3.2	
	- target value	See Note 5	
	- Lower warning limit	As per AS 3942 Clause 4.3.2 and Note 7	
	- specified limits	As per Clause 4.2.1.4	
	- 5-point rolling mean	As per Clause 4.2.1.4	B
	(b) Coefficient of variation chart, showing:		
	- Upper warning limit	9.0%	
	- specified limit	As per Clause 4.2.1.4	
	- 5-point rolling coefficient of variation	As per Clause 4.2.1.4	B
Cylinder unit mass	(a) Mean chart, showing:	As per AS 3942 Clause 4.3.2	
	- Lower warning limit	LWL = RCUM in the paving trial, less 30 kg/m$^{3.}$	
	- RCUM for the paving trial(s)		A
	(b) Standard deviation chart, showing:	As per AS 3942 Clause 4.3.4	
	- 10-point rolling standard deviation		
	- process standard deviation s_{100}	UWL = 15 kg/m^3 See Note 4	E
Fraction passing 75 µm sieve (6)	(a) Sample chart, showing:	Based on the calculated combined grading for all possible stockpile combinations	
	- specified upper limit	Upper limit = 7.0% (Clause 2.3)	D
	- individual results		C

Notes:

(1) Abbreviations:

UCL: upper control limit UWL: upper warning limit

LCL: lower control limit LWL: lower warning limit

(2) Key to decision rules:

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

B: In accordance with Clause 4.2.1.4.

C: Five consecutive increasing values.

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

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

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

(4) The process mean ($\overline{\overline{X}}$) and standard deviation (s_{100}) must be calculated in accordance with Clause 1.5 on a rolling basis using 100 values (that is, k = 100).

(5) 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 must be at least three standard deviations above the minimum specified value.

(6) 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.

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

(8) This parameter is not applicable to SFRC.

4.2.2 Mixing, Transport, Consistence and Air Content

The handling, storing and batching of materials and the mixing, transport and consistence of concrete, including any retempering, must conform to AS 1379 Sections 3 and 4 and Appendix A, all as modified by the following requirements (within Clause 4.2.2).

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

Weigh cementitious materials separately from each other.

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.

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

See Clause 1.3 for definitions of the terms "batch", "load" and for mixer types. Additionally:

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

(b) For mobile batch mixers: a "batch" is deemed to be the same as a "load". A load must not comprise more than a single batch.

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

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

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

4.2.2.1 Mixing Time

Determine the minimum mixing time MT_{min} as defined in sub-clause (c) hereunder.

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

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

- for split-drum mixers, a minimum of 30 secs of mixing must be provided after the final addition of water;
- for twin-shaft mixers, a minimum of 15 secs of mixing must be provided after the final addition of water.

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

For mobile mixers, see Clause 4.2.2.7 for retempering provisions.

(c) Determine the minimum mixing time MT_{min} from mixer uniformity testing in accordance with Clause 4.2.2.2, and the following:

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

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

(iii) for mobile batch mixers, the mixing time must not be less than that shown on the mixer identification plate [(x)], or 3.0 minutes, whichever is the greater.

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

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

For steel-fibre reinforced mixes, Clause 6.3.7 also applies.

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

4.2.2.2 Mixer Uniformity Testing

(a) Mixer uniformity testing - general

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

(i) in accordance with the manufacturer's instructions; and

(ii) in the sequence proposed to be used in the Works; and

(iii) to the maximum volume (or throughput) proposed to be used in the Works.

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

(x) ~as required and defined by AS 1379.

Concrete from the mixer uniformity test may be incorporated into the base or into associated works such as anchors, kerbs, subgrade beams or drainage structures on the condition that all concrete from the test conforms to the relevant Specification and is placed in a discrete sub-Lot which must be removed in total if the mixer fails to meet the criteria as specified in subclause (e) hereunder.

(b) Uniformity testing of continuous mixers

Assess continuous mixers in accordance with sub-clause (c) below, with each sample separated by an interval equivalent to at least 2 m^3 of throughput.

(c) Uniformity testing of central batch mixers

Where concrete is to be produced and mixed by a central mixer, conduct mixer uniformity tests before production paving is commenced with that mix, and thereafter upon production of each 30,000 m^3 of concrete from that mixer, or as otherwise required in accordance with AS 1379 Clause 3.5. 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 must thereafter be adopted for all base mixes.

Conduct tests on three batches [(xi)] or runs of the same mix which conform to all of the requirements of this Specification. A run from a continuous mixer must comprise not less than 5 m^3 of mix.

Assess and report:

(i) mixing speed;

(ii) batch (or run) volume;

(iii) duration of charging;

(iv) total mixing time or, for continuous mixers, the throughput rate;

(v) 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 must be from the truck prior to tipping. Obtain the samples by using a shovel or scoop but exclude the top 100 mm of concrete.

(B) By discharge into a transport vehicle typical of that to be used in the work, and then spread evenly over a length of between 6 m and 10 m onto ground which is either sealed or pre-dampened to prevent absorption of water from the mix. Sampling must be from ground in accordance with AS 1012.1.

In each case, 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 must be individuals (not composites) in accordance with AS 1012.1 Clause 7.2.2.

Additionally, cast and assess test cylinders for mass per unit volume (MUV) and compressive strength in accordance with Clause 7.1. Assess the results in accordance with sub-clause (e) below.

(d) Uniformity testing of mobile batch mixers

[(xi)] as distinct from "loads"

All mobile batch mixers must display an identification plate (or equivalent certification) in accordance with AS 1379 to certify conformity with mixer uniformity criteria.

All mixers must be certified as belonging to a fleet which is operating under a mixer uniformity and compliance program as detailed below. Such program must record the progressive maintenance regime for each mixer and the results of compliance by mixers which have been tested for mixer efficiency under a statistical sampling procedure. Such individual results must comply with the limits given in AS 1379. Where a mixer is one of the test samples, show the date of the latest test on its mixer compliance plate (or Certificate).

Carry out further tests:

(i) upon evidence of non-uniformity of mixing which appears to be associated with mixer wear, or

(ii) where the discharge time for that mixer is more than 25% longer than the typical time for other trucks using the same mix.

Because of the retempering provisions of this Specification, these criteria apply also to mobile mixers which are used to transport centrally-mixed concrete.

All samples for uniformity testing must be individuals and not composites; AS 1012.1 Clause 3 refers.

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

Over a period of 24 months, randomly test the number of mixers shown in Table R83.15. The fleet will be deemed to conform if all selected mixers satisfy the requirements of Appendix A in AS 1379.

Table R83. 15 - Mobile Mixer Fleet Testing

Population Size	Sample Size
< 16	All
16 – 25	17
26 – 50	22
51 – 90	24
91 – 150	26
151 – 280	28
281 – 500	32

This sampling program is predicated on an 8% Limiting Quality Value, and where a mixer fails to satisfy a mixer uniformity test, the entire fleet is deemed to have failed, until:

(A) the producer immediately stands down the mixer while reasons for the failure are investigated to determine whether the failed result is a true outlier. If it is found that the failure was due to extraordinary reasons, it may be treated as a one-off event; and

(B) you must immediately test another randomly selected mixer from the same fleet and that result will determine the continued compliance of the fleet, as follows:

(1) if it passes, the fleet will carry provisional compliance until the failed mixer is either repaired and passed or is withdrawn from operational service;

(2) if it fails, proceed in accordance with sub-clause (A).

(e) Compliance for uniformity

(i) Central batch mixers and continuous mixers:

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

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

(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; and

(C) no slump value is outside the specified range; and

(D) CoV_C is less than 4.5%; and

(E) CoV_{MUV} is less than 1.0%.

(ii) Mobile batch mixers:

Assessment must be in accordance with AS 1379.

HOLD POINT	
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 8 days after the uniformity assessment.
Release of Hold Point:	The Principal will consider the submitted results, prior to authorising the release of the Hold Point within two working days of receipt of the results.

4.2.2.3 Admixture Addition

Detail in the PROJECT QUALITY PLAN how admixtures will be incorporated to conform to this requirement.

This clause does not cover the addition of water; see Clause 4.2.2.7.

(a) Incorporation during initial batching

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

(i) addition into the water weighhopper, or

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

They must 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 must be operated at the designated mixing speed for not less than 30 revolutions or for such additional time as may be necessary to re-establish uniformity of the mix, except that if assurance is not available

that the batch was initially mixed for 55 revolutions, the adjusted batch must be re-mixed for a minimum of 55 revolutions.

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

4.2.2.4 Batch Delivery Docket

Accompany each batch of concrete with an identification certificate (delivery docket) which is pre-numbered and which must be issued sequentially in accordance with the order of batching. The certificate must record the details required to establish the time of completion of batching as defined in Clause 1.3.

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 (as defined) must be in accordance with Clause 4.2.2.7.

Any addition of admixture which occurs after the completion of batching (as defined) must be in accordance with Clause 4.2.2.3.

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

Detail in the PROJECT QUALITY PLAN how the identification certificate will be monitored for compliance with the requirements of this Specification.

4.2.2.5 Production and Transport Capacity

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

4.2.2.6 Consistence (Slump)

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

Test within 40 minutes of the completion of batching (as defined).

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

(a) slipformed concrete: ± 10 mm

(b) fixed-formed concrete: ± 15 mm.

Record all slump test results, whether conforming or otherwise.

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

Sample as follows:

(i) For tipper delivery: obtain a composite test sample(xii) in accordance with AS 1012.1 Clause 7.3. Take the sample prior to discharge from the truck using a shovel or scoop. Exclude the top 100 mm.

(xii) ~ with the exception of Mixer Uniformity Testing where samples must be individuals; Clause 4.2.2.2(c) refers.

(ii) For agitator delivery: the test sample must be an individual sample obtained in accordance with AS 1012.1 Clause 7.2.2.

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.

If the result from the repeat test falls outside the specified limits, act as follows:

- 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 4.2.2.7.
- For concrete delivered by tippers, the concrete is deemed to be nonconforming.

The minimum frequency of routine testing is as follows:

(a) For tipper delivery

(i) Initial daily slumping:

Test every load prior to discharge until eight consecutive conforming loads are tested. Calculate the standard deviation (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 prior to 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 (prior to 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 prior to discharge until four consecutive conforming batches are tested; and thereafter

(ii) Test every alternate batch for slump.

Conduct additional slump testing as required in accordance with the provisions for retempering in Clause 4.2.2.7.

4.2.2.7 Retempering

Concrete which is delivered by other than a mobile batch mixer must 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 completion of batching;

(b) retemper only in the presence of your representative who has been previously nominated to the Principal for this purpose;

(c) retemper only at either the batch plant, the testing station, or the point of placement;

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

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

Do not use nonconforming concrete in the Works.

Detail in the PROJECT QUALITY PLAN how concrete supply will be monitored for compliance with these retempering provisions.

4.2.2.8 Forming Time

Determine a maximum forming time (as defined in Clause 1.3) for each nominated mix in order to achieve the requirements of Clauses 4.2(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 30°C;

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

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 PROJECT QUALITY PLAN.

4.2.2.9 Air Content

For mixes that contain an air-entraining agent, test the air content for conformity in accordance with Clause 3.7.2.

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) must be on loads of concrete from which cylinders are moulded for 28-day compressive strength under Clause 5.3.

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 must not be used in the Works, except that concrete batched for base may be used in anchors and subgrade beams subject to conformity with the relevant requirements.

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

4.2.2.10 Transport of Mixes for Fixed-form Paving

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

4.3 CONCRETING PERSONNEL

4.3.1 General

For concrete paving, include in the PROJECT QUALITY PLAN the name of the Paving Supervisor with details of qualification(s) and experience in concrete paving.

4.3.2 Paving Supervisor

The Paving Supervisor must hold a TfNSW Concrete Paving Crew Grey Card and have suitable qualification(s) in concrete paving and must be present during all stages of the paving operations until implementation of the curing regime.

Paving operations include, but not be limited to, the following activities:

(a) establishment of stringlines;

(b) fixed form placement;

(c) placing and fixing reinforcement, tiebars and dowels;

(d) receiving and placing concrete;

(e) operation of slipform pavers or vibrating screeds;

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

4.3.3 Paving Crew

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

HOLD POINT	(TfNSW Concrete Paving Crew Grey Card)
Process Held:	First concrete paving in the Works, including paving trial.
Submission Details:	At least two weeks prior to the first concrete paving, submit to the Principal the names of the personnel who will be involved in concrete paving operations; which of these persons hold a TfNSW Concrete Paving Crew Grey Card; and corresponding evidence of this. At least four working hours prior to concrete paving, submit to the Principal a statement stating that at least half of the personnel who will be involved in concrete paving operations hold a TfNSW Concrete Paving Crew Grey Card.
Release of Hold Point:	The Principal will verify that at least half of the personnel who will be involved in the concrete paving operations hold a TfNSW Concrete Paving Crew Grey Card prior to authorising the release of the Hold Point.

4.4 PAVING CONCRETE

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

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

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

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

For each of the proposed slipform paving configurations, nominate 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.

For fixed-form paving, nominate the following parameters:

(i) the size and number of vibrators;

(ii) the pattern and spacing of vibrator insertions.

For transition zones, provide the following information:

(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.

4.4.1 Slipform (Mechanical) Paving

Detail in the PROJECT QUALITY PLAN the equipment and methods to be used for placing, spreading and finishing the concrete base, including the parameters nominated in Clause 4.4.3 for each of the proposed slipform paving configurations.

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

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

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

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

(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 PROJECT QUALITY PLAN.

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 Clause 4.6.1 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 5.6.

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

The edge produced must maintain its shape and must not sag or tear. If excessive bleed water occurs, such that it flows over the slab edge, 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 sub-Lots), use supplementary fixed-form paving methods in accordance with Clause 4.4.2.

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 requirements of Clause 4.6.5.1 are met.

4.4.2 Fixed-form (Manual) Paving

Detail in the PROJECT QUALITY PLAN the equipment and methods to be used for placing, spreading and finishing the concrete base, including the parameters nominated in Clause 4.4.3.

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 in formwork such that the specified systematic vibration and compaction can be achieved throughout the slab with only minimal mortar losses and such that the requirements of Clause 4.6.5.1 are met.

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 5.2.

Prior to the demonstration of such conformity, adopt one of the three methods listed in Table R83.16 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 8,000 and 12,000 vibrations/minute (130 – 200 Hz);

(c) by systematic procedures using one of the methods shown in Column 1 of Table R83.16.

The number of standby vibrators must 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:

(i) traverse the full width of the slab on each pass;

(ii) the screed's length must be compatible with the width of the slab under construction;

(iii) constructed of tubular steel trusses or rigid metal and/or timber;

(iv) operating at a frequency of between 3,000 and 6,000 vibrations/minute (50 – 100 Hz) and a 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.

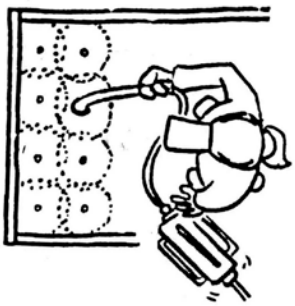
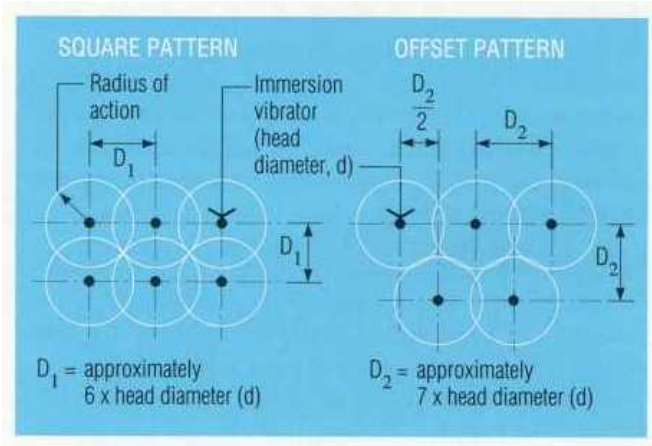
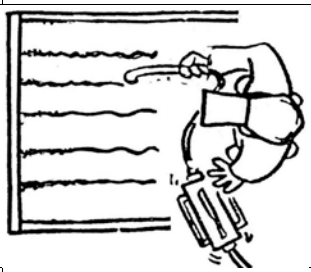
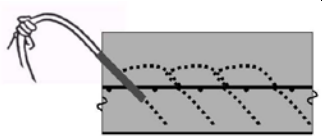
Provide at least two passes of the screed after any significant disturbance of the concrete surface, such as by walking in the mix.

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 Clause 4.6.2 if an interruption to paving occurs which is likely to result in a loss of integrity in the concrete mass. If subsequent testing at the location of an interruption indicates the presence of non-uniform or nonconforming concrete, remove and replace the affected section with conforming concrete in accordance with Clause 5.6.

Table R83.16 – 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, jointly 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) nett horizontal travel speed not greater than 1.5 m/minute; and (d) withdrawal speed not greater than 1.5 m/minute.

Note:

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

4.4.3 Placing and Paving Operations

The subbase at the time of base paving must be clean and free of loose or foreign matter, including sealing aggregate, and must not hold ponded water.

Where the subbase is lean-mix concrete (LCS), treat it with debonding agent in accordance with TfNSW R82.

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

Where the subbase is other than LCS or asphalt, it must 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 embedments;

(e) provide the specified thickness and surface finish.

Maintain records showing the location of each load of concrete in the finished work in accordance with the provisions for traceability in TfNSW Q. The method of traceability must 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 PROJECT QUALITY PLAN.

4.4.4 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 10°C or more than 32°C, except that when the diurnal air temperature changes are greater than or equal to 20°C, the upper limit of temperature of concrete to be placed in the Works is 30°C.

(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. Cease concrete batching when the air temperature reaches 32°C and is rising.

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

4.4.5 Prevention of Moisture Loss

Detail in the PROJECT QUALITY PLAN 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 Figure R83.4.

If you choose 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.

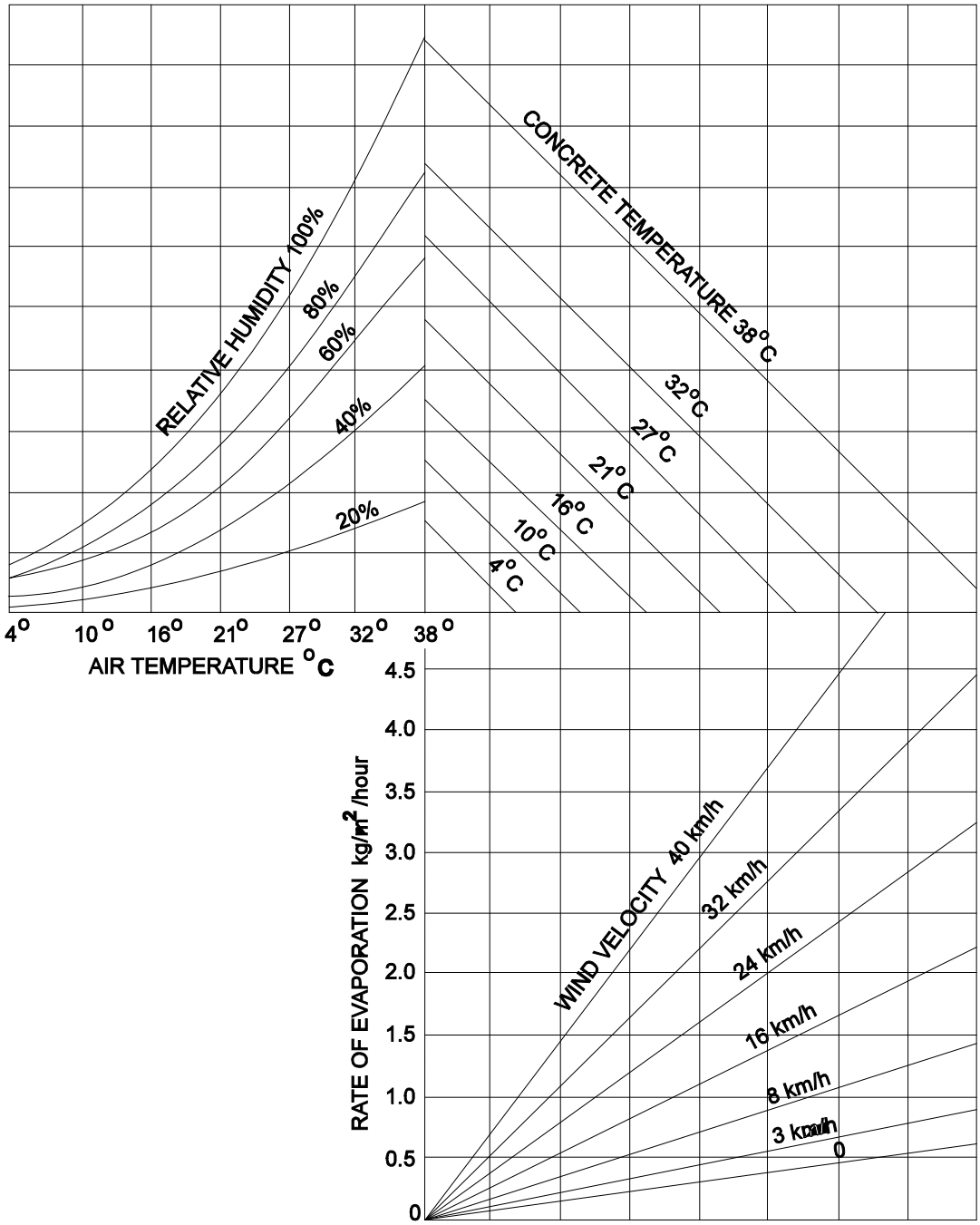


Figure R83.4 - Evaporation from Concrete Freshly Placed on Site

Notes:

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

With air temperature at 27°C, relative humidity at 40%, concrete temperature at 27°C, and a wind velocity of 26 km/h, the rate of evaporation would be 1.6 kg/m^2/hour. To determine the evaporation rate from the graph, enter the graph at the air temperature (in this case 27°C), 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)

4.4.6 Texturing of Surface

Unless specified otherwise in Annexure R83/A, texture the surface by both a hessian drag and tining, except that:

(a) tining is not required beneath a bituminous or asphalt surfacing unless specified otherwise in Annexure R83/A;

(b) light brooming may be applied in lieu of a hessian drag; and

(c) for steel fibre reinforced concrete pavement, see Clause 6.5.

Detail as part of the PROJECT QUALITY PLAN the procedures and equipment proposed to complete the surface texture.

Produce an Average Texture Depth as given in Table R83.17.

Table R83.17 - Specified Average Texture Depths (1)

Type	Description	Average Texture Depth (1)	Test Method (2)
1	Hessian drag (3) with no tining or grooving (4)	0.40 mm ± 0.05 mm (4) or alternatively, 0.55 mm ± 0.05 mm (4)	TfNSW T192 TfNSW T240
2	Transverse tining (5,6)	0.60 mm ± 0.10 mm or alternatively, 0.9 mm (–0.30, +0.20)	TfNSW T192 TfNSW T240
3	Longitudinal tining (5,6)	0.65 mm ± 0.15 mm or alternatively, 0.80 mm ± 0.20 mm	TfNSW T192 TfNSW T240
4	Diamond grinding (5,6)	Minimum 0.65 mm	TfNSW T192

Notes:

(1) Note that these are *average* depths over the area of test and are not actual depths. This is the same measure as that calculated as "*Texture Depth (TD)*" under TfNSW T240.

(2) Texture testing is exempt from the requirement in TfNSW Q for NATA registration.

(3) An acceptable 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 Annexure R83/A.

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

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

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

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 must be treated with saw-grooving in accordance with Clause 4.4.6.4 or with diamond grinding in accordance with Clause 5.7.

4.4.6.1 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.

4.4.6.2 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 Annexure R83/A 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 must 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:

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

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

Texture at 90^0 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 must 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.

4.4.6.3 Texture Testing

Test the texture in accordance with subclause (a) or (b).

(a) Sand patch testing method

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:

(i) for concrete which is deemed (under Clause 4.4.8.4) 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;

(ii) for concrete less than 20 MPa, cease grinding when the target condition has been achieved uniformly over the test area.

Sweep the test area prior to test to completely remove all loose material.

(b) Laser testing method

Test in accordance with TfNSW T192. For tining, grinding and/or grooving, test orthogonal to the direction of texturing and for a minimum length of 7 m.

4.4.6.4 Sawcut Grooves

Sawcut grooves must:

(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;

(e) be aligned parallel with the tining unless otherwise specified in Annexure R83/A.

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

4.4.7 Curing

Cure the base by the application of a sprayed curing compound.

In confined spaces (such as tunnels) where the use of curing compounds is deemed undesirable, cure the base for a minimum of 7 days using water or blanket techniques in accordance with Clause 4.4.7.3.

Cure all other structural concrete (including kerbs and gutters) either by application of a compound or by a method included in Clause 4.4.7.3.

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 minutes and 30 minutes later or as recommended by the manufacturer.

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

Spraying equipment and compounds must conform to Clause 4.4.7.1. Fully operational spraying equipment will be a pre-condition for paving to proceed.

4.4.7.1 Materials and Equipment

Provide as part of the PROJECT QUALITY PLAN the supplier's recommended procedures for storage and agitation of compounds under varying weather conditions in order to maintain uniformity. The compound when sprayed must have a uniform consistency and must be conforming in all regards.

Spray application methods are categorised as follows:

(a) Class 1: 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: 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.

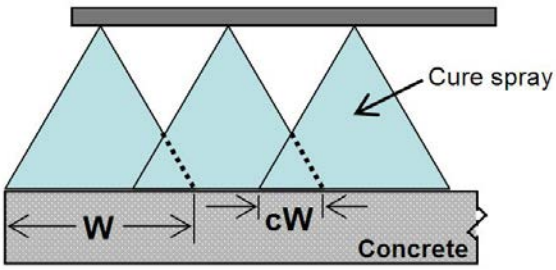
(c) Class 3: by a mechanical sprayer fitted with a spray bar with multiple nozzles spaced to give a uniform cover for the full paving width in a single pass;

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.

Set the spray nozzles to provide an overlap factor (by width measurement) as shown in Figure R83.5. Determine this factor in accordance with Clause 4.4.7.2(iii).

For fan sprays, rotate each nozzle sufficiently about a vertical axis to prevent interference between adjacent fans.



where:
W = theoretical coverage
c = overlap factor (decimal)

Figure R83.5 - Curing Spray Overlap

4.4.7.2 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/m^2, 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/m^2 or 25% more than the rate stated on the test certificate.

For Class 1 and Class 2 applications, the rate in each pass must be the higher of 0.30 L/m^2 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.

Maintain the curing membrane intact in a continuous and unbroken membrane for 7 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 4.4.8.4.

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 7 days that has been

trafficked by persons during placement at the construction joint (and notwithstanding that membrane damage may not be readily apparent).

You will bear the cost of any respraying and of making good any damage to the curing membrane.

For Class 3 curing, submit as part of the PROJECT QUALITY PLAN the procedures that are proposed for demonstration of the following:

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

(ii) the variables and methods to be used to measure and calibrate a uniform output across the full spray width and edges (litres/m^2);

(iii) field trials that are proposed in order to develop operating parameters such as nozzle height, spray pressure and the spray overlap factor 'c' (as shown in Figure R83.5) and to demonstrate uniform and conforming coverage, including edges. Determine these parameters and provide them to the Principal prior to a Paving Trial that requires Class 3 curing;

(iv) during the Paving Trial, verify the operating parameters developed under (iii).

In the absence of an alternative method approved by the Principal, 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 R83.18;

(B) by testing the local amount of curing compound as measured on test mats placed on the pavement at random locations. Use three (3) felt mats per test, each approximately 0.25 m^2 in area and placed within an area of 50 m^2 on the surface to be treated.

Table R83.18 - Testing Procedures for Application Rate

Class of curing (1)	Test procedures (2)	Frequency
1 and 2	(A)	Each paving area of between 500 m^2 and 1000 m^2 (3)
3	(A); and (B)	Each paving area of between 1000 m^2 and 1500 m^2 (3) (a) in the Paving Trial; and thereafter (b) one in every sixth sub-Lot until three (3) consecutive conformities are obtained; then (c) one every fifty (50) sub-Lots. Testing frequency reverts to (b) if a nonconformity is encountered.

Notes:

(1) See Clause 4.4.7.1.

(2) See sub-clauses (A) and (B) above.

(3) You 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 sub-Lot.

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 R83.18 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.

4.4.7.3 Curing of Other Structural Concrete

Cure all structural concrete members, including anchors, kerbs and gutters, for a minimum of seven (7) days from placing.

Use curing compounds in accordance with the principles stated within Clause 4.4.7, or use wet curing.

Plastic covers must form a continuous barrier against loss of moisture and must be fully secured around all edges so 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.

4.4.8 Protection of Work

4.4.8.1 Temperature

If the temperature at the site is forecast [xiii] to fall below 10^0C 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 5°C. 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 PROJECT QUALITY PLAN 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 5°C constitutes a nonconformity.

If you propose the use of subbase protective covers, it must seek the prior agreement of the Principal if it is to claim payment under Pay Item R83P9.

4.4.8.2 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 PROJECT QUALITY PLAN 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.

Beyond this time, assess rain-exposed surfaces under the finished surface criteria.

[xiii] ~ by the Bureau of Meteorology

No payment will be made for rain protection.

4.4.8.3 Anchor Slabs

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

No payment will be made for anchor protection.

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

(b) 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/m^2 pressure over the track area, with the concrete protected from surface damage.

(c) 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.

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

(e) 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.

For trafficking purposes, assess the insitu concrete strength using cylinders which have been moulded for the purpose of Clause 4.2.1.5.

Alternatively, trafficking strength may be assessed from cores taken for the purposes of Clause 5.2, subject to the following:

(i) The cores must be wet-conditioned, prepared and tested in accordance with AS 1012.14, except that the total duration of wet-conditioning (including that required for compaction testing) must be not less than 24 hours nor more than 36 hours and must conclude within 3 hours prior to strength testing.

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

(iii) Do not take additional cores for this purpose without the prior approval of the Principal.

(iv) The requirements of Clause 5.3.3 apply, except that strength assessment may be based on a single core per sub-Lot [xiv];

(v) Assessment of any particular sub-Lot must be based on not fewer than three core results of equal or lesser age (in days) compared with the sub-Lot under assessment;

(vi) Upon determination of an acceptable insitu strength of any sub-Lot, all concrete placed prior to that sub-Lot using the same concrete mix may be assumed to have achieved an equivalent trafficking strength.

A Hold Point applies to trafficking of the base at both the 20 MPa and the 25 MPa compressive strength levels.

HOLD POINT	
Process Held:	Trafficking of base - 20 MPa level.
Submission Details:	Insitu strength test results of the base.
Release of Hold Point:	The Principal will consider the submitted results within two working days of receipt of the results, prior to authorising the release of the Hold Point.

HOLD POINT	
Process Held:	Trafficking of base - 25 MPa level.
Submission Details:	Insitu strength test results of the base.
Release of Hold Point:	The Principal will consider the submitted results within two working days of receipt of the results, prior to authorising the release of the Hold Point.

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

The cost of rectifying such damage is borne by you.

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

4.5 CONCRETE PAVING TRIALS

Prior to routine concrete base paving, construct a trial section of concrete base using the authorised concrete mix, equipment and methods.

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

Construct a separate trial for each paver.

Give the Principal seven days written notice of your intention to commence:

(a) the paving trial;

[xiv] Cl 5.3.3 requires two cores per Lot for acceptance purposes, but assessment for trafficking purposes may be based on a single core per Lot.

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

Table R83.19 details the requirements for construction and testing of paving trials.

Table R83.19 – Concrete Paving Trial Construction and Testing Requirements

Property and Testing Requirements		Paving type	
		Fixed-form	**Slipform**
Length of paving trial	Minimum	15 m	50 m
	Maximum	50 m	100 m
Minimum concrete volume of trial		20 m³	-
Cylinders: minimum testing for UCS (1) and MUV (1). As per Clause 5.2.1, except test MUV at age between 2 and 3 days.	7 days (2)	4 loads	6 loads
	28 days (2)	4 loads	6 loads
Flexure beams (2): minimum testing for strength and MUV (1)	7 days (2)	3 loads	4 loads
	28 days (2)	3 loads	4 loads
Fresh concrete: Wash-out test to Clause 4.2.1(b)	At 10%, 50% and 90% of discharge	3 loads	3 loads
Cores: minimum testing for relative compaction. As per Clause 5.2.1, except: (a) extract cores at age between 2 and 3 days; and (b) determine MUV within 2 days of extraction.	Transition sub-Lots	not applicable	2 per sub-Lot
	Standard sub-Lots	4 (3)	3 (3)
	At inserted tiebars at induced joints	NA	See Clause 4.1.2.2
	At inserted tiebars in formed joints	2 (4)	2 (5)
Photographs of cores through inserted tiebars (Clauses 4.1.2.1 & 4.1.2.2) (6) (a) inspect and photograph within 1 day of coring; (b) photograph resolution must be adequate to show entrapped voids around and above the tiebars.		All (4)	All
Metal detector survey for tiebar location (plan location and depth) in accordance Clauses 4.1.2.2 and 4.1.2.3.		not applicable	All

Notes:

(1) MUV: mass per unit volume (or "unit mass").
UCS: ultimate compressive strength

(2) See Clause 4.2.1.2 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 sub-Lot.

(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 4.1.2.1. 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 1 day of coring as advance warning ahead of compaction testing.

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

HOLD POINT

Process Held:	Base paving subject to the trial.
Submission Details:	Submission of checklists and test results (as listed in Table R83.20).
Release of Hold Point:	The Principal will inspect the trial and consider the submitted documents, prior to authorising the release of the Hold Point.

Provide a written report with the 7-day test results which compares all results from the paving trial with those from the laboratory trial mix. Provide a table which shows, as a minimum, the information contained in Table R83.20 together with 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.

Within 5 working days of its receipt, the Principal will assess the report and provide comments on any issues of concern.

Table R83.20 - Paving Trial Analysis

Row	Item	Result		
		Laboratory trial mix	Paving trial	Alphanumeric notes
A	Location	(a)	(b) Length (m):	(a) Name of laboratory & suburb (b) Location of the Trial (c'way, Ch, etc)
B	Mix details	Date: Mix No: Mix type: (tick one) - Fixed-form ☐ - Slipform ☐	Date: Trial No: Mix variations (c): ▪ ▪	(c) List any variations to the authorised mix except for admixtures and water
C	Air content (%)		Min: Max: Mean:	
D	Admixture content	AEA: WRA Other	AEA (d): WRA (d): Other (d):	(d) Provide the ranges (max & min).
E	1. Slump (mm) 2. Water content (e)			(e) In accordance with Cl 4.2.1
F	Compressive strength 7D	(1)	(3)	
G	Compressive strength 28D	(1)	(3)	
H	Flexural strength 7D	(1)	(3)	
I	Flexural strength 28D	(1)	(3)	
J	Unit mass - cylinders	Mean (1):	Min (1): Max (1): Mean:	
K	Unit mass - beams	Mean (1):	Min (1): Max(1): Mean:	
L	Core length (mm) (f)	NA	(g)	(f) Excluding any debonding material (g) Provide all results
M	Cores (h): Unit mass (& relative compaction)	NA	Transition sub-Lots Other sub-Lots	(h) Record all individual results; e.g. 2360 (99.5%), 2340 (98.5%)
N	Curing application rates	NA	Min (i): Max (i): Mean (j):	(i) For Class 3, report min and max values for each test (j) For all Classes

Numerical notes:

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

(2) Record individual specimen results.

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

Submit the Paving Trial test results at timings in accordance with Table R83.21.

Table R83.21 - Paving Trial Submissions

Item	Timing of Submission	Clause Reference
Surface profile	Hold Point submission	5.5.1 and 5.5.2
Tiebar location and cover	Hold Point submission	4.1.2.2 and 4.1.2.3
Texture depth	Hold Point submission	4.4.6
Curing application Row N	Hold Point submission	4.4.7
Table R83.20 Rows A to E	Hold Point submission	Table R83.20
Class 3 curing calibration results	Hold Point submission	4.4.7
Photographs of cores at inserted tiebars	within 4 days of the Trial	Table R83.20
Table R83.20 Rows J, K, L, M	within 5 days of the Trial	Table R83.20
Table R83.20 Row F, H	within 9 days of the Trial	Table R83.20
Assessment of paving mix	with the 7-day test results	
Table R83.20 Rows G, I	within 30 days of the Trial	
Tiebar pull-out testing	within 30 days of the Trial	4.1.2.1

The trial section will be accepted as part of the Works if it conforms to the Specification. If the relative compaction of the trial section is less than 98.0%, remove the trial section and construct a new trial section, all at no cost to the Principal.

In the event of other nonconformity in the trial section, the Principal may require a new trial section, which must be treated as if it was the first trial section.

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

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

(ii) the concrete base fails substantially to conform to the Specification; or

(iii) NCRs are not submitted in accordance with the Quality Management System documents.

4.6 JOINTS AND EDGES

Deal with detritus from sawcutting operations in accordance with the Specification TfNSW G36.

Refer to Annexure R83/A 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 on the Drawings. Do not sawcut traffic presence detector loops unless specifically approved.

Where scabbling is required, expose coarse aggregate over a large proportion of the scabbled face (avoiding the arrisses as shown on the Drawings) and achieve a rough surface with indentations 4 -

6 mm deep. Scabbled joints within the base must always be subsequently debonded, but do not debond joints in anchors.

4.6.1 Joint Cleaning and Sealants

Handle and install sealants in accordance with the manufacturer's written recommendations, which must 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 PROJECT QUALITY PLAN the procedures and equipment proposed to complete joint sealing.

Test joints and sealants at random locations at the minimum frequency specified in Table R83.22.

Table R83.22 - 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 sub-Lot commencing with the paving trial, until three consecutive conforming sub-Lots are obtained; and thereafter (b) at one joint in every alternate sub-Lot. If any joint fails, re-clean all joints within the sub-Lot and revert to test frequency (a).	Include all joint types in the calculation of jointing output, and in the selection of testing location. Test at one location per joint per sub-Lot, and (a) at every sub-Lot commencing with the paving trial, until three consecutive conforming sub-Lots are obtained; and thereafter (b) at every third sub-Lot. If any test fails, re-clean all joints within the sub-Lot and revert to test frequency (a).	Test at one location per joint per sub-Lot; and (a) at every sub-Lot commencing with the paving trial, until three consecutive conforming Lots are obtained; and thereafter (b) at every third sub-Lot. If any test fails, re-clean all joints within the sub-Lot and revert to test frequency (a).
Sealant dimensions (7) - depth (4) - width (3) - recess	Test at one location per joint; and (a) three tests per sub-Lot commencing with the paving trial, until six consecutive conforming samples are obtained; and thereafter (b) one test per sub-Lot. Testing frequency reverts to (a) if a nonconformity is encountered.	Include all joint types in the calculation of jointing output, and in the selection of testing location. Test: (a) two locations per 30 m of joint type until 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 sub-Lot commencing with the paving trial, until three consecutive conforming samples are obtained; and thereafter (b) one test every fifth sub-Lot. 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 sub-Lot commencing with the paving trial, until three consecutive conforming samples are obtained; and thereafter (b) one test every third sub-Lot. Testing frequency reverts to (a) if a nonconformity is encountered at any time.	(a) One test per sub-Lot commencing with the paving trial, until three consecutive conforming samples are obtained; and thereafter (b) one test every third sub-Lot. 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 TfNSW T379. An acceptable result is when Grade 1 (None) visual rating category is achieved.

(6) Test for adhesion in accordance with TfNSW T380.

(7) Ignore Transition areas in the selection of sub-Lots for testing.

Reinstate the backer road and sealant at all test locations for sealant dimensions and field adhesion.

WITNESS POINT

Process Witnessed:	Testing of joints and silicone sealants.
Submission Details:	Submission of notice of time and location of test at least two (2) working days before testing.

4.6.2 Transverse Construction Joints

Transverse construction joints must:

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

(b) be continuous over the paved width without steps or offsets in any axis so that the line of the joint does not deviate by more than 20 mm from a 3 m straightedge;

(c) be constructed at 90°± 6° to the longitudinal joint, with 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 4.1 (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 must be used giving anchorage strength of at least 85% of the yield strength of the bar;

(e) if initially nonconforming or damaged, be reinstated or repaired prior to the placement of adjoining concrete. The repair material must not be placed integrally with the adjoining concrete.

(f) have the face of the joint debonded to prevent intimate microtexture bond;

(g) conform in all regards to the requirements of Clause 4.4.2.

Intimate bond at the microtexture level can induce spalling at arrises and must be avoided. For this reason, debonding of the joint face is specified including joints between new and existing concrete pavements.

The first-placed face must be dense and fully compacted and must be free of honeycombing and re-entrant angles. Where the face is nonconforming or the edge is damaged, reinstate or repair it prior to 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 days prior to placing the abutting concrete. All aspects of the treatment must be in accordance with Clause 4.4.7 except that the compound must be a wax emulsion conforming to TfNSW R82 and a single application must be used at a rate 25% higher than the rate stated on the test certificate for curing efficiency, subject to a minimum value of 0.20 L/m^2. The coating must be intact and effective at the time of subsequent concrete placement.

Do not spray reinforcement with wax or bitumen compounds.

4.6.3 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 must:

(a) be initiated by sawcutting unless the Drawings allow the use of crack inducing inserts outside trafficked areas;

(b) be continuous across the full 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 Specification;

(f) have trafficking controlled in accordance with Clause 4.4.8.4;

(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 must also be sealed.

Use sawcutting, except where shown otherwise on the Drawings.

4.6.3.1 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 must 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 must not show more than 10 mm of vertical or horizontal edge ravelling. The cumulative length of ravelling with a dimension greater than 3 mm must not exceed 300 mm 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 must not show ravelling greater than 20 mm in any axis at the point of intersection with the sawn joint.

If a nonconformity occurs, immediately implement Corrective Action in accordance with the requirements of TfNSW Q.

4.6.3.2 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 arrisses;

(b) has a sufficiently high pressure to ensure that the faces are dust-free when dry. Gravity fed liquid from tanks is not acceptable;

(c) does not leave any substance deleterious to the concrete or to the adhesion of the joint sealants to be used;

(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.

4.6.3.3 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 must 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 day any backer rod which is damaged or removed prior to sealing.

In a two-cut operation, the preliminary seal must remain in position until the commencement of the widening sawcut, at which time it must be pushed to the bottom of the initial sawcut in a way which is effective in preventing sawcut residue from entering the underlying joint.

In a single-cut operation, the preliminary seal must remain in position until permanent sealing.

4.6.3.4 Temporary Sealing

(a) In two-cut operations

The preliminary seal must be effective in preventing sawcut residue from entering the underlying joint.

After widening, clean the sawcut in accordance with Clause 4.6.3.2. Within 2 hours of cleaning, seal the joint with a continuous closed-cell polyethylene backer rod of a suitable diameter to prevent the ingress of incompressibles and to maintain moist conditions within the joint.

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

The top of the backer rod must be neither higher than the concrete surface nor more than 5 mm below it. The backer rod must pass over any longitudinal joint seal already in place.

(b) Prior to 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 PROJECT QUALITY PLAN.

(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 day any temporary sealant which is damaged.

4.6.3.5 Permanent Sealing

The permanent sealant must 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 must extend down the vertical faces of joints and any underlying crack.

Place a permanent seal in the joint between 7 and 14 days after initial sawing unless diamond grinding or grooving is proposed, in which case place the permanent seal within 14 days of the completion of that operation within each sub-Lot, 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 4.6.1.

Prior to introducing the silicone sealant into the groove, clean the joint in accordance with Clause 4.6.3.2 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 must 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 3 days and 5 days in accordance with Clause 4.6.1.

4.6.4 Isolation and Expansion Joints

Provide joints as shown on the Drawings to a position tolerance of 25 mm. They must:

(a) be continuous across the full width of the base without steps or offsets in any axis so that the line of the joint does not deviate by more than 20 mm from a 3 m straightedge;

(b) be constructed with the joint face square (± 5°) to the finished top surface of the base;

(c) be treated with joint filler conforming to Specification TfNSW 3204 and joint sealant installed in accordance with Clause 4.6.3, 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 must extend down the full vertical face of the joint. At other edges, the filler must 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 [xv], prepare the joint cavity (for permanent sealing) within the sealant area by one of the following methods:

(i) By sawing

Undertake all operations including cleanliness and adhesion testing in accordance with Clauses 4.6.1 and 4.6.3 as if it were the second cut of a two-cut operation.

[xv] ~for example, *formed* joints

(ii) 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 4.6.1 and 4.6.3.

4.6.5 Longitudinal Joints

Provide longitudinal joints as shown on the Drawings to a position tolerance of 25 mm.

Longitudinal joints must:

(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 4.1.2.

(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 prior to the placement of adjoining concrete. The repair material must not be placed integrally with the adjoining concrete;

(iv) prepare the sealant faces in accordance with Clause 4.6.4.

(d) for induced joints:

(i) be provided by sawcutting in accordance with this Specification;

(ii) exhibit at the surface not more than 10 mm width of vertical or horizontal edge ravelling. The cumulative length of ravelling with a dimension exceeding 3 mm must not exceed 300 mm in any 3.0 m length of joint edge (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 4.6.1 and 4.6.3;

(vi) permanently seal the full vertical face at the ends of sawcuts.

4.6.5.1 Condition of Formed Joints and Debonding

Intimate bond at the microtexture level can induce spalling at arrisses and must be avoided. For this reason, debonding of the joint face is specified including joints between new and existing concrete pavements.

The first-placed face must be dense and fully compacted and must be free of honeycombing and re-entrant angles. Where the face is nonconforming or the edge is damaged, reinstatement or repair must be carried out prior to the placement of adjoining concrete. Do not place the repair material integrally with the adjoining concrete.

Re-spray the first-placed face with curing compound not more than 10 days prior to placing the abutting concrete. All aspects of the treatment must be in accordance with the requirements for curing the concrete, except that the compound must be a wax emulsion conforming to TfNSW R82 and a single application must be used at the specified rate plus an increase of 25%. The coating must be intact and effective at the time of subsequent concrete placement.

Steel tiebars must not be sprayed with wax or bitumen compounds.

4.6.5.2 Sawcutting

Sawcutting must 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. Provide sufficient standby equipment on site to maintain continuity of sawing.

4.6.5.3 Cleaning

Clean joints in accordance with Clause 4.6.3.2.

Do not use grit blasting.

4.6.5.4 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 must 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 must 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 day any temporary seal which is damaged or removed prior to permanent sealing.

4.6.5.5 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.

Residue from cleaning operations must not enter transverse joints.

At the time of sealant installation, the joint faces must be clean and surface-dry. Undertake all operations including cleanliness and adhesion testing in accordance with Clauses 4.6.1 and 4.6.3.

4.6.5.6 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 Annexure R83/A.

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 4.6.3.5, to prevent ingress of mortar. Prepare joints for sealing (regardless of their original method of construction) in accordance with Clause 4.6.4.

Fix drilled tiebars where specified and debond the existing face in accordance with Clause 4.6.5.1.

4.6.6 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.

Reinforce re-entrant angles that exceed 190° with SL82 reinforcing fabric.

4.6.7 Outer Edges

Outer edges must:

(a) not deviate from the design position at any point by more than 25 mm;

(b) be continuous over the full length without steps or offsets in any axis so that the line of the edge does not deviate by more than 20 mm from a 3 m straightedge, after due allowance for any planned curvature;

(c) have face geometry conforming to Clause 4.6.5, but having corrugations and tiebars only if and as specified on 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 sub-Lots:

(i) one test per 10 m of edge, until five conforming results are recorded; and thereafter

(ii) one test per 50 m of edge.

The testing frequency reverts to (i) if nonconformity is detected.

4.7 KERB AND CHANNEL (GUTTER)

Construct kerb and channel (gutter) in accordance with Specification TfNSW R15 and as shown on the Drawings, and subject to the following conditions:

(a) kerbs of types SA, SB, SC, SE, SO and SL beside concrete base must not to be extruded unless the Drawings specifically allow extrusion;

(b) concrete for the above kerb types must conform to either this Specification or AS 1379 for normal class concrete with strength grade N32 and 20 mm aggregate, unless specified otherwise on the Drawings or in Specification TfNSW R53;

(c) kerb longitudinal joints must conform to Clause 4.6.4 (including debonding of formed joints), but the rounding of the kerb or channel (gutter) lip must not be greater than 5 mm, even if a larger rounding is shown on the kerb Drawings;

(d) untied joints must be sealed in accordance with the Drawings;

(e) at all kerb joints, the first placed joint face must be reinstated or repaired if initially nonconforming or damaged, prior to the placement of adjoining concrete. The repair material must not be placed integrally with the adjoining concrete;

(f) all inlet pits must be separated from adjoining base concrete by a Type 15 isolation joint (without subgrade beam) in accordance with the Drawings;

(g) cure all kerbs in accordance with Clause 4.4.7.

4.8 SPECIAL SLABS

4.8.1 Odd-shaped and Mismatched Slabs

Odd-shaped and mismatched slabs must:

(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 must be marked in accordance with Clause 4.8.2. The imprint must be to a depth of 4 mm ± 1 mm below the circular surround.

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

4.8.2 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 must be to a depth of 4 mm ± 1 mm below the circular surround.

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

4.9 SLAB ANCHORS

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

(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 CRC base:

  (i) multiple Type 12 anchors are provided at bridge approaches and at flexible pavement transverse interfaces;

  (ii) anchors may be provided at other CRC slab transitions as shown in the Drawings;

  (iii) anchors are not provided within continuous lengths of CRC, 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 must conform either with this 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 4.4.2;

(g) anchor stirrups must be lapped (as defined) to the base reinforcement;

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

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

Detail in the PROJECT QUALITY PLAN how you will pave over anchors without damaging the stirrup reinforcement.

4.10 TRAFFIC ISLANDS AND MEDIANS

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

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

Under concrete cappings in traffic islands and medians, use only material which conforms to the requirements for DGS20 under Specification TfNSW 3051.

5 END PRODUCT CRITERIA

5.1 CONCRETE CRACKING

Detail in the PROJECT 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 (that is, not an induced 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 in unreinforced slabs.

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

(A) PCP and SFCP slabs: if they contain only plastic shrinkage cracks with a cumulative length of 1 m or less in any slab.

(B) PCP-R, SFCP-R and JRCP slabs: if they contain only plastic shrinkage cracks with a cumulative length of 1 m or less in any slab, and drying shrinkage cracks.

Remove and replace all other cracked slabs in accordance with Clause 5.6.

(b) In CRC 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.

(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 m or less in any 5 m x 5 m square area of base must be filled with a suitable low viscosity penetrating epoxy resin, within 7 seven days of casting of the concrete. The epoxy resin must not extend laterally by more than 15 mm beyond the edge of the crack nor completely fill the tining.

Planned cracks forming induced longitudinal joints must be treated in accordance with Clause 4.6.5.

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

(c) General:

Within 4 days of paving, report all nonconforming cracking and submit scaled crack maps of all nonconforming cracking.

5.2 CONCRETE COMPACTION

5.2.1 Conformity for Compaction

Sub-Lot definition for compaction is as defined in Clause 1.3, except for Transition Zones in slipformed work.

For the purpose of compaction testing, treat Transition Zones as separate sub-Lots 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 4.4(B);

(b) Where a transition point (as defined) is remote from a transverse construction joint, treated the transition point as if it were a joint (that is, generate two transition sub-Lots as in (a) above).

Conformity for within-in core variability is assessed under Clause 5.2.4. Conformity for compaction is assessed as follows.

In fixed-formed paving:

A sub-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 Clause 4.4.2; and

(b) vibration was undertaken in such a way as to limit lateral spreading of the mix; and

(c) any disturbed areas (such as workers' footprints) in the compacted mix have been reinstated in accordance with Clause 4.4.2; and

(d) the relative compaction is at least 98.0%, determined in accordance with TfNSW T381 as the percentage ratio of the core unit mass of the sub-Lot to the representative cylinder unit mass (RCUM) for the sub-Lot.

Sub-Lots which do not conform to sub-clauses (a), (b) and (c) will not be assessed under sub-clause (d), and they must be removed and replaced.

Sub-Lots which conform to sub-clauses (a), (b) and (c) but which do not conform to sub-clause (d) must be assessed as follows:

(i) If the relative compaction is between 97.0% and 98.0%, take cores in accordance with Clause 5.3.3 and assess the sub-Lot in accordance with Clause 5.3.4.2 on the basis of the 28-day core compressive strength.

(ii) If the relative compaction is less than 97.0%, the sub-Lot must be removed and replaced in accordance with Clause 5.6.

In slipformed paving:

A sub-Lot conforms for compaction if:

(a) it has been internally vibrated by a planned and systematic procedure in accordance with Clause 4.4.1; 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 as the percentage ratio of the core unit mass of the sub-Lot to the representative cylinder unit mass (RCUM) for the sub-Lot (when calculated in accordance with Clause 5.2.1.1).

Sub-Lots which do not conform to sub-clauses (a) and (b) will not be assessed under sub-clause (c) and they must be removed and replaced.

Sub-Lots which conform to sub-clauses (a) and (b) but which do not conform to sub-clause (c) must be assessed as follows:

(A) If the relative compaction is between 97.0% and 98.0%, take cores in accordance with Clause 5.3.3 and assess the sub-Lot in accordance with Clause 5.3.4.2 on the basis of the 28-day core compressive strength.

(B) If the relative compaction is less than 97.0%, the sub-Lot must be removed and replaced in accordance with Clause 5.6.

5.2.1.1 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) the test cylinders are those which are moulded for 28-day compressive strength testing. At an age of between four and seven days, determine the unit mass (MUV) on all 28-day cylinder specimens in accordance with AS 1012.12 Method 2, amended in accordance with sub-clauses (b) and (c) hereunder;

(b) determine the MUV in accordance with Clause 7.2.1;

(c) round individual results to the nearest even number (in contrast to AS1012.12 which requires rounding to the nearest 10 kg/m^3). The unit mass for a pair of cylinders is the average of the two results unless they differ by more than 20 kg/m^3, in which case the higher result represents the unit mass of the pair. Round the averaged result to the nearest 5 kg/m^3.

For each nominated mix in use, make a statistical check to determine the representative cylinder unit mass (RCUM) using the pair unit mass as defined under sub-clause (c).

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/m^3.

Thereafter, take the RCUM for any sub-Lot as the mean of the five consecutive pairs of 28-day cylinders of that mix up to and including that sub-Lot (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/m^3.

Do not use the unit mass of flexure specimens or 7-day compressive strength specimens in calculations of the RCUM.

5.2.1.2 Core Specimens

Specimens for determining the relative compaction of concrete must 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 not later than 2 days after paving.

The location of coring must conform to Clause 5.2.1.3.

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 must not be subjected to temperatures:

(a) in excess of the ambient temperature or 28°C, whichever is higher; and

(b) less than 10°C.

Test all cores for unit mass in accordance with Clause 5.2.3 and report all results.

5.2.1.3 Frequency and Location of Coring for Compaction

The sub-Lots for determining compaction are based on the sub-Lots created in accordance with Clause 1.3 of this Specification. Transition zones generate separate sub-Lots.

(a) In slipformed concrete:

  (i) take at least one core specimen from each sub-Lot until ten consecutive conforming sub-Lots (that is, not less than 98.0% compaction) are obtained, and then;

  (ii) at least one core from each second sub-Lot until ten consecutive conforming sub-Lots are obtained, and then;

  (iii) one core from each third sub-Lot.

  In each case, avoid transition zones and select sampling sub-Lots on the basis of time sequence.

  If a nonconforming result is obtained, the frequency of testing, commencing from the nonconforming sub-Lot, reverts to that specified in sub-clause (i).

(b) In manually paved base, take two cores from each sub-Lot. The core locations must be separated by at least one-third of the length of the sub-Lot.

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

(i) two cores from each sub-Lot until three consecutive conforming sub-Lots (that is, not less than 98.0% compaction) are obtained; and then;

(ii) two cores from each third sub-Lot, which must be selected on the basis of time sequence, until four consecutive sub-Lots conform; and then;

(iii) one core from each fifth sub-Lot, which must be selected on the basis of time sequence.

If a nonconforming result is obtained, the frequency of testing, commencing from the nonconforming sub-Lot, reverts to that specified in sub-clause (i).

Choose the location of coring in accordance with TfNSW Q but with grid lines established in accordance with the criteria shown for a dual-lane paving run in Figure R83.6. 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 location by the minimum extent necessary to:

(i) exclude reinforcement and tiebars from the core except as required under Clause 4.1.2.2 or as otherwise required by the Principal to assess process uniformity;

(ii) in jointed pavements, to maintain a longitudinal separation of 1.0 m minimum from any transverse untied joint.

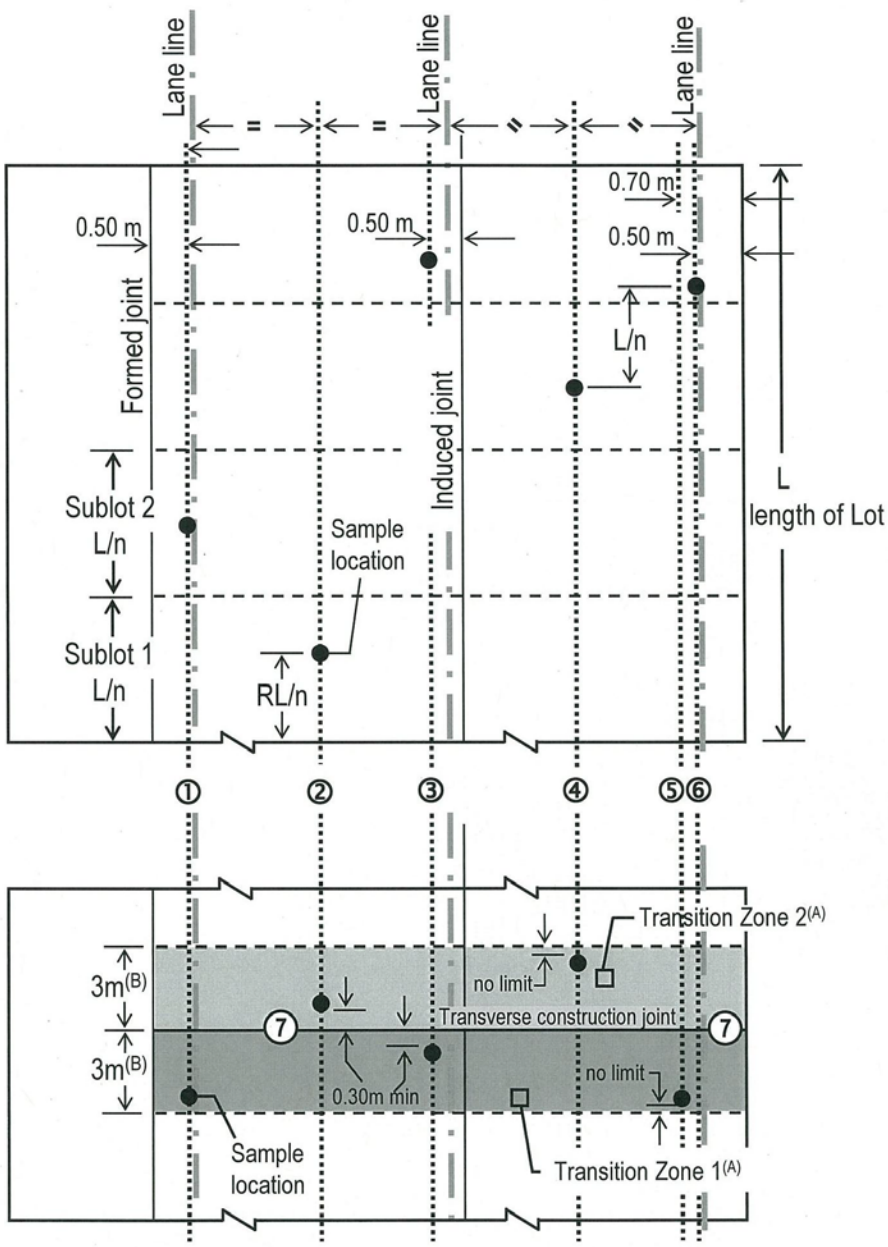
In continuously reinforced pavement, adjust the location in both directions by the minimum extent necessary to avoid the reinforcement.

For small and/or odd-shaped slabs in all Base types, avoid coring:

(A) within 0.50 m of an edge or longitudinal joint; and

(B) within 0.30 m of a transverse tied joint; and

(C) within 1.5 m of a transverse untied joint.



Notes
(A) Transition Zones apply to slipform paving only.
(B) ~ or as otherwise nominated under Clause 4.3.3(viii)

Figure R83.6 - Sampling Locations for a Dual-lane Paving Sub-Lot

5.2.2 Repair of Core Holes

Clean and restore all core holes taken in the base with low-shrink cementitious concrete having a compressive strength of not less than that in the base. The authorised base mix may be used for this purpose.

The surface of the restored hole must be similar in colour to the surrounding surface. Prior to trafficking, the concrete in the core must be cured sufficiently to achieve an expected compressive strength of 10 MPa. Demonstrate the expected strength gain by previous testing or by a technical data sheet.

The cost of restoring core holes will be borne by you, except in the case of additional cores ordered by the Principal.

5.2.3 Core Testing for Unit Mass

Test the full core except that:

(a) non-concrete materials such as bitumen must be removed;

(b) up to 15 mm of concrete may be removed from each end of the core where it can be demonstrated to constitute planned nonhomogeneity (such as surface texture);

(c) testing under Clause 5.2.4 requires the full core to be divided.

Determine the unit mass of cores in accordance with Clause 7.2.2.

Where two cores are available from a sub-Lot, the unit mass of the sub-Lot is the average of the test results unless they differ by more than 20 kg/m^3, in which case the lower result applies. Round averaged results to the nearest 5 kg/m^3.

Where three or more cores are available from a sub-Lot, the unit mass of the sub-Lot is the mean of the test results. Round the mean to the nearest 5 kg/m^3. However, if the lowest result differs from the mean by more than 30 kg/m^3, the lowest result applies.

5.2.4 Within-core Variability

Test cores for variability at a frequency as follows:

(a) for cores taken over tiebars as required by Clause 4.1.2.2: test all cores;

(b) for cores extracted under Clause 5.2.1:

  (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 ten 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 variability, do not dress voids prior to sawcutting. Testing for the unit mass of the full core is optional but if testing is done, the report must include a description of its void condition and its conformity (or otherwise) with TfNSW T368 in terms of voids and steel.

Prepare and test for variability as follows:

(i) Divide the cores as follows:

  (A) Cores from CRCP, JRCP, PCP-R, SFCP-R and all tiebar cores:
  saw each core horizontally along the line of the reinforcement.[xvi] 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.

[xvi] Clause 5.2.1.3 requires action to avoid steel bar and mesh. 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.

(B) Cores from PCP, SFCP:
saw horizontally into two core cylinders of equal length, with a tolerance of 20 mm.

(ii) Determine the unit mass of each specimen in accordance with Clause 7.2.2.

Calculate the difference in unit mass between the upper and lower parts of the core. The variability must not be greater than 30 kg/m^3 when calculated as the difference between the two results using the measured unit mass values rounded to the nearest even number.

In the event of a nonconformity, take action as follows:

(A) in fixed-form paving:
initiate corrective action before commencement of the next day's paving;

(B) in tiebar cores:
a Hold Point applies to slipform paving:

HOLD POINT

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

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

(iii) in slipform paving (excluding tiebar cores):
initiate corrective action before commencement of the next day's paving.

5.3 CONCRETE COMPRESSIVE STRENGTH

5.3.1 Sub-Lot Definition

See Clause 1.3.

5.3.2 Cylinder Strength Testing

For each sub-Lot of base, mould two pairs of cylinder test specimens for compressive strength testing; one pair at 7 days and the other pair at 28 days. Seven-day testing is covered by Clause 4.2.1.

Sampling must conform to AS 1012.1.

Mould the specimens in accordance with Table R83.7.

Determine the compressive strength of concrete using moulded 28-day test cylinders of 100 mm nominal diameter conforming to Clause 3.5, with compaction by internal vibration in accordance with TfNSW T304.

The following provisions also apply:

(a) All specimens of a set must be moulded from the same sample of concrete;

(b) For concrete delivered by mobile mixer, sampling must occur at the point of discharge or the point of testing, and after final retempering.

Inspect, cap and crush the concrete specimens in accordance with AS 1012.9. Determine their unit mass in accordance with Clause 5.2.1.

If the age of the test specimens is greater than 28 days at the time of compressive testing, adjust the test results for age in accordance with Clause 5.3.5.

The compressive strength (f_c) 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 ten 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.

5.3.3 Core Strength Testing

Where core strength testing is required, it must be carried out as follows:

(a) for slipformed base, take two cores at locations separated by at least one third of the length of the sub-Lot;

(b) for manually paved base, take two cores at locations separated by at least one third of the length of the sub-Lot;

(c) for transition sub-Lots, take one core;

(d) wet-condition the cores up to the time of testing and in accordance with AS 1012.14, except that Clause 6.4(d)(i)(B) therein is amended by replacing the words "for three days" with the words "for not less than two days nor more than three days".

Do not take additional cores for this purpose without the prior approval of the Principal.

Adjust the test results for age and shape in accordance with Clause 5.3.5.

5.3.4 Conformity for Compressive Strength

5.3.4.1 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 sub-Lot is less than $0.9f_{cMin}$, remove and replace the sub-Lot represented by the test cylinders in accordance with Clause 5.6.

Concrete with a 28-day cylinder strength between $0.9f_{cMin}$ and f_{cMin} occurring during progress of the Contract will be accepted subject to a deduction, provided that it represents less than 5% of the area of the applicable base category placed up to and including that sub-Lot. Such concrete will be subject to a deduction under Pay Item R83P11.2 of 4% of the schedule rate for supply and place concrete in base, for each 0.5 MPa or part thereof deficiency in strength.

5.3.4.2 Cores

Where required to be tested in accordance with Clause 5.2.1(i) or (A), the sub-Lot will conform for core strength if the corrected strength is greater than or equal to f_{cMin} for all core specimens from that sub-Lot.

Where this criteria is not met, the sub-Lot is nonconforming but will be accepted subject to a deduction of 4% for each 0.5 MPa or part thereof deficiency in strength, provided that:

(a) the mean of all corrected core strength results from the sub-Lot is greater than or equal to f_{cMin};

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

(c) the total area of such a sub-Lot is less than 5% of the area of the applicable base category placed up to and including that sub-Lot;

(d) the deficiency in strength is based on the lowest corrected core strength result from that sub-Lot;

(e) the deduction is applied to the schedule rate for supply and place concrete in base.

Nonconforming sub-Lots which do not meet these criteria must be removed and replaced in accordance with Clause 5.6.

5.3.5 Correction Factors for Age and Shape

Correction factors, AF for age and SF for shape, are given in Table R83.23 and Table R83.24 respectively. For intermediate ages, determine factor AF on a pro-rata basis rounded to two decimal places.

Alternatively, you may derive AF for your 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 your cylinder AF in the ratio used at specific ages in Table R83.23.

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 R83.23 - Age Correction Factors

Age of specimen at time of test (days)	Correction Factor (AF)					
	Compressive Strength				Flexural Strength [2]	
	Cylinders		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
365 or greater	1.25	1.38	1.10	1.21	1.10	1.13

Notes:

(1) Relative to the total cementitious content.

(2) Not specified for sub-Lot acceptance.

(3) Where you elect to derive factor AF for your mix, data must be obtained, as a minimum, at these ages, with a tolerance of three days.

Table R83.24 - Shape Correction Factors for Cores

Length/Diameter Ratio of Core	Factor SF
2.0	1.00
1.75	0.98
1.5	0.96
1.25	0.93
1.0	0.87

5.4 GEOMETRY AND THICKNESS

5.4.1 Alignment Tolerances

Within four days of placing an area of concrete base, survey the alignment and inspect each joint for conformity. Tolerances on horizontal alignment are given in Clause 4.6 for the outer edges of the base and for joints.

If nonconformity is detected, immediately implement Corrective Action in accordance with the requirements of TfNSW Q.

5.4.2 Level Survey

Within four days of placing an area of concrete base, carry out a survey in accordance with TfNSW G71 to determine conformity of the base surface level and thickness.

The level at any point on the top of the base must not vary by more than 20 mm above or 5 mm below the contract level.

Assess levels within sub-Lots which correspond to those established under Clause 1.3. Round the departures from the contract level to the nearest 5 mm. A sub-Lot is nonconforming if it contains any individual nonconforming levels.

Take levels with a flat based staff of base area between 300 mm^2 and 4000 mm^2 at the following locations. Report the levels to the nearest millimetre:

(a) (i) at cross-section offsets shown in Figure R83.6; and

(ii) at the same longitudinal plan locations as those surveyed for the invert levels under Clause 3.2,

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 Principal. A condition of acceptance is continued correlation with all pavement thickness results calculated from the model with pavement thickness measured from cores and production of a schedule at locations the same as those for accurately located levels.

The schedules of measured levels must show actual and contract levels (after applying the approved design adjustment, refer to Clause 3.2.4) 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.

Assess the base surface levels for conformity on the basis of individual survey points. Submit a nonconformity report and attach the survey report and the relevant assessment of thicknesses in accordance with Clause 5.4.3.

5.4.3 Thickness Assessment

(a) Assess thickness within sub-Lots which correspond to those established under Clause 1.3. Calculate base thickness to the nearest 1 mm at individual survey points selected in accordance

with Clause 5.4.2 as the difference between the finished base level and the base invert level surveyed in accordance with Clause 3.2.

Adjust the calculated thickness to allow for the design surface longitudinal and transverse slopes between the two surveyed points. Include in the PROJECT QUALITY PLAN the method of determining the thickness adjustment.

(b) Measure the base thickness to the nearest 1 mm on the cores taken for compaction testing. Adjust the measured thickness in accordance with Clause 3.2.4 to remove the contribution of the interlayer treatment.

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

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 Principal 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 Principal.

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

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

5.4.4 Conformity for Thickness

Assess sub-Lots for thickness in accordance with Table R83.25.

Apply deductions under Pay Item R83P11.3 to the schedule rate for supply and place of concrete in base.

Table R83.25 - Assessment Criteria for Thickness

Thickness deficiency (mm)				Status
Mean of sub-Lot (1)	**Individual points (1, 2)**			
	≥ 20 mm	**10 – 15 mm**	**5 mm**	
≥ 15 mm	U	U	U	Nonconforming, remove and replace
10 mm	2 or more	U	U	Nonconforming, remove and replace
	0 – 1	U	U	Nonconforming, 60% deduction
5 mm	2 or more	U	U	Nonconforming, remove and replace
	0 – 1	3 or more	U	Nonconforming, 60% deduction
		0 – 2	U	Nonconforming, 45% deduction
≤ 0 mm (3)	2 or more	U	U	Nonconforming, 60% deduction
	1	3 or more	U	Nonconforming, 45% deduction
		0 – 2	U	Nonconforming, 24% deduction
	0	3 or more	U	Nonconforming, 24% deduction
		1 – 2	U	Nonconforming, 12% deduction
		0	U	Conforming

Notes:

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

(2) In cells labelled "U", there is no limit 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.

5.5 SURFACE PROFILE

5.5.1 Transverse Profile

Within two days of paving, test surface deviations in a transverse direction in accordance with TfNSW T183. Deviations under a 3 m straightedge must not exceed 5 mm, except for areas within 10 m of superelevation transitions where deviations must not exceed 3 mm. Where the surface deviation is convex, place the straightedge so that the cantilever length does not exceed 0.75 m.

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, must be undertaken at each superelevation transition at three random locations within 10 m, at both mid-slab and longitudinal joints.

5.5.2 Longitudinal Profile

Within 2 days of paving, test the longitudinal profile by one of the following:

(a) measuring deviations under a 3 m straight-edge in accordance with TfNSW T183;

(b) testing with a Class 1 Profiler device in accordance with TfNSW T369;

(c) a California Profilograph.

Test in each trafficked lane and the near-side shoulder in the following areas:

(i) within 15 m each side of transverse construction joints.

(ii) at approach sections (as defined).

Extend the limit of profile testing beyond the defined 15 m in accordance with Clause 5.5.3 to cover any area paved under the Contract which cannot be tested for roughness. Profile testing must also extend beyond the limit of the Contract (where an abutting running surface is available at base level) by at least 10 m or whatever lesser length is available. Assessment for payment deduction purposes will be limited to the first level recorded beyond the limit of Contract.

(iii) 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 a traffic lane and in accordance with the operating manual for the device in use.

(B) A discontinuity in measurement occurs when the data acquisition system is reset during recording. At discontinuities in measurement of a profile, provide an overlap of at least 5.0 m on a line within 0.01 m offset of the original, and record the chainage (longitudinal location) of the discontinuity to an accuracy of at least 0.2 m.

Discontinuities are not permitted in profile measurements of test lengths that are less than 100 m. Captured data must be discarded and testing recommenced from the start point.

(C) At junctions of testing lines at ramps and intersections of road pavement, extend the measurement for a distance of at least 1.0 m beyond the junction, and record the point of intersection to an accuracy of 1.0 m in both measurement series.

(D) 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.

(E) Report deviations using the simulated straightedge function.

The requirements for surface correction are as follows:

- grind high deviations under a 3 m straightedge that exceed 5 mm;
- grind areas which are high by 20.0 mm or more. Such grinding may be used under Clause 5.5.3 to reduce the level of deduction or to increase the level of incentive payment.
- grinding may be carried out at your discretion for areas which are high by less than 20.0 mm. Such grinding may be used under Clause 5.5.3 to reduce the level of deduction or to increase the level of incentive payment.

Carry out grinding in accordance with Clause 5.7.

5.5.3 Ride Quality

5.5.3.1 Testing

After completion of grinding under Clause 5.5.2, assess the ride quality of the finished surface using either:

(a) a laser profilometer in accordance with TfNSW T188; or

(b) a Class 1 profiler in accordance with TfNSW T369.

Report the longitudinal profile in terms of the International Roughness Index (IRI), with units of "metres level change per kilometre (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 timing of testing must also conform to Clause 4.4.8.4. Measure the ride quality within the sections nominated in Table R83.26. For testing under TfNSW T188, use a test speed of:

(i) 50 km/h where the posted speed limit is less than 80 km/h; and

(ii) 80 km/h where the posted speed is 80 km/h or greater.

The roughness value for any sub-Lot is the average of three survey runs over that sub-Lot.

Roughness testing must extend as close as practicable to approach sections (as defined). Any area not assessed for roughness must be assessed for profile in accordance with sub-clause (b) above. 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 must be adjusted to conform to sub-clause (D).

(D) The testing wheels must not run closer than 0.3 m to a formed longitudinal joint except in ramp junction zones as per (E) hereunder. Ramp junction zones (for the purpose of this specification) are indicated in Figure R83.7.

(E) Test ramp junction zones in the wheel path which a vehicle would typically follow when loading on or off the through carriageway.

Ignore longitudinal joints within the ramp junction for the purpose of roughness testing.

For ramp junction zones which widen to dual ramp lanes, the roughness result is the average of separate runs along wheel paths leading to each lane.

(F) The incentive/deduction for any segment (with the exception of ramp junction zones) applies to the width of the slab bounded by longitudinal joints.

For the left (slow) lane of a typical dual lane carriageway, the incentive/deduction applies to the slab width bounded by the formed shoulder joint and the induced central joint. For the adjacent right (fast) lane, the result applies to the width bounded by the central induced joint and the outer median edge, including any integrally placed median shoulder.

(G) Within ramp junctions, the incentive/deduction applies to the total width of the traffic lanes bounded by outer edge lines.

(H) Where a longitudinal joint runs down the middle of a traffic lane, ignore the joint for the purpose of roughness testing, subject to compliance with sub-clause (D). The result so obtained applies to the combined width of the two adjoining slabs bounded by the next longitudinal joints.

For the purpose of profile testing, adjust the test line where required in order to conform to sub-clause (D).

(I) Where shoulders are too narrow to fully contain the test vehicle, run the vehicle with two wheels within the test lane and the other wheels within the adjacent lane. The result so obtained is hereafter referred to as a composite result.

Where the adjacent lane was constructed under the Contract, the composite result is applied to the shoulder in accordance with this Specification.

Where the adjacent lane was constructed by others, no incentive/deduction applies to the shoulder.

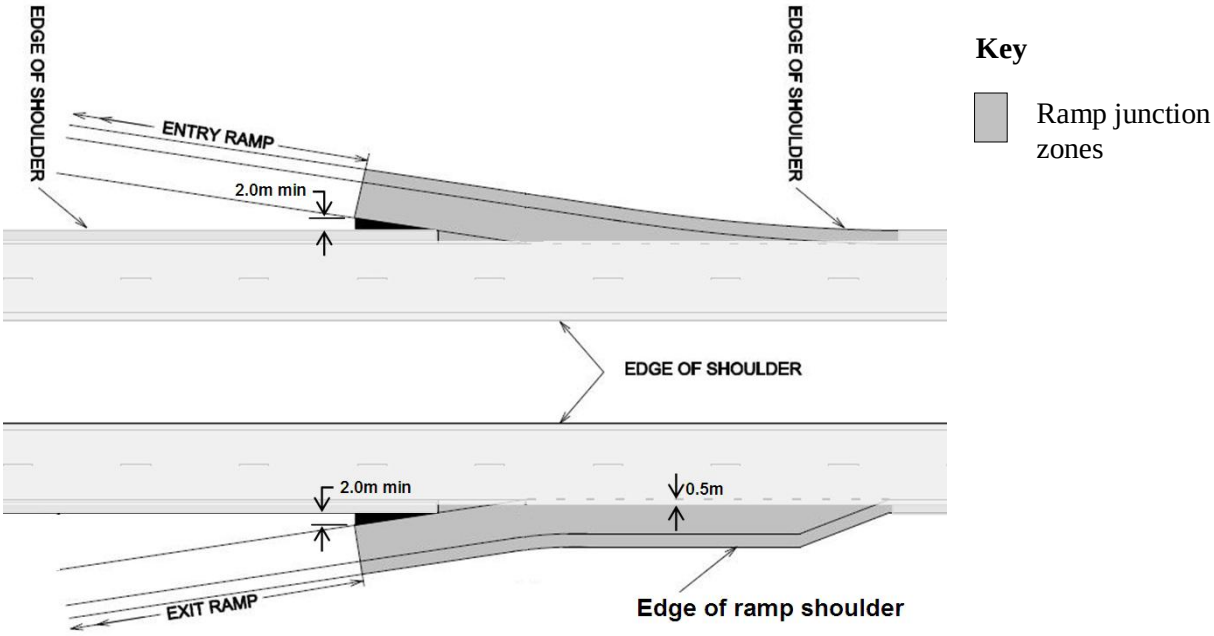


Figure R83.7 – Ramp junction zones

5.5.3.2 Assessment

Assign a pavement roughness category (PRC) according to Table R83.26 for each test segment.

Assess the roughness according to Table R83.27. Segments of base which score a positive value will earn an incentive payment. Segments of base which score a negative value are deemed nonconforming but may be accepted subject to a deduction.

Table R83.26 – Pavement Roughness Categories (PRC)

Nominated pavement section		PRC
Through carriageways	trafficked lanes (3) – longitudinal grade ≤ 4.0%	1
	trafficked lanes (3) – longitudinal grade > 4.0%	3
	shoulders (2)	3
Ramps (2)	within ramp junction zones (4)	3
	beyond ramp junction zones (4) - speed limit greater than or equal to 80 km/h - speed limit less than 80 km/h	 2 3
Minor roads (2)	speed limit greater than or equal to 80 km/h	3
	speed limit less than 80 km/h	4
Project specific areas (1)		
Under asphalt surfacing (4)		See Note 5

Notes:

(1) Values to be provided, if applicable, by the Principal. Some areas may not be assessable. Annexure R83/A refers.

(2) Shoulders on ramps and minor roads are not to be separately assessed.

(3) See Clause 5.5.3.1 for possible exemption of approach sections.

(4) The Principal may elect to add further areas which will be asphalt surfaced at a later date under separate contract; see Annexure R83/A.

(5) Under asphalt surfacings, 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 (1) would become two (2) under an asphalt surfacing.)

Calculate an incentive/deduction value for each segment in accordance with Table R83.27 and Pay Items R83P10 and R83P11.1, except that:

(a) An incentive/deduction will not apply to any area of a segment which is to be removed, for whatever reason, at no cost to the Principal.

(b) For base which is nonconforming in terms of thickness, compaction or strength:

  (i) an incentive will not apply, notwithstanding its possible acceptance by the Principal;

  (ii) a deduction will be applied to base which is accepted by the Principal.

(c) Replacement base (as covered by Clause 5.6) must be assessed for both incentive and deduction.

Carry out surface grinding in accordance with Clause 5.7 where specified in Table R83.27.

Table R83.27 - Incentive/Deduction Levels

NAASRA Roughness (Informative [3]) R (counts per km)	Roughness Index (RI) [2]	Incentive/Deduction (%) "+" denotes an incentive "–" denotes a deduction				
		PRC 1 [1]	PRC 2 [1]	PRC 3 [1]	PRC 4 [1]	PRC 5 [1]
R < 20	RI < 0.9	+ 3.0	+ 3.0	+ 3.0	+ 3.0	0
20 ≤ R < 25	0.9 ≤ RI < 1.1	+ 2.0	+ 2.0	+ 2.0	+ 2.0	0
25 ≤ R < 30	1.1 ≤ RI < 1.3	+ 1.0	+ 1.0	+ 1.0	+ 1.0	0
30 ≤ R < 35	1.3 ≤ RI < 1.5	+ 1.0	+ 1.0	+ 1.0	+ 1.0	0
35 ≤ R < 40	1.5 ≤ RI < 1.7	0	0	0	+ 1.0	0
40 ≤ R < 45	1.7 ≤ RI < 1.9	– 2.0	0	0	+ 1.0	0
45 ≤ R < 50	1.9 ≤ RI < 2.1	– 2.0	– 1.0	0	0	0
50 ≤ R < 55	2.1 ≤ RI < 2.3	– 4.0	– 3.0	– 2.0	0	0
55 ≤ R < 60	2.3 ≤ RI < 2.5	– 8.0	– 5.0	– 2.0	0	0
60 ≤ R < 65	2.5 ≤ RI < 2.7	– 16.0	– 8.0	– 4.0	– 1.0	0
65 ≤ R < 70	2.7 ≤ RI < 2.9	Grind	– 12.0	– 8.0	– 4.0	– 2.0
70 ≤ R < 75	2.9 ≤ RI < 3.1	Grind	– 16.0	– 16.0	– 8.0	– 4.0
75 ≤ R < 80	3.1 ≤ RI < 3.3	Grind	Grind	Grind	– 12.0	– 8.0
80 ≤ R ≤ 85	3.3 ≤ RI ≤ 3.5	Grind	Grind	Grind	– 16.0	– 12.0
R > 85	RI > 3.5	Grind	Grind	Grind	Grind	– 16.0

Notes:

(1) Categories defined in Table R83.26.

(2) RI: measured Roughness Index using the quarter-car model (IRIqc).

(3) This column is Informative only. Base the assessment on the Roughness Index.

5.6 REMOVAL AND REPLACEMENT OF CONCRETE BASE

Deal with detritus from sawcutting operations in accordance with the TfNSW G36.

5.6.1 General

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

HOLD POINT

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 Principal will consider the submitted documents prior to authorising release of the Hold Point.

Replace the nonconforming base in full slab widths between longitudinal joints and/or external edges.

Carry out paving by the slipform method where practicable.

5.6.2 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 $90^0 \pm 6^0$ 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:

(i) make longitudinal sawcuts along existing longitudinal joints to define the edges of the base section to be removed. These must not extend more than 250 mm past the transverse sawcut at each end of the section to be removed, nor into the underlying subbase.

(ii) prepare each longitudinal joint in compliance with the criteria for longitudinal construction joints as defined in this Specification.

Make additional internal sawcuts without over-sawing into the adjacent base or the underlying subbase. Also remove and replace any base adjoining the removed slabs, which is damaged by your operations.

Dispose of the removed base slabs in accordance with TfNSW G36.

Prepare and debond the subbase in accordance with TfNSW R82 prior to construction of the replacement base.

All work involved in the replacement of base must conform to this 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 must be scabbled (unless the removal has resulted in the exposure of a corrugated face), and assessed and treated in accordance with Clauses 4.6.1 and 4.6.4, including the installation of tiebars as appropriate.

(C) Transverse contraction joints must be continuous across the full width of the base containing the replaced section. Seal the length of the joint across the full width of the base with a silicone sealant that conforms to this Specification.

5.6.3 CRC Base

In CRC base, the proposed method must 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 $90^0 \pm 6^0$ 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 must 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 must not extend more than 250 mm past the transverse sawcut at each end of the section to be removed, nor into the underlying subbase.

(B) prepare each longitudinal joint in accordance with the criteria for longitudinal construction joints.

Make additional internal sawcuts without over-sawing into the adjacent base or the underlying subbase. Also remove and replace any base adjoining the removed slabs, which is damaged by your operations.

At the time of casting replacement concrete, the longitudinal steel must be straight and must not be in compression.

Dispose of the removed base concrete in accordance with the TfNSW G36.

5.7 RECTIFICATION OF FINISHED SURFACE AND RIDE QUALITY

Areas requiring surface rectification must be diamond grinded with purpose-built equipment conforming to TfNSW R93. Do not use impact methods such as milling or profiling.

Carry out the work in accordance with TfNSW R93 as modified hereunder.

Unless stated otherwise in Annexure R83/A, grinding equipment must create a longitudinal texture as follows:

(a) grooves must be uniformly spaced using 3.2 mm wide blades separated by 2.5 mm wide blade spacers; and

(b) with a minimum average texture depth in accordance with Clause 4.4.6.

Do not carry out grinding until all necessary slab replacements have been completed within the area to be grinded.

Where grinding is required, carry it out over the full width of a traffic lane.

Within seven days of grinding, re-assess the surface for conformity in accordance with Clauses 5.4 and 5.5.

Restore sealants and surface texture to conform to this Specification.

6 STEEL FIBRE REINFORCED CONCRETE

6.1 GENERAL

The use of steel fibre reinforced concrete (SFRC) is limited to applications specifically shown on the Drawings. In summary:

(a) it is always used in SFCP and SFCP-R;

(b) it is not used in PCP or JRCP;

(c) it is not used in CRCP under this specification.

The requirements for the supply and placement of steel fibre reinforced concrete (SFRC) and steel fibre reinforced concrete base pavement (SFCP) are the same as for base concrete and concrete base pavement in this Specification, except as provided in Clauses 6.2 to 6.9. The requirements of this clause are in addition to, and where in conflict, in place of, the requirements of the other clauses of this Specification.

6.2 STEEL FIBRES

6.2.1 Properties

Steel fibres must 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) must be greater than 30 and less than 68;

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

Do not use fibres that are longer than 50 mm.

6.2.2 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/m^3, whichever is the higher.

where:

M_f = minimum unit mass of steel fibre (kg/m^3)

F = fibre factor (25)

F_S = fibre size factor as per Table R83.28

F_D = fibre density (7850 kg/m^3)

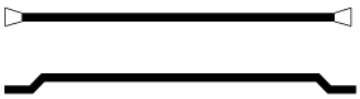
F_A = fibre anchorage performance factor as per Table R83.29

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

Table R83.28 - Steel Fibre Size Factor (F_S)

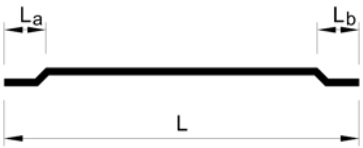
Volume of Single Fibre (mm^3)	Size Factor (F_S)
0 – 5	1.2
6 – 10	1.3
11 – 20	1.4
21 – 30	1.5
31 – 40	1.6
41 – 50	1.7
51 – 60	1.8

Table R83.29 - Steel Fibre Anchorage Performance Factor (F_A)

Category	Characteristic Fibre Shapes		Anchorage Performance Factor (FA)
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 % = $(L_a + L_b)/L * 100$



6.3 STEEL FIBRE REINFORCED CONCRETE

6.3.1 Strength

Acceptance of strength in the Works is based on 28 day flexural strength.

Compressive strength testing is only required as follows:

(a) In the trial mix (in accordance with Clause 3.8) and in the paving trial (in accordance with Clause 4.5), at both 7 and 28 days.

(b) In the Works at 7 days for the purpose of a statistical check on concrete uniformity (in accordance with Clause 4.2.1).

28-day compressive strength testing is not required in the Work except for the paving trial.

6.3.1.1 Compressive Strength

In the Trial Mix, determine the compressive strength in accordance with AS1012.9. Mould the specimens in accordance with TfNSW T304. Cure the specimens in accordance with AS 1012.8.

Compressive specimens must be of the size listed in Table R83.30 according to the maximum length (L_f) of steel fibre in the mix.

The 28-day compressive strength in the trial mix (F_{28}) must be not less than 40 MPa.

Comply with Clause 4.2.1.1 for the assessment of 7-day compressive strength in the Work. Mould one pair of cylinder test specimens from each sub-Lot.

6.3.1.2 28-day Flexural Strength

Inspect and test flexure beams in accordance with AS 1012.11 (as amended in sub-clauses (a) and (b) below) and Clause 6.6. Determine their unit mass in accordance with AS 1012.12.2.

The flexural strength at 28 days in the trial mix (F_{28}) must be not less than 5.8 MPa and in the Work must be not less than 5.5 MPa.

Flexure specimens must be the size listed in Table R83.30. Take care during sampling and moulding to minimise disturbance to the fibre distribution and orientation in the test specimen.

Table R83.30 - SFCP Specimen Sizes

Fibre Length L_f (mm)	Flexure Specimens		Compression Specimens
	Specimen Size (mm)	Standard Reference	Specimen Diameter (mm)
$L_f \leq 35$	100×100×350	AS 1012.8	100
$35 < L_f \leq 50$	150×150×500	AS 1012.8	150

Key:
L_f = maximum length of steel fibre in the mix

6.3.2 Consistence

Determine consistence by measuring slump in accordance with AS 1012.3 Method 1.

Nominate a slump for each nominated concrete mix, within the range specified below and such as to allow the production of a dense, non-segregated base with bleeding limited to prevent bleed water flowing over the slab edge under the conditions of placement.

The nominated slump must be:

(a) between 15 mm and 40 mm for slipform mixes;

(b) between 50 mm and 60 mm for fixed-form mixes.

6.3.3 Shrinkage

The drying shrinkage must conform to Clause 3.7.1.

6.3.4 Air Content

Do not use air entraining agent in SFRC. Air content testing is not required.

6.3.5 Batching, Mixing and Transport

6.3.5.1 Charging

In addition to the requirements of Clause 4.2.2, the method of charging the mixer must be consistent with the recommendations of the supplier of the steel fibre.

6.3.5.2 Mixing

For mobile mixers, provide the full period of mixing at either the testing station or the point of placement. Ignore all other mixing and agitation for the purpose of assessing the actual mixing time for a specific batch.

The minimum mixing period for steel-fibre reinforced concrete is:

(a) 5.0 minutes for initial mixing;

(b) as determined under Clause 4.2.2.2 for subsequent re-mixing.

6.4 NOMINATED CONCRETE MIXES

In addition to the requirements of Clause 3.8, submit details of the source, dimensions and nominated mix quantity of steel fibres.

In addition to the requirements of Clause 4.2.2, the permissible tolerance for weigh batching of steel fibres is +10% and –0%. If you propose to vary the quantity of steel fibres in the nominated mix, submit a new nominated mix in accordance with Clause 3.8.1.

6.5 TEXTURING

With reference to Clause 4.4.6, provide light brooming in lieu of the longitudinal hessian-drag. Brooming may be either longitudinal or transverse.

Provide tining in accordance with Table R83.17 and Clause 4.4.6.

Do not use power trowelling.

6.6 CONFORMITY FOR FLEXURAL STRENGTH

6.6.1 Test Specimens

Test specimens for determining the flexural strength of concrete must be standard beams conforming to Table R83.30 for both size and Standard Reference according to the maximum length (L_f) of steel fibre in the mix.

Take samples of concrete for testing in accordance with AS 1012.1. Mould the test specimens in accordance with T304 using the compaction method specified.

Cure the test specimens in accordance with AS 1012.8.

6.6.2 Frequency of Test Specimens

For each sub-Lot of base placed at the one time, take a set of three test specimens to determine the flexural strength at 28 days.

6.6.3 Flexural Strength

The flexural strength of the concrete represented by a set of beams taken from one sample is the average of individual results not more than 0.5 MPa from the median value.

Should any specimen be tested more than 28 days after moulding, the equivalent 28-day flexural strength is the test flexural strength divided by the factor AF applicable to the age of the specimen at the time of test as shown in Table R83.23.

For intermediate ages, determine the factor on a pro-rata basis.

If the 28-day flexural strength of test beams for any sub-Lot is less than 5.0 MPa, remove and replace the sub-Lot represented by the test beams in accordance with Clause 5.6.

Concrete with a 28-day flexural strength between 5.0 MPa and 5.5 MPa may be accepted provided it represents isolated sections and such sections comprise less than 5% of the area of base placed up to and including that sub-Lot. Such concrete is subject to a deduction under Pay Item R83P12.1 of 8% of the schedule rate for supply and place steel fibre reinforced concrete in base, for each 0.1 MPa or part thereof deficiency in flexural strength.

6.7 CONFORMITY FOR THICKNESS

Clause 5.4 applies with the following amendments to the deduction values given in Table R83.25.

(a) 18% for areas with a mean thickness of 5 mm less than the specified thickness;

(b) 45% for areas with a mean thickness of 10 mm less than the specified thickness.

These deductions are made under Pay Item R83P12.2.

6.8 CONFORMITY FOR COMPACTION

Sub-Lot definition for compaction is in accordance with Clause 1.3.

Calculate the relative compaction in accordance with TfNSW T381.

Determine the unit mass of cores in accordance with Clause 7.2.

Determine the unit mass of flexure beams in accordance with AS 1012.12 Method 2, amended in accordance with Clause 6.9.

If the relative compaction of the core specimen is less than 97.0%, remove and replace the sub-Lot represented by the core in accordance with Clause 5.6.

6.9 REPRESENTATIVE BEAM UNIT MASS

For steel fibre reinforced concrete, determine the unit mass reference values for concrete compaction using standard moulded beams and in accordance with the following provisions:

(a) The test beams are those which are moulded for 28-day flexure strength testing. At an age of between four and seven days, determine the unit mass (MUV) on all 28-day beam specimens in accordance with AS 1012.12 Method 2, amended in accordance with sub-clauses (b) and (c) hereunder.

(b) MUV testing must be in the saturated surface-dry condition and without dressing of voids; see TfNSW T368.

(c) Round individual results to the nearest even number (in contrast to AS1012.12 which requires rounding to the nearest 10 kg/m^3). The unit mass for a set of beams is the average of individual results not more than 20 kg/m^3 from the median value. Round the averaged result to the nearest 5 kg/m^3.

For each nominated mix in use, make a statistical check to determine the representative beam unit mass (RBUM) using the set unit mass as defined under subclause (c).

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/m^3.

Thereafter, take the RBUM for any sub-Lot as the mean of the five consecutive sets of 28-day beams of that mix up to and including that sub-Lot (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/m^3.

7 TESTING PROCEDURES

7.1 MIXER UNIFORMITY

As required by Clause 4.2.2.2(c), cast a minimum of 24 test cylinders in accordance with TfNSW 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.

Test each sample at 7 days for mass per unit volume (MUV) and compressive strength as follows:

(a) mass per unit volume (MUV) in accordance with Clause 5.2.1.1, except that results are to be rounded to the nearest 1 kg/m³ and;

(b) compressive strength, with sampling and moulding in accordance with Clause 5.3.2, except that results are to be rounded to the nearest 0.1 MPa.

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

$$\mathrm{CoV_C} = \frac{\sigma_{compressive}}{\mu_{compressive}} \times 100 \qquad \text{where:}$$

$\mathrm{CoV_C}$ = compressive strength Coefficient of Variation, reported to the nearest 0.1%;

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

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

$$\mathrm{CoV_{MUV}} = \frac{\sigma_{MUV}}{\mu_{MUV}} \times 100 \qquad \text{where:}$$

$\mathrm{CoV_{MUV}}$ = MUV Coefficient of Variation, to the nearest 0.1%;

σ_{MUV} = Standard Deviation of MUV, to the nearest 1 kg/m^3;

μ_{MUV} = mean of MUV, to the nearest 1 kg/m^3.

7.2 UNIT MASS OF CYLINDERS AND CORES

7.2.1 Cylinders

Determine the unit mass of cylinders in accordance with AS 1012.12.2, qualified as follows:

(a) Determine m_1 the initial mass of the specimen prior to dressing, in accordance with AS 1012.12.2 Clause 6(a) and in the saturated surface-dry (SSD) condition. This will require wet conditioning for 24 hours in accordance with Clause 6(c).

(b) Assess the cylinder in accordance with TfNSW T368 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 must be fully intact at the time of weighing.

(e) Calculate the volume and mass per unit volume in accordance with AS 1012.12.

(f) The concrete age at testing must be at least 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 AS1012.12 which requires rounding to the nearest 10 kg/m^3).

7.2.2 Cores

Determine the unit mass of cores in accordance with AS 1012.12.2, qualified as follows:

(a) Determine m_1 the initial mass of the specimen including any steel but prior to dressing, in accordance with AS 1012.12.2 Clause 6(a) and in the saturated surface-dry (SSD) condition. This will require wet conditioning for 24 hours in accordance with Clause 6(c).

(b) Assess the cores in accordance with TfNSW T368 for excessive voids. Dress and/or seal voids where required.

(c) Determine m_2 the immersed mass including steel and dressing in accordance with AS 1012.12.2.

(d) Determine m_3 the SSD mass including steel and dressing. The dressing must be fully intact at the time of weighing.

(e) Calculate the volume and mass per unit volume in accordance with AS 1012.12.

(f) The concrete age at testing must be at least three days.

(g) Adjust the unit mass for the presence of steel reinforcement in accordance with TfNSW T368.

(h) Report the height and diameter of the core, as tested.

(i) Round individual results for unit mass to the nearest even number (in contrast to AS1012.12 which requires rounding to the nearest 10 kg/m^3).

ANNEXURE R83/A – PROJECT SPECIFIC REQUIREMENTS

A1 TEXTURING OF SURFACE

Table A.1 is to be read in conjunction with Table R83.17. It qualifies texturing requirements under Clause 4.4.6. Examples might include:

(a) limitations on transverse or longitudinal tining;

(b) supplementary transverse grooving at superelevation transitions;

(c) Clause 4.4.6.4 requires grooving to be parallel with tining. Provide grooving details where a different alignment is required, or where no tining exists;

(d) diamond grinding in lieu of plastic texturing.

Table R83/A.1 - Schedule of Texturing Exceptions

Control/chainage	Texture Type(s)	Texture Depth	Test Method

A2 TREATMENT OF EXISTING BASE EDGE, JOINT OR KERB

Prior to widening, treat existing joints, edges and/or kerbs in accordance with Table R83/A.2.

Table R83/A.2 - Schedule of Treatments

Control/Chainage	Treatment Type	Details

Note:

1. Treatments may include:

(a) sawing and removal of the outer edge;

(b) scabbling of the exposed face;

(c) modifications to existing corrugations;

(d) installation of drill-ties.

A3 RIDE QUALITY TESTING

Table R83/A.3 must be read in conjunction with (and provides information supplementary to) Table R83.26.

Table R83/A.3 - Pavement Roughness Categories for Project-Specific Areas

Nominated Project-Specific Areas [1]			
Location	**Control/Chainage**	**Assessable? (Yes/No)**	**PRC**
Through carriageways			
Ramps			
Minor roads			
Under asphalt surfacing		Yes	5
		No	Not applicable

Note:

(1) Nominations are to be limited to areas which are not covered in Table R83.26.

A4 RECTIFICATION OF FINISHED SURFACE AND RIDE QUALITY

Table R83/A.4 must be read in conjunction with (and provides information supplementary to) Clause 5.7.

Table R83/A.4 – Diamond Grinding Details

Width of spacers between blades (specification of this detail is optional) [1]:	..... mm
Minimum texture depth:	…….. mm

Note:

(1) The default width of the spacing is 2.5 mm (0.100”). Wider spacers must be determined from trials.

ANNEXURE R83/B – MEASUREMENT AND PAYMENT

Payment will be made for all costs associated with completing the work detailed in this Specification in accordance with the following Pay Items.

Where no specific pay items are provided for a particular item of work, the costs associated with that item of work are deemed to be included in the rates and prices generally for the Work Under the Contract.

Unless specified otherwise, a lump sum price for any of these items will not be accepted.

No account will be taken of the allowable tolerances in the measurement of the quantity for payment.

Pay Item R83P1 – Supply and Place Concrete in Base

Pay Item R83P1.1 – Supply and Place Concrete in Base (other than steel fibre reinforced concrete)

The unit of measurement is the cubic metre.

The width and length is as specified on the Drawings or directed by the Principal. The thickness is the thickness specified or as directed by the Principal across each section. Include in the measurement the additional base above terminal anchors, taken from the Drawings.

Provide a separate rate for each type of base concrete specified on the Drawings.

The pay item includes the costs of mix designs and trials, paving trials, construction joints, outer edges and all concrete required to produce paved concrete.

Pay Item R83P1.2 – Supply and Place Steel Fibre Reinforced Concrete in Base

The unit of measurement is the cubic metre.

The width and length is as specified on the Drawings or directed by the Principal. The thickness is the thickness specified or as directed by the Principal across each section. Include in the measurement the additional base above terminal anchors, taken from the Drawings.

The pay item includes the steel fibre reinforcement, the costs of mix designs and trials, paving trials, construction joints, outer edges and all concrete required to produce paved concrete.

Pay Item R83P2 – Finish, Cure and Texture Base

The unit of measurement is square metres of surface of the base. The width and length is as specified on the Drawings or as directed by the Principal.

The sides of the slabs must not be included in the measurement of surface area.

Pay Item R83P3 – Supply and Place Wire Reinforcing Fabric

The unit of measurement is the square metre.

The width and length is as specified on the Drawings or as directed by the Principal. The areas that contain laps must only be measured once.

Pay Item R83P4 – Supply and Place Steel Bar Reinforcement

The unit of measurement is the tonne.

The mass is determined from the unit masses given in AS/NZS 4671 Clause 7 and the actual length of bar, excluding laps and splices, measured in place. Only one bar may be measured within a lap or splice.

The pay item includes bar reinforcement in anchors. The pay item excludes dowels and tiebars.

Pay Item R83P5 – Longitudinal Joints

The unit of measurement is the metre.

The measurement is along the line of the joint.

The pay item includes the provision of tiebars (where specified) and the application of debonding treatment at formed joints.

Pay Item R83P6 – Expansion Joints and Isolation Joints

The unit of measurement is the metre.

The distance is measured along the line of the joint.

The pay item includes the provision of dowels, where specified.

Pay Item R83P7 – Transverse Contraction Joints

The unit of measurement is the metre.

The measurement is along the line of the joint.

Provide a separate rate for SFCP, where applicable.

The pay item includes the provision of dowels, where specified.

Pay Item R83P8 – Terminal and Slab Anchors

The unit of measurement is the cubic metre.

The volume is taken from the Drawings or as directed by the Principal. The depth is measured from the top of the subbase.

The pay item includes excavation for the anchor.

Pay Item R83P9 – (Not Used)

Pay Item R83P10 – Incentive for Ride Quality

The width and length is as specified in Clause 5.5.3.

The incentive is applied to pay item R83P1 after conversion to a square metre rate based on the thickness as specified or as directed by the Principal across each test segment.

Pay Item R83P11 – Deductions (other than steel fibre reinforced concrete pavement)

Pay items R83P11.1 to R83P11.4 apply to nonconforming work where there is a specified disposition for acceptance that includes deductions. The value is negative.

Pay Item R83P11.1 – Ride Quality

This pay item includes deductions for nonconforming works as defined in Clause 5.5.3.

The deduction is applied to pay item R83P1 after conversion to a square metre rate based on the thickness as specified or as directed by the Principal across each test segment.

Pay Item R83P11.2 – Compressive Strength

This pay item includes deductions for nonconforming works defined in Clause 5.3.

Pay Item R83P11.3 – Thickness

This pay item includes deductions for nonconforming works defined in Clause 5.4.

Pay Item R83P12 – Deductions (steel fibre reinforced concrete pavement)

Pay items R83P12.1 to R83P12.2 apply to nonconforming work where there is a specified disposition for acceptance that includes deductions. The value is negative.

Pay Item R83P12.1 – Flexural Strength

This pay item includes deductions for nonconforming works defined in Clause 6.6.3.

Pay Item R83P12.2 – Thickness

This pay item includes deductions for nonconforming works defined in Clause 6.7.

ANNEXURE R83/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.3.

C1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS

Clause	Type	Description
3.2	Hold	High subbase levels
3.2 and TfNSW G71	Hold	Survey Report verifying subbase conformity
3.8.1	Hold	Submission of nominated mix
3.8.1	Witness	Trial mix
4.1.1	Hold	Placing concrete around steel reinforcement
4.2.1	Hold	Results from process control charts
4.2.2.2	Hold	Results for mixer uniformity testing
4.3.3	Hold	Submission of names of personnel involved in concrete paving operations and evidence that at least half of them hold a TfNSW Concrete Paving Crew Grey Card
4.4.8.4	Hold	Trafficking of base
4.5	Hold	Base paving subject to paving trial
4.6.1	Witness	Testing of joints and silicone sealants
5.2.4	Hold	Voids above inserted tiebars
5.4.2 and TfNSW G71	Hold	Survey Report verifying base conformity
5.6.1	Hold	Removal and replacement of nonconforming concrete base

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW Q Annexure Q/E.

Clause	Description of Identified Record
2.8	Certify by written report that the curing compound conforms to this Specification, and submit NATA endorsed test results
2.9	Certify that the proposed sealant conforms to this Specification and provide all relevant test results
2.9	Certify compliance of each production batch of sealant
2.10	Evidence that steel reinforcement material supplier and reinforcement fabricator are certified by ACRS
3.2	Schedule of base invert levels and relevant nonconformity report
3.8.1	Certify that each nominated mix and its constituents meet the requirements of this Specification, submit NATA endorsed test results for all relevant tests (except Vebe) and submit a copy of the verification checklist
3.8.2	Notification of variations to a nominated mix
4.1.1	Certificate of compliance covering the installation of reinforcement and embedments
4.2.1	Results for compressive and flexural strength, relative compaction and thickness for the same sub-Lot plus proposal for Corrective Action to achieve conformity
4.3.3	Names of personnel for carrying out concrete paving operations, together with evidence of relevant training and experience
4.4.8.4	Insitu strength test results of the base
4.5	Submission of checklists and test results, excluding results for compressive and flexural strength
5.6.1	Nonconformity report for each location of removal and replacement of concrete base with the proposed method and precautions to prevent damage

ANNEXURE R83/D – PLANNING DOCUMENTS

Refer to Clause 1.2.4.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. The requirements of this Specification and others included in the Contract must be reviewed to determine additional documentation requirements.

(a) Sub-Lot definition (Clause 1.3);

(b) Admixture selection (Clause 2.7);

(c) Joint sealant details and certification (Clause 2.9);

(d) Dowel debonding and support system (Clause 4.1.3);

(e) Bending of anchor stirrups (Clause 4.1.6);

(f) Materials handling, batching and mixing proposals (Clause 4.2.2);

(g) Admixture incorporation method (Clause 4.2.2.3);

(h) Control of batching time under Clause 4.2.2.4 and retempering under Clause 4.2.2.7 and nomination of your representative under Clause 4.2.2.7(b);

(i) Determination of maximum forming time (Clause 4.2.2.8);

(j) Name, qualification(s) and experience of the Paving Supervisor for concrete paving work (Clause 4.3);

(k) Equipment and methods for spreading and paving (Clause 4.4);

(l) System to indicate the malfunction of individual vibrators (Clause 4.4.1);

(m) Traceability of loads of concrete placed (Clause 4.4.3);

(n) Meteorological data and measures to restrict evaporation (Clause 4.4.5);

(o) Texturing procedures and equipment (Clause 4.4.6);

(p) Handling, spraying and assessing rates of curing compounds (Clause 4.4.7.1);

(q) Procedures for Class 3 curing (Clause 4.4.7.2);

(r) Protection of work from low temperatures (Clause 4.4.8.1) and rain (Clause 4.4.8.2);

(s) Procedures and equipment for joint sealing (Clauses 4.6.1 and 4.6.3.4);

(t) Method of paving over anchors (Clause 4.9);

(u) Crack inspection schedule (Clause 5.1);

(v) Method of calculating adjusted thickness from survey (Clause 5.4.3).

ANNEXURES R83/E TO R83/K – (NOT USED)

ANNEXURE R83/L – MINIMUM FREQUENCY OF TESTING

Clause	Characteristic Analysed	Test Method	Minimum Frequency of Testing
Fine aggregate:			
2.3	Material < 75 µm	AS 1141.11	One per 5,000 t (TF) (4) for the first 15,000 t and thereafter one per 10,000 t
2.3	Material < 2 µm	AS 1141.13	One per 5000 t (TF) (4) for the first 15,000 t and thereafter one per 10,000 t
2.3	Methylene Blue Adsorption Value (MBV)	TfNSW T659	One per 20,000 t (Ind) (4)
2.3	MBV75 value		One per 20,000 t (Ind) (4)
2.3	Bulk Density (compacted)	AS 1141.4 Clause 7.2	Trial mix submission (3)
2.3	Water Absorption	AS 1141.5	Trial mix submission (3)
2.3	Soundness (sodium sulphate)	AS 1141.24	One per 5000 t (Ind) (4) for the first 15,000 t and thereafter one per 10,000 t
2.3	Organic impurities	AS 1141.34 and AS 1289.4.1.1. See Table R83.2 Note 4.	One per 2000 t (TF) (4) for the first 10,000 t and thereafter one per 10,000 t
2.3	Sugar content	AS 1141.35	One per 5000 t (Ind) (4)
2.3	Acid insoluble residue	TxDOT Tex-612-J	Trial mix submission (4) (TF) (4)
2.3	Micro-Deval loss (6)	ASTM D7428	Trial mix submission (4,6) (TF) (4)
2.3	Flow Cone time (5)	TfNSW T279	One per 10,000 t (TF) (4)
2.3	Hardness	Vickers Hardness (macro) ASTM E384-11e1	Trial mix submission (4) (TF) (4)
2.3	Glass content	TfNSW 3154	Trial mix submission (3) (TF) (4)
Coarse aggregate:			
2.4	Bulk and particle density	AS 1141.4, AS 1141.6	In the trial mix
2.4	Water absorption	AS 1141.6	Trial mix submission (3) (TF) (4)
2.4	Material < 75 µm	AS 1141.11	One per 5000 t (TC) (4) for the first 15,000 t and thereafter one per 10,000 t
2.4	Particle shape	AS 1141.14	One per 10,000 t
2.4	Ratio AGD/ALD	TfNSW T275 and T278	One per 10,000 t
2.4	Wet strength	TfNSW T215	One per 10,000 t (1)
2.4	Wet/dry strength variation	TfNSW T215	One per 10,000 t (1)
2.4	Weak particles	AS 1141.32	One per 20,000 t
2.4	Light particles	AS 1141.31	One per 20,000 t

Clause	Characteristic Analysed	Test Method	Minimum Frequency of Testing
2.4	Fractured faces	TfNSW T239	One per 10,000 t
2.4	Foreign materials content	TfNSW T276	One per 4000 t
2.5.1	Alkali-aggregate reactivity	See Clause 2.5.1	Trial mix submission (3)
Other Materials:			
2.6	Cementitious materials	TfNSW 3211	
2.8	Conformity of curing compound	AS 3799	As per Clause 2.8
2.9	Joint sealant	See Clause 2.9	
2.11	Water	AS 1379	At the trial mix and thereafter one per 5000 m^3 of concrete
Placing Concrete in Base			
3.7	Shrinkage	AS 1012.13	Trial mix submission (3)
3.7.2	Chloride ion content	See Clause 3.7.2	One per 30,000 m^3 of concrete
3.7.2	Sulphate ion content	See Clause 3.7.2	One per 30,000 m^3 of concrete
3.7.2	Bleeding	AS 1012.6	At the trial mix
3.7.2	Coefficient of Thermal Expansion (CTE)	AASHTO T336	Trial mix submission (3). Report only.
4.1.2	Tiebars; pull-out testing		As per Clause 4.1.2.1
4.1.2	Tiebars; location and compaction		As per Clause 4.1.2.2
4.1.2	Tiebars; concrete cover		As per Clause 4.1.2.3
4.1.3	Dowels; pull-out testing	TfNSW T366	Trial mix submission (3), 3 dowels and as per Clause 4.1.3
4.2.1	Particle size distribution of combined aggregate: either - by calculation or - by wet-sieving (3)	AS 1141.11 By calculation TfNSW T329 (3)	One per 500 m^3 for the first 5,000 m^3 and thereafter one per 2,500 m^3. In the Paving Trial and thereafter one per 1500 m^3 of concrete (5)
4.2.1	Flexural strength	AS 1012.11	As per Clause 4.2.1.2
4.2.1	Water content		In the Paving Trial and thereafter one per 500 m^3 for the first 5000 m^3 and thereafter one per 2500 m^3
4.2.2	Concrete slump	AS 1012.3 Method 1	As per Clause 4.2.2
4.2.2	Air content of concrete	AS 1012.4 Method 2	As per Clause 4.2.2
4.2.2	Mixer Uniformity	AS 1379 and Clause 2.4.4	As per Clause 4.2.2

Clause	Characteristic Analysed	Test Method	Minimum Frequency of Testing
4.4.6	Average depth of surface texture		
	(a) Hessian drag only	TfNSW T240 or T192	Only where tining and/or grooving is not specified, one per 2000 m^2 of Base.
	(b) Combined surface texture	TfNSW T240 or T192	One per 2000 m^2 of base
4.4.7	Application rate of curing compound	See Clause 4.4.7	As per Clause 4.4.7.2
4.4.8.4	In-situ compressive strength (for trafficking purposes)	Cylinders as per TfNSW T367, or Cores as per Clause 4.4.8.4	As per Clause 4.4.8.4 As per Clause 4.4.8.4
	Cylinder compressive strength of concrete at:		
4.2.1	- 7 days	AS 1012.9	As per Clause 5.3.2
5.3.2	- 28 days	AS 1012.9	As per Clause 5.3.2
4.6.1	Joints and sealants	TfNSW T379 and T380	As per Clause 4.6.1
5.2	Relative compaction of concrete	TfNSW T381	As per Clause 5.2.1
5.4	Surface level and alignment	Various	As per Clause 5.4
5.4.3	Thickness	Survey and Core length	As per Clause 5.4.3
5.5.2	Surface profile	See Clause 5.5	As per Clause 5.5
5.5.3	Ride Quality	TfNSW T188 or T369	As per Clause 5.5.3
Steel fibre reinforced concrete			
6.3.2	Compressive strength	AS 1012.9	As per Clause 6.3.2
6.3.3	Consistence	AS 1012.3 Method 1	As per Clause 4.2.2
6.6.2	Flexural strength	AS 1012.11	As per Clause 6.3.2
6.7	Thickness	Survey and Core length	As per Clause 5.4.3
6.8	Relative compaction of concrete	TfNSW T381	As per Clause 5.2.1

Notes:

(1) Provided that all of the six previous tests have met specification requirements for both wet strength and wet/dry strength variation then the following reduced frequency may apply;
- where all wet/dry variation results are < 25% : 1 per 15,000 t.

(2) Only the + 1.18 mm fraction need be tested; Clause 4.2.1(b) refers.

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

(4) Frequencies are based on aggregate quantities as follows (consistent with Tables R83.2 & R83.3):
- Ind: individual aggregate quantities
- TF: total fine aggregate quantities
- TC: total coarse aggregate quantities

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

(6) See Table R83.2 Note 6 regarding the warrant for testing.

ANNEXURE R83/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.4.

TfNSW Specifications

TfNSW G36	Environmental Protection
TfNSW G71	Construction Surveys
TfNSW Q	Quality Management System
TfNSW R15	Kerbs and Channels (Gutters)
TfNSW R53	Concrete for General Works
TfNSW R82	Lean-mix Concrete Subbase
TfNSW R93	Diamond Grinding of Concrete Pavement
TfNSW R106	Sprayed Bituminous Surfacing (with Cutback Bitumen)
TfNSW R145	Pavement Marking (Performance Based)
TfNSW B203	Welding of Reinforcing Steel
TfNSW 3051	Granular Pavement Base and Subbase Materials
TfNSW 3154	Granulated Glass Aggregate
TfNSW 3204	Preformed Joint Fillers for Concrete Road Pavements and Structures
TfNSW 3211	Cements, Binders and Fillers
TfNSW 3253	Bitumen for Pavements
TfNSW 3254	Bitumen Emulsion

TfNSW Test Methods

TfNSW T183	Surface Deviation Using A Straightedge
TfNSW T188	Project Ride Quality (Vehicular Laser Profilometer)
TfNSW T192	Determination of the Texture Depth of Road Surfacing by the TRL Mini texture Meter
TfNSW T215	Wet/Dry Strength Variation
TfNSW T239	Fractured Faces of Coarse Aggregate
TfNSW T240	Road Surface Texture Depth (Sand Patch)
TfNSW T276	Foreign Materials Content of Recycled Crushed Concrete
TfNSW T278	Aggregate Shape by the Ratio of Greatest to Least Dimension
TfNSW T279	Flow Time and Voids Content of Fine Aggregate by Flow Cone
TfNSW T304	Moulding of Concrete Specimens for testing in Compression, Indirect Tension and Flexure
TfNSW T329	Wet Sieving of Concrete
TfNSW T363	Accelerated Mortar Bar Test for the Assessment of Alkali-reactivity of Aggregate
TfNSW T364	Concrete Prism Test for AAR Assessment

TfNSW T366	Dowel Pull-Out Test
TfNSW T367	Field Simulated Curing And Testing of Moulded Concrete Specimens
TfNSW T368	Dressing of Voids In Concrete Specimens And Unit Mass Adjustment for Embedded Steel
TfNSW T369	Longitudinal Profile Testing
TfNSW T379	Cleanliness of Sawn Concrete Pavement Joints
TfNSW T380	Field Adhesion of Joint Sealant to Concrete
TfNSW T381	Relative Compaction of Pavement Concrete
TfNSW T659	Methylene Blue Adsorption Value of Road Construction Materials
TfNSW T862	Stability of Wax Emulsion Curing Compound
TfNSW T1005	Recording the Infrared Spectrum of Materials
TfNSW T1192	Adhesion of Sealant
TfNSW T1193	Accelerated Aging of Cured Sealant

TfNSW Standard Drawings

DS2012/001191	Plain concrete pavement (PCP) – construction
DS2012/001190	Continuously reinforced concrete pavement (CRCP) – construction
DS2014/005559	Jointed reinforced concrete pavement (JRCP) – construction
DS2013/001838	Plain concrete pavement (PCP) – maintenance

Australian Standards

AS 1012	Methods of testing concrete
AS 1012.1	Sampling of concrete
AS 1012.3.1	Determination of properties related to the consistency of concrete - Slump test
AS 1012.3.3	Determination of properties related to the consistency of concrete - Vebe test
AS 1012.4.2	Determination of air content of freshly mixed concrete – Measuring reduction in air pressure in chamber above concrete
AS 1012.5	Determination of mass per unit volume of freshly mixed concrete
AS 1012.6	Determination of bleeding of concrete
AS 1012.8.1	Method for making and curing concrete – Compression and indirect tensile test specimens
AS 1012.8.2	Method for making and curing concrete – Flexure test specimens
AS 1012.9	Compressive strength tests – Concrete, mortar and grout specimens
AS 1012.11	Determination of the modulus of rupture
AS 1012.12.2	Determination of mass per unit volume of hardened concrete - Water displacement method
AS 1012.13	Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory

AS 1012.14	Method for securing and testing cores from hardened concrete for compressive strength
AS 1012.20.1	Determination of chloride and sulfate in hardened concrete and concrete aggregates – Nitric acid extraction method
AS 1141	Methods for sampling and testing aggregates
AS 1141.3.1	Method 3.1: Sampling – Aggregates
AS 1141.4	Bulk density of aggregate
AS 1141.5	Particle density and water absorption of fine aggregate
AS 1141.6.1	Particle density and water absorption of coarse aggregate – Weighing-in-water method
AS 1141.6.2	Particle density and water absorption of coarse aggregate – Pycnometer method
AS 1141.11.1	Particle size distribution – Sieving method
AS 1141.12	Materials finer than 75 µm in aggregates (by washing)
AS 1141.13	Material finer than 2 micrometer
AS 1141.14	Particle shape, by proportional calliper
AS 1141.24	Aggregate soundness – Evaluation by exposure to sodium sulphate solution
AS 1141.31	Light particles
AS 1141.32	Weak particles (including clay lumps, soft and friable particles) in coarse aggregates
AS 1141.34	Organic impurities other than sugar
AS 1141.35	Sugar
AS 1289	Methods of testing soils for engineering purposes
AS 1289.4.1.1	Soil chemical tests – Determination of the organic matter content of a soil – Normal method
AS 1289.4.2.1	Soil chemical tests – Determination of the sulfate content of a natural soil and the sulfate content of the groundwater – Normal method
AS 1379	Specification and supply of concrete
AS 1478.1	Chemical admixtures for concrete, mortar and grout- Admixtures for concrete
AS/NZS 2310	Glossary of paint and painting terms
AS 2341.18	Methods of testing bituminous and related roadmaking products - Determination of softening point (ring and ball method)
AS 2350.2	Methods of testing Portland, blended and masonry cements – Chemical composition
AS 2706	Numerical values – Rounding and interpretation of limiting values
AS 2758.1	Aggregates and rock for engineering purposes – Concrete aggregates
AS 3600	Concrete structures
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/NZS 4671	Steel reinforcing materials
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS ISO 9001	Quality management systems – Requirements

ASTM, EN and ISO Standards

ASTM-C603	Standard Test Method for Extrusion Rate and Application Life of Elastomeric Sealants
ATSM-C661	Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer
ASTM-C679	Standard Test Method for Tack-Free Time of Elastomeric Sealants
ASTM-C793	Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants
ASTM-C794	Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
ASTM-D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM-D7428	Standard Test Method for Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
ASTM E384-11	Standard Test Method for Knoop and Vickers Hardness of Materials
EN 14889-1	Fibres for concrete – Part 1: Steel fibres – Definitions, specifications and conformity
ISO/IEC 17000	Conformity assessment – Vocabulary and general principles

Regulation

Road Transport (Mass, Loading & Access) Regulation 1996

Texas Department of Transportation document

Tex-612-J	Acid insoluble residue for fine aggregate