ROADS AND MARITIME SERVICES (RMS)

QA SPECIFICATION R84

CONTINUOUSLY REINFORCED CONCRETE BASE

REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 2/Rev 0		Completely revised. Some requirements transferred to Annexure R84/3	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		
	4.5,	Clause numbers changed		
	5.3, 5.4	Rearranged under new clause headings		
	A2.1.1	Table A3.2 & A3.3 renumbered		
	Annexure R84/3	Subclause numbers changed for: A2.1, A2.6, A3.2, A4.1, A4.2.1, A4.3.6, A4.5.4, A5.2.1, A5.4.2,		
	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.		
Ed 2/Rev 2	5.5.3.2	Table R84.14 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, 5.2.1, 5.3.2, A4.2.1.3,	Minor changes. A2.1.2, A4.2.1.1, A4.2.1.2, A4.5.2.5. A5.2.1.1, A5.3.2,		
	2.9	Reference to AS 1379 changed		
	3.8.1(iii)	Results format specified		
	4.1.1	Clearance to joints changed.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 2/Rev 3 (cont'd)	4.3.7(g)	Curing required until 30MPa		
	5.4.3	Thickness assessment changed		
	6	Sub items required for R84 P1		
	A2.1.1	Test methods changed		
	A4.1.1.2	Fabric splicing changed		
	Annex R84/7	New annexure listing Identified Records		
Ed 2/Rev 4	1.2, 2.4, 3.3, 3.8.1, 4.2.1, Annx R84/3:	Minor changes 4.5.5, 5.2.2, 5.4.2, Annx R84/2 A4.5.1, A4.5.4.1, A5.2.1.2	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		
	4.2.1	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 R84P1 changed		
	Annex R84/3 - A4.1.2.2	Voids above tie bars to be filled		
	- A4.2.1.2	Minimum frequency for testing flexural specimens changed		
	- A4.2.2	Continuous mixers included		
	- A5.2.3	Assessment of cores changed		
	- A5.3.3	Cores must be wet conditioned		
	- A5.4.2	Survey model included		
	Annex R84/4	Particle size distribution testing requirements changed		
Ed 2/Rev 5	Introduction	Specification User Guide	GM, RNIC	21.08.03
	1.2	Various revisions to Table R84.1		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 2/Rev 5 (cont'd)	3.7, 3.8, 4.1.2, 4.3.4, 4.3.6, 4.4, A4.2.2,	Minor editorial changes. 5.2.1, 5.4.2, A3.8.1, A4.1.1, A4.1.2.2, A5.2.1.1, A5.2.4, A5.3.2		
	1.2, 2.8, Pay Item R84P4	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.		
	2.2	Quartz content changed under AC surfacing		
	2.4	Flyash requirements changed		
	2.6	Curing compound requirements changed		
	2.7	Silicone test methods changed		
	3.3	Sand fraction changed		
	3.5, 5.4.4	Removal of upper limit on combined strength & thickness		
	3.8.1(iii)	Test methods specified		
	4.1.2	Plain tie bar length added		
	4.1.3(a)	As 4680 added. Extra dowel and steel requirements added		
	4.1.3, 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	Sub-headings added		
	4.2.2(a)	New mixing requirements added.		
	4.2.2(f)	Time limits increased		
	4.3.2	Vibrator requirements added		
	4.3.3	Details required in PQP		
	4.3.4	Second paragraph revised		
	4.3.8.2	Rain damage to be assessed		
	4.3.6, 4.4	Reference panel deleted		
	4.5, 5.6	New requirements on control of sawcutting detritus		
	4.5.4	Expansion joint details added		
	4.5.5(c)(iii)	Item added		
	4.5.8	Test edge alignment		
	4.6, 4.8	Concrete requirements revised		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 2/Rev 5 (cont'd)	4.8	Slump and compaction requirements changed for slab anchors		
	5.4.4	General revision		
	5.5.2	Incentive payments applicable at minor grinding		
	Annex R84/2	New requirements under (h), (k) and (o)		
	A2.6	Viscosity added		
	A4.2.1.1	General revision		
	A4.2.1.3	AS1012.12 amendment changed		
	A4.2.1.5	General revision		
	A4.2.2(c)	General revision		
	A4.3.3	Compaction and training requirements added		
	A4.3.7	Hand lances permitted to 4.5 m		
	A5.2.1.3	Use of lots redefined		
	A5.2.3	General revision		
	A4.5.1	New clause		
	A5.2.1.3, A5.2.3, A5.2.4	General revision		
	Annex R84/4	AS 1141.12 added, and revision to items 2.3, 3.3, 4.3.6, 4.5.1,		
	Annex R84/5	New definitions and symbols added		
	Annex R84/8	New annexure		
Ed 2/Rev 6	2.4	RTA Laboratory details updated	GM, IC	23.03.07
	4.4	Requirement for concrete pavement training records added to Hold Point.		
	Annex R84/3, A4.3.3	Training requirements amended to include reference to Concrete Paving Crew Training		
Ed 2/Rev 7	Table R84.1	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 R84/6	Reference to survey requirements changed from "RTA Q" to "RTA G71".		
	Annex R84/5	Abbreviation for ACRS added.		
	Annex R84/7	Reference to G2 changed to Q. ACRS endorsed test certificate for steel reinforcement inserted in Schedule of Identified Records.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 2/Rev 8	2.8 Annex R84/7	Steel reinforcement requirements clarified. Certification requirement for steel reinforcement amended.	GM, IC	11.10.10

Transport Roads & Maritime Services

NSW GOVERNMENT

QA SPECIFICATION R84

CONTINUOUSLY REINFORCED CONCRETE BASE

IC-QA-R84

VERSION FOR:
DATE:

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CLAUSE PAGE

FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from RMS Specification R84 Edition 2 Revision 7.

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 have been 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~~.

RMS QA SPECIFICATION R84

CONTINUOUSLY REINFORCED CONCRETE BASE

1 GENERAL

1.1 SCOPE

This Specification is for construction of the base (upper) layer of continuously reinforced concrete pavement (CRCP), including:

(a) reinforced concrete materials

(b) concrete mix design requirements

(c) process control and manufacture of CRCP

(d) end product criteria for CRCP

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

The elements of (e) are set out in annexures as are the project details, definitions of terms symbols and abbreviations, and a schedule of hold points and witness points.

Limiting values will be interpreted in accordance with the Rounding Method in AS 2706.

1.2 REFERENCES

The standard specifications and test methods referred to are listed in Table R84.1, using abbreviated titles. Unless otherwise specified, the applicable issue of a reference document, unless an RMS specification, will be that current one week before the closing of tenders, or where no issue is current at that date, the most recent issue.

Table R84.1 - Reference Documents

Australian Standards		RMS Specifications	
Concrete Testing	AS 1012	Quality Management System	RMS Q
Aggregate Testing	AS 1141	General Requirements	RMS G2-C2
Soil Testing	AS 1289	Environmental Protection (Management Plan)	RMS G35
Concrete Manufacture	AS 1379	Environmental Protection (Management System)	RMS G36
Concrete Admixtures	AS 1478	Construction Surveys	RMS G71
Method of sampling portland and blended cements	AS 2349	Concrete (for General Use), Mortar and Grout	RMS R53
		Lean-mix concrete subbase	RMS R82
Testing Portland and Blended Cement	AS 2350	Sprayed Bituminous Surfacing	RMS R106
Rounding; Limit Values	AS 2706	Wax Emulsion Concrete Curing Compound	RMS 3202
Concrete Aggregates	AS 2758.1	Preformed joint fillers	RMS 3204
Testing of Supplementary Cementitious Materials	AS 3583	Cements, Binders and Fillers	RMS 3211
		Welding of Bridges and other Road Structures	RMS B204
Curing Compounds	AS 3799	RMS Test Methods	
Quality control – Guide to the use of control chart methods including Cusum techniques	AS 3940	Pavement roughness	RMS T182
		Laser profilometer	RMS T187
		Texture depth by TRL Meter	RMS T192
Quality Control Guide	AS 3942	Ten percent fines	RMS T215
Steel reinforcing materials	AS/NZS 4671	Aggregate least dimension	RMS T235
Hot-dip galvanized (zinc) coatings	AS/NZS 4680	Aggregate fractured faces	RMS T239
Control Chart Methods	AS 4940	Surface texture depth	RMS T240
Quality management systems - Requirements	AS/NZS ISO 9001	Moulding of concrete specimens	RMS T304
		Accelerated AAR assessment	RMS T363
ASTM Standards		Dowel pull-out test	RMS T366
Weathering of sealants	ASTM-C793	Field simulated curing	RMS T367
Peel adhesion of sealants	ASTM-C794	Dressing of voids and adjustment for steel	RMS T368
Density of Plastics	ASTM-D792	Longitudinal profile testing	RMS T369
Rubber hardness	ASTM-D2240	Infrared spectrophotometer	RMS T1005
Petrographic Examination of Aggregates for Concrete	ASTM-C295	Adhesion of sealant	RMS T1192
		Sealant accelerated ageing	RMS T1193
Regulations		AUSTROADS Test Methods	
Road Transport (Mass, Loading & Access) Regulation 1996		ARRB Walking Profilometer	Manual

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. Steel-plant slag is not acceptable.

During the Contract, all aggregate testing must be on samples taken either from dedicated stockpiles or from materials delivered to site.

Within 12 months prior to the date of closing of tenders, all aggregate must be assessed for potential alkali-aggregate reaction and soluble salt content, for which the following conditions apply:

(a) If significant alkali-aggregate reaction is detected by RMS T363, the aggregate may only be used in accordance with the appropriate action nominated in Annexure R84/3.

(b) Chloride and sulphate ion contents must be determined by one of the methods in Annexure R84/3, and aggregates may only be used if the chloride and sulphate contents indicated for the concrete are not greater than 0.8 kg/m^3 and 5% respectively.

2.2 FINE AGGREGATE

Fine aggregate must consist of clean, hard, uncoated grains of uniform quality, and must:

(a) have a size less than AS 4.75 mm sieve;

(b) have at least 50% (by mass) natural sand;

(c) natural sand to have at least 70% (by mass) quartz and chert particles when tested in accordance with ASTM C295, with no more chert than quartz, except as provided under (d);

(d) where an asphaltic surfacing is to be provided, the quartz-chert content of the natural sand must be at least 50%;

(e) comply with AS 2758.1 as qualified hereunder;

(f) comply with Table R84.2. If two or more fine aggregates are to be blended, that from each source must comply with the requirements of this table;

Any manufactured fine aggregate fraction must be crushed from rock complying with Clause 2.3 and must be non-plastic when tested in accordance with AS 1289.3.

Table R84.2 - Fine Aggregate Properties

Property	Requirement	Test method
Bulk Density	1200 kg/m^3 minimum	AS 1141.4[(1)]
Water Absorption	5.0% maximum	AS 1141.5
Soundness	12% max weighted average loss	AS 1141.24
Organic impurities	0.5% maximum	AS 1289.4.1.1-1997
Sugar content	less than 1 part in 10,000	AS 1141.35-1995
Alkali reactivity	As per Clause 2.1	RMS T363
Notes: (1) "Bulk density" in AS 2758.1 means the same as "unit mass" in AS 1141.4.		

2.3 COARSE AGGREGATE

Coarse aggregate must conform to Clause 2.1 and AS 2758.1. The properties of the coarse aggregate must also comply with Table R84.3. If two or more coarse aggregates are to be blended, that from each source must comply with these requirements.

Table R84.3 - Coarse Aggregate Properties

Property	Requirement	Test method
Bulk Density (1)	minimum 1200 kg/m^3	AS 1141.4
Particle Density (2)	minimum 2100 kg/m^3	AS 1141.6
Water Absorption	Slag: 6% max Other: 2.5% max	AS 1141.6
Material finer than 75 μm	maximum 1.0%	AS 1141.12
Particle shape, 2:1 and 3:1 ratios	maximum 25% and 10%	AS 1141.14
ALD for size $< 9.5, \geq 6.7$ mm and $< 6.7, \geq 4.75$ mm	minimum 5.5 mm, minimum 3.8 mm	RMS T235
Wet Strength	minimum 80 kN	RMS T215
Wet/Dry variation	maximum 35%	RMS T215
Weak particles	maximum 0.3%	AS 1141.32
Light particles	maximum 1.0%	AS 1141.31
Slag iron unsoundness	maximum 1.0%	AS 1141.37
Slag dusting unsoundness	maximum 1 in 12 particles	AS 1141.61
Fractured faces (2 or more)	minimum 80%	RMS T239 (3)
Alkali reactivity	see Clause 2.1	RMS T363

Notes:

(1) "Bulk density" in AS 2758.1 means the same as "unit mass" in AS 1141.4.

(2) "Particle density" in AS 2758.1 means the same as "bulk density" in AS 1141.6.

(3) RMS T239 Clauses 6.1, 6.2, 6.3, and 7(b) to (d) may be ignored.

2.4 CEMENT AND FLY ASH

Cement must comply with SL requirements of RMS 3211, unless a blend is approved by the Principal.

Fly ash must be fine grade complying with RMS 3211.

~~A minimum 10 kg representative grab sample of cement to be used in the Works, with records, packaging and labelling as detailed in AS 2349, must be delivered at the start of concrete works to the RMS Chemicals and Materials Laboratory, Unit H, 75 St Hilliers Road, AUBURN, NSW 2144 (phone 02 8745 6038).~~

The Contractor's PROJECT QUALITY PLAN must detail how cement and fly ash supplies will be monitored for compliance.

2.5 ADMIXTURES

Chemical admixtures and their use must comply with AS 1478, but they must not contain calcium chloride, calcium formate, triethanolamine or any other accelerator, unless approved in writing by the Principal. 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) The Contractor's PROJECT QUALITY PLAN must provide details of the criteria for initiating changes in admixture type with season. During the warm season, a lignin or lignin-based ('ligpol') set-retarding admixture (Type Re or WR Re) must be used to control slump. If a retarder is used during the cool season, it must be a lignin Type WR Re containing not more than 6 per cent reducing sugars.

(d) Superplasticisers and high range water reducers Type HWRRe may also be used.

Air-entraining agents are mandatory and must ensure the concrete complies with Clause 3.7.

2.6 CURING COMPOUND

The compound must be either:

(a) C5 hydrocarbon resin compound complying with AS 3799 Class B and with no aromatic hydrocarbon additions, or

(b) water borne hydrocarbon resin or styrene butadiene resin (SBR) complying with AS 3799 Class Z,

(c) bitumen emulsion grade CRS/170 complying with RMS 3254;

except that under an asphaltic or sprayed bituminous surfacing, a category (a) or (c) compound, compatible with the surfacing, must be used.

For paving from November to March, a Type 2 compound must be used which contains titanium dioxide reflective pigment.

At other times, a Type 1-D compound must be used.

Attention is drawn to RMS R141 Clause 3.1 regarding linemarking.

For each nominated curing compound, certify by written report that the compound complies with this Specification, and submit NATA endorsed test results in accordance with Annexure R84/3.

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

Subsequent testing and certification must be in accordance with Annexure R84/3.

2.7 JOINT SEALANT

Joint sealant must be silicone sealant for casting in-situ, complying with the requirements of Table R84.4.

The Contractor must:

(a) certify that the proposed sealant complies with the Specification;

(b) provide all relevant test results endorsed by a registered laboratory;

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

Compliance of each production batch must also be certified by the manufacturer.

Table R84.4 - Silicone Joint Sealants

Test Method	Attribute	Requirements
ASTM-D792 (Method A)	Specific gravity	1.1 – 1.55
ASTM-D2240 (Standard Curing)	Durometer hardness	10 – 25
ASTM-C603	Extrusion rate	90 – 250 g/min
ASTM-C679	Tack free time	30 - 70 mins
ASTM-C793	Accelerated weathering	No chalking, cracking, or bond loss at 5000 HRS.
ASTM-C794	Adhesion to concrete	Minimum 35N average peel strength.
RMS T1193	Accelerated Ageing	
*RMS T1192	Adhesion to concrete	Pre-treatment as per RMS T1193. Extension to 70%, compression to 50%. Not more than 10% failure over the cross-sectional area.
(Not applicable)	Colour	Grey, compatible with pavement concrete.

2.8 STEEL REINFORCEMENT

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

The reinforcement material supplier must be certified by the Australian Certification Authority for Reinforcing Steels for the supply of reinforcement material.

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

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

2.9 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 4, “Limits for Impurities in Mixing Water”, except for the following:

(a) chloride ion: maximum 500 parts per million determined by AS 1478 Appendix D; and

(b) sulfate ion: maximum 400 parts per million determined by AS 1289.4.1.2.

Refer to Annexure R84/3 Clause A2.1.2 for testing requirements.

3 DESIGN

3.1 GENERAL

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 the Contractor will not be entitled to any additional payment.

3.2 SURVEY AT THE TOP OF THE UNDERLYING LAYER

The Contractor must:

(a) measure the base invert levels in accordance with Annexure R84/3;

(b) prior to base paving, submit a Survey Report conforming with RMS G71 and highlighting all locations where the actual level is higher than the design level; and

(c) apply a HOLD POINT to subbase surface debonding treatment and base paving if any high levels exist within the schedule.

In the case of nonconforming levels which are high, the Contractor may locally redesign the pavement levels in accordance with Annexure R84/3, and submit the redesign to the Principal for approval. The Principal will then respond within four (4) working days.

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

HOLD POINT

Process Held	Subbase surface debonding treatment and 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 release.

3.3 MIX PARTICLE SIZE DISTRIBUTION

At least 38% by mass of the total aggregates in the concrete mix must be fine aggregate. The particle size distribution of combined aggregates must comply with Table R84.5, when checked in accordance with Annexure R84/3.

Table R84.5 - Combined Aggregate Particle Size Distribution

AS sieve	Percent passing by mass	AS sieve	Percent passing by mass
19.00 mm	95 – 100	1.18 mm	22 – 34

13.20 mm	75 – 90	600 μm	16 – 27
9.50 mm	55 – 75	300 μm	5 – 12
4.75 mm	38 – 48	150 μm	0 – 3
2.36 mm	30 – 42	75 μm	0 – 2

3.4 BINDER CONTENT

The hydraulic, cementitious binder content must comply with one of the categories listed in Table R84.6, unless an alternative blend is approved by the Principal.

Table R84.6 - Cementitious Binder Content

Mix Category	Flyash (kg/m^3) (1)	Portland Cement (kg/m^3) (1)	Total Binder (kg/m^3) (1)
1. No flyash	Nil	300 minimum	300 minimum
2. Low flyash	30 - 49	290 minimum	320 minimum
3. High flyash	50 - 70	280 minimum	330 minimum
Notes: (1) per yielded cubic metre of concrete			

The Principal may approve an alternative blend of Portland cement, flyash, and/or ground granulated slag (complying with AS 3582.2), subject to:

(a) the total binder requirements in Table R84.6;

(b) provision by the Contractor of supporting technical data, including in-service performance of the binder;

(c) written endorsement from the admixture manufacturer, as to the suitability of proposed admixtures for that binder.

3.5 STRENGTH

The minimum requirements for compressive and flexural strength at 28 days are given in Table R84.7. Maximum compressive strengths are reduced for base thicknesses in excess of 20 mm above the specified thickness as detailed in Clause 5.4.4.

Table R84.7 - Concrete Strengths

Description	Compressive Strength	Flexural Strength (2)
Trial mix concrete		
- Min @ 28 days	40.0 MPa (F_{28Min})	4.7 MPa (F_{f28Min})
- Max @ 28 days	1.45 F_{28Min}	---
Pavement concrete		
- Min @ 28 days	35.0 MPa (f_{cMin})	4.5 MPa (f_{fMin}) (1)

Test methods	AS 1012.8 except: RMS T304 for moulding AS 1012.9 for testing	AS 1012.8 except: RMS T304 for moulding AS 1012.11 for testing
Test specimen size	cylinder 100 mm diameter	beam 100 × 100 × 350 mm
Notes: (1) Specified only for process control, not specified for lot acceptance. (2) Applicable to base pavement mixes only. Not applicable to non-pavement mixes such as anchors and kerbs.		

3.6 CONSISTENCE

Consistence of the concrete must be determined by measuring the slump in accordance with AS 1012.3 Method 1. Nominate a slump for each concrete mix, within the ranges:

(a) 20 - 40 mm for concrete to be slipformed

(b) 55 - 65 mm for concrete to be placed manually.

The slump adopted must allow the production of a dense, non-segregated base with minimal bleeding. Bleed water must not form in sufficient quantity to flow over the slab edge.

For slipform concrete mixes, the Vebe reading must not exceed 3 seconds in the trial mix in accordance with AS 1012.3 Method 3.

3.7 OTHER ATTRIBUTES

Requirements for drying shrinkage, bleeding, air content and compaction are given in Table R84.8.

Table R84.8 - Other Concrete Attributes

Attribute	Test Method	Requirement
Drying shrinkage (1)	AS 1012.13, with compaction by external vibration	450 microstrain maximum @ 21 days in air
Bleeding (1)	AS 1012.6, with compaction by internal vibration	3% maximum
Air content of fresh concrete	AS 1012.4 Method 2, with compaction by internal vibration	4.5 ± 1.5 %
Compaction	Clause 5.2	Relative compaction 98.0% minimum
Notes: (1) To be tested only in the trial mixes.		

3.8 NOMINATED CONCRETE MIXES

3.8.1 Submission of Nominated Mixes

Before commencing production of each base concrete mix,:

(a) conduct trial mixes to demonstrate that the proposed mix designs comply with 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 Vebe);

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

Trial mixing must comply strictly with the Contractor's 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 must be within twelve months prior to paving work. If sufficient production mix results are available from within this period, the Principal may reduce the scope of the trial mix.

HOLD POINT

Process Held:	Production of each concrete mix.
Submission Details:	At least 5 working days before commencing production, submit the statement and attachments referred to in Clause 3.8.1.
Release of Hold Point:	The Principal will consider the submitted documents prior to the Principal authorising release.

WITNESS POINT

Process Witnessed:	Trial mix
Submission Details:	Submission of notice of time and location of mixing at least two (2) working days before mixing.

The following details are required for each 'nominated' mix:-

(i) Material Constituents:

(A) Cement - brand and source.

(B) Fly ash - powerhouse source.

(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 and soluble salt content, in accordance with Annexure R84/3.

(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 trial batch: for each nominated mix (Clauses 3.3 to 3.7), determined at the nominated slump with a tolerance of ± 10 mm and showing conformity for:

(A) cement content and fly ash 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) Vebe reading;

(H) drying shrinkage after twenty one days air drying;

(I) air content, and

(J) bleeding.

All test specimens must be moulded from the same homogeneous batch and using test methods in accordance with Clauses 3.5, 3.6 and 3.7. Strength values must be determined in accordance with Annexure R84/3.

The unit mass must be reported for all specimens tested under items (B), (C), (D), (E) and (F), using test methods specified in Clauses A4.2.1 and A5.2.1.

Test results must certify that the specimens were prepared specifically in accordance with this specification.

3.8.2 Variations to Nominated Mixes

The nominated mix may be varied without submitting a new 'nominated mix', the allowable variations being:

(a) Cement and other cementitious material each up to 10 kilograms per cubic metre, provided that the requirements of Clause 3.4 are still met.

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

(c) Admixture dosages in accordance with Clause 2.5.

(d) Water, unspecified.

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

If the Contractor wishes to vary the quantities of the constituents in excess of the above amounts, or wishes to change the type of admixture or the source of supply of any constituent, submit a new nominated mix in compliance with Clause 3.8.1.

Tolerances on the particle size distribution of aggregates are specified under Process Control, Clause 4.2.1.

4 PROCESS CONTROL

4.1 PLACING STEEL REINFORCEMENT

4.1.1 General

Unless shown otherwise on the Drawings, steel reinforcement must be placed in accordance with Annexure R84/3, located clear of all joints and edges by 70 ± 20 mm, and:

(a) Longitudinal steel must be placed on top of transverse steel and have a top cover of 90 ± 10 mm.

(b) Transverse steel must have a minimum bottom cover of D/2 minus 30 mm, where D is the nominal thickness of the base.

(c) Tiebars must be placed below the longitudinal steel and have a minimum bottom cover of D/2 minus 20 mm.

HOLD POINT

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

4.1.2 Tiebars

Tiebars must be a minimum length of 1.0 m. Drill-ties must be a minimum length of 750 mm.

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 of by vibrating screedboard;

(d) an anchorage strength of at least 85% of the bar's yield strength; and

(e) a location tolerance of ± 25 mm vertically and ± 75 mm horizontally, on all parts of a tiebar.

In longitudinal tied joints, tiebars must be placed:

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

(ii) not closer than 150 mm to a transverse tied joint; and

(iii) to ensure a minimum vertical clearance of 30 mm to any crack inducer (or sawcut).

In transverse tied joints, tiebars must be placed not closer than 100 mm to a longitudinal joint or slab edge.

Testing must be conducted for tiebar location and anchorage, including concrete compaction, in accordance with Annexure R84/3.

4.1.3 Dowels

Dowels, if required, must be installed ahead of paving and must:

(a) be galvanised in accordance with AS/NZS 4680;

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

(c) be coated at one end over a minimum length of L/2 + 50 mm with a tough, durable debonding agent of thickness 0.75 ± 0.25 mm (L = dowel length in mm). At formed joints, the debonding must be within the second-placed slab.

(d) when tested in accordance with RMS 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 (± 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. Details of the proposed dowel support system and the method of debonding must be submitted as part of the PROJECT QUALITY PLAN;

(h) be 450 mm long and be aligned at 90° to the joint, unless otherwise shown in the Drawings;

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

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

Prior to placing concrete, the alignment tolerance of individual dowels at any location as measured in the dowel assembly will be ± 2 mm for two thirds of the dowels within a joint.

In the finished slab, the alignment tolerance on dowel location will be ± 3 mm.

4.1.4 Protective Coatings

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

4.1.5 Bending

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

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 complies with 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 must be 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 R84.8B.

Table R84.8B - 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 400	$4d_b$
• Bars other than in (b) and (c) below	$5d_b$
(b) Bends designed to be straightened or rebent subsequently	
• $d_b \leq 16$ mm	$4d_b$
• $d_b = 20, 24$ mm	$5d_b$
• $d_b \geq 28$ mm	$6d_b$
(c) Bends in reinforcement epoxy coated or galvanised either before or after bending	
• $d_b \leq 16$ mm	$5d_b$
• $d_b \geq 20$ mm	$8d_b$
Notes: 1. "d_b" is the nominal diameter of a bar or wire	

4.1.6 Welding

All welding must comply with the requirements of Specification RMS B204. For Grade 400 & 500 bars, the welding procedure must comply with the bar manufacturer's recommendations for control of heat input.

Welded splices must be tested and must meet the specified tensile strength of the parent metal. Testing must be carried out by a laboratory with appropriate NATA registration.

4.1.7 Lapped Splices

Lapped bars splices not shown in the Drawings must have lengths not less than the values listed in Table R84.8C.

Table R84.8C - Splice Lengths

Bar type	**Bar diameter** (mm)	**Splice length** (mm)
Deformed	12	360
"	16	480
"	20	700
"	24	950
"	28, 32 and 36	1250

Plain (fitment)	d_b < 13 mm	40 d_b or 300 mm whichever is the greater
Notes: 1. "d_b" is the nominal diameter of a bar or wire		

4.1.8 Mechanical Splices

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

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

4.1.9 Storage

Reinforcement must be supported above the surface of the ground, and must be protected from damage and from deterioration due to exposure.

4.1.10 Surface Condition

At the time concrete is placed, the steel must be free from loose or thick rust, grease, tar, paint, oil, mud, mortar or any other coating, but must not be brought to a smooth polished condition. Its surface condition must be such as not to impair its bond to the concrete or its performance in the member.

4.2 PRODUCTION AND TRANSPORT OF CONCRETE

4.2.1 Production Mixes

For producing a concrete mix, always target the nominated design particle size distribution and binder content. The allowable tolerances on coarse and fine aggregates and binder content for the mix are given in Table R84.9.

Notwithstanding these tolerances, the combined aggregate particle size distribution and binder content must comply with Clauses 3.3 and 3.4.

Table R84.9 - Production Tolerances

Description	**Tolerance** (% by mass)	**Description**	**Tolerance** (% by mass)
Particle Size Distribution:		Particle Size Distribution:	
19.00 mm sieve	± 2	2.36 mm sieve	± 10
13.20 mm sieve	± 5	1.18 mm sieve	± 10
9.50 mm sieve	± 5	600 μm sieve	± 10
4.75 mm sieve	± 2	300 μm sieve	± 5
		150 μm sieve	± 2
Binder content	± 3.0		

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.

For the purpose of this clause, concrete delivered by agitators must be considered to be of a different mix to that delivered by tippers.

For each nominated pavement mix[(i)] in use, process control charts must be developed for the parameters listed in Table R84.10.

[(i)] Non-pavement mixes such as anchors and kerbs are excluded.

Table R84.10 - Control Charts

Parameter	Control chart requirements		
	Chart types and controls	**Specifications and criteria**	**Decision rules (2)**
7-day compressive strength	(a) Mean chart, showing:	As per AS 3942 Cl 4.3.2.	
	- target value	Contractor to nominate, based on previous experience.	
	- Lower warning limit	As per Cl A4.2.1.1.	
	- 5-point rolling mean	As per Cl A4.2.1.1.	**A**
28-day flexural strength (7)	(a) Mean chart, showing:	As per AS 3942 Cl 4.3.2.	
	- target value	See Note 5.	
	- Lower warning limit	As per AS 3942 Cl 4.3.2.	
	- specified limits	As per Clause A4.2.1.5.	
	- 5-point rolling mean	As per Clause 4.2.1.5.	**B**
	(b) Standard deviation chart, showing:	As per AS 3942 Cl 4.3.4.	
	- specified limit	As per Clause A4.2.1.5	
	- 5-point rolling standard deviation 's_R'	As per Clause A4.2.1.5.	**B**
Cylinder unit mass	(a) Sample chart, showing:		
	- individual values	See Note 3.	
	- RCUM for the paving trial(s)		
	(b) Mean chart, showing:	As per AS 3942 Cl 4.3.2.	
	- Lower warning limit	LWL = RCUM in the paving trial, less 30 kg/m^3.	
	- RCUM		**A**
	(c) Standard deviation chart, showing:	As per AS 3942 Cl 4.3.4.	
	- process standard deviation 's'	UWL = 15 kg/m^3 See Note 4.	**E**
Fraction passing 0.075 mm sieve(6)	(a) Sample chart, showing:	Based on the calculated combined grading for all possible stockpile combinations.	
	- specified upper limit	Upper limit = 2% (Clause 3.3).	
	- 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 A4.2.1.5.

   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 lot/sublot 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) must be calculated in accordance with Annexure R83/5 on a rolling basis using 100 values (i.e. k=100).

5. Target values 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. This parameter is not applicable to SFRC.

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.

CORRECTIVE ACTION must also be taken if:

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

(ii) the results are not recorded and/or reported within the specified time, or

A HOLD POINT on the use of the relevant concrete mix must be observed if:

(i) the rolling mean 28-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:	Results for compressive and flexural strength, relative compaction and thickness for the same Lot. Also, the proposal for Corrective Action to achieve conformity
Release of Hold Point:	The Principal will release the Hold Point when appropriate Corrective Action has been implemented.

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

4.2.2 Mixing, Transport, Consistence and Air Content

The Contractor's PROJECT QUALITY PLAN must detail 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 of charging must be consistent with the recommendations of the suppliers of mix additives.

The handling, storing and batching of materials and the mixing, transport and consistence of concrete, including any "retempering", must comply with AS 1379 (Section 4 and Appendix A), Annexure R84/3 and the following conditions.

Mixing time

(a) The minimum mixing time must be determined from mixer uniformity testing in accordance with Annexure R84/3, noting:

(i) for stationary batch mixers, the mixing time must not be less than 54 seconds plus 6 seconds for each cubic metre (or part thereof); and

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

For mixers which do not have a certified compliance plate, the mixing time must be at least 3 $^{1}/_{2}$ minutes.

(b) The maximum mixing time will be five (5) minutes for split drum mixers, or ten (10) minutes otherwise.

Admixture addition

(c) Admixtures must be separately and thoroughly prediluted in the mixing water prior to their introduction to the other materials. They must then be mixed in accordance with the manufacturer's instructions, and by a method which ensures that no adverse interaction occurs. The Contractor's PROJECT QUALITY PLAN must detail how admixtures will be incorporated to comply with this requirement.

Batch delivery docket

(d) Each batch or load of concrete must be accompanied by 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 Annexure R84/5. Depending on the mixer and transport types, this may require the recording of times for charging, and/or mixer discharge and/or slump adjustment.

The Contractor's PROJECT QUALITY PLAN must detail how this will be monitored for compliance.

Subsequent addition of water (retempering) in accordance with paragraph (f) below and Annexure R84/3 must be deemed to have taken place after completion of batching.

Transport capacity

(e) For slipform paving, sufficient transport capacity must be provided to enable continuous paving at a speed of at least one (1) metre per minute.

Consistence (slump)

(f) Consistence must be tested by the slump test in accordance with Annexure R84/3 within the following times as measured from the completion of batching and as appropriate for temperature of concrete as follows:

- For temperature ≤ 25°C: 40 minutes
- For temperature > 25°C: 30 minutes

Concrete temperature must be measured at the commencement of discharge of a batch at intervals not exceeding 60 minutes throughout the paving operation. The latest value must apply.

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

- 10 mm for slipformed concrete
- 15 mm for manually placed concrete.

The Contractor must record all slump test results, and must not use nonconforming concrete in the Works. The Contractor's PROJECT QUALITY PLAN must detail how concrete supply will be monitored for compliance with the retempering provisions in Annexure R84/3.

Forming time

(g) The Contractor must determine a maximum forming time (as defined in Annexure R84/5) for each nominated mix in order to achieve the requirements of Clause A4.2(c) with consideration of the prevailing weather conditions and concrete temperature and the requirements of Annexure R84/3 Clause A4.2.2. The procedure to determine the "maximum forming time" must be included in the PROJECT QUALITY PLAN.

The Contractor must monitor the actual "forming time" and record it for any batch exceeding:

- 90 minutes for air temperatures less than 30°C;
- 45 minutes for air temperatures greater than or equal to 30°C.

Conformity of such a batch will be conditional on the conformity for compaction and compressive strength of cores from that specific batch.

Air content

(h) Air content must be tested in accordance with Annexure R84/3 for conformity with Clause 3.7.

4.3 PAVING CONCRETE

4.3.1 Slipform (Mechanical) Paving

Paving must be carried out by the slipform method where practicable, using equipment in accordance with Annexure R84/3. Details of the equipment and methods to be used for placing, spreading and finishing the concrete base must be submitted as part of the PROJECT QUALITY PLAN, including the parameters nominated in Annexure R84/3 for each of the proposed slipform paving configurations.

The Contractor must:

(a) 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,

(b) co-ordinate the delivery, spreading and paving activities to maintain the continuous and uniform progress of the paver;

(c) record details of any interruptions to the progress of the paver, including the reason, location, and duration; and

(d) form a transverse construction joint in accordance with Clause 4.5.1, 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, such concrete must be removed and replaced 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 (such as, but not confined to, transverse construction joints) where the paver is unable to fully compact and finish the concrete, supplementary manual vibration must be provided, with operating parameters in accordance with Clause 4.3.2. The number of standby vibrators must be not less than one fourth of the number in use, with a minimum of one.

Program slipform and manual paving operations to ensure that the ride quality of the finished pavement is optimised.

4.3.2 Manual (Fixed-Form) Paving

Details of the equipment and methods to be used for placing, spreading and finishing the concrete base must be submitted as part of the PROJECT QUALITY PLAN, including the parameters nominated in Annexure R84/3.

Forms must be designed and constructed so that they can be removed without damaging the concrete and must be braced in a substantial and unyielding manner. Forms must be mortar tight and debonded to ensure non-adhesion of concrete to the forms. They must be set to tolerances equivalent to those specified for the finished base surface.

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

The concrete must then be compacted by internal vibrators with the following operating parameters:

(a) a minimum diameter of 50 mm, and

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

(c) by regular and systematic insertions using one of the methods shown in Table R84.10A Column 1.

Establish and document suitable vibrator operating parameters for the specific site conditions in order to yield consistent conformity under Clause 5.2. Prior to the demonstration of such conformity, the guideline parameters listed in Table R84.10A Column 3 must be adopted.

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

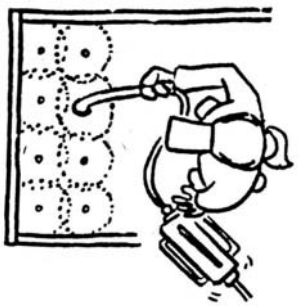
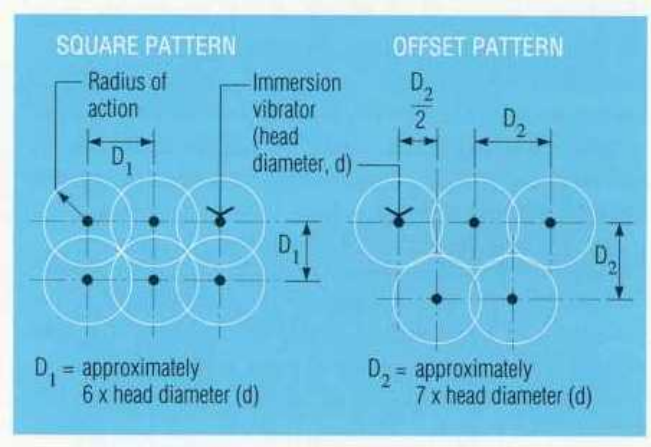
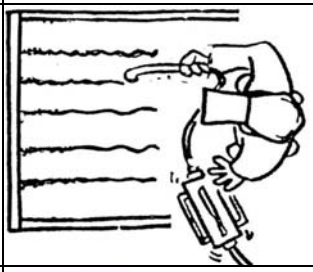
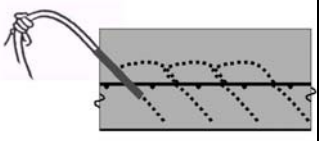
The slab must then be compacted and finished by at least two passes of a hand-guided vibratory screed traversing the full width of the slab on each pass.

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

Power trowelling of the surface will not be permitted.

If an interruption to paving occurs which is likely to result in a loss of integrity in the concrete mass, form a transverse construction joint in accordance with Clause 4.5.1. Should subsequent testing at the location of an interruption indicate the presence of non-uniform or nonconforming concrete, such concrete must be removed and replaced in accordance with Clause 5.6.

Table R84.10A – Internal Vibration Methods

Method	Diagram	Guideline Parameters [1]
1 Dip method		(a) insertions using one of the following patterns, where the spacings D_1 and D_2 must be 300 mm maximum, and (b) insertion durations of 10 secs minimum, and (c) withdrawal speed not exceeding 1.5 m/min.  Source [ii]
2 Drag method		(a) vibrator paths at spacings of 350 mm maximum, and (b) travel speed of 1.5 m/min maximum.
2M Modified Drag method (for reinforced pavement)	 (Section view)	(a) vibrator paths at spacings of 350 mm maximum, and (b) insertion spacings of 350 mm maximum, and (c) nett horizontal travel speed of 1.5 m/min maximum, and (d) withdrawal speed not exceeding 1.5 m/min.

Notes:

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

4.3.3 Placing and Paving Operations

Anchors must be constructed at the locations shown on the Drawings, and in accordance with Clause 4.8.

ii Source: "Concrete Practice on Building Sites". SAA Handbook HB67 – 1995, jointly as Cement & Concrete Association publication C&CAA T43 (1995).

The subbase surface on which concrete base is to be placed must be treated with debonding agent in accordance with RMS R84, and must be clean and free of loose or foreign matter.

Maintain records showing the location of each batch/load of concrete in the finished work, in accordance with RMS Q. The system must be sufficiently accurate to enable subsequent identification of specific batches/loads for examination and/or testing. Details must be submitted as part of the PROJECT QUALITY PLAN.

Details of the equipment and methods to be used for placing and paving the concrete base must be submitted as part of the PROJECT QUALITY PLAN, including the parameters nominated in Annexure R84/3.

4.3.4 Temperature and Rain

Measure and record concrete temperature at the point of placement and air temperature in the shade. The air temperature must be taken outdoors at a location remote from artificial influences such as machinery.

Concrete must not be placed in the Works during rain or when rain appears imminent or when the air temperature in the shade is below 5°C or above 36°C.

Concrete must not be placed in the Works if its temperature at the point of discharge from transport vehicles is less than 10°C or more than 32°C, except as follows.

Where 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 must be 30°C.

4.3.5 Prevention of Moisture Loss

The Contractor's PROJECT QUALITY PLAN must identify 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 Annexure R84/3.

Should the Contractor elect to use an evaporation retarder to restrict the evaporation of water, it must be applied by a fine uniform spray. Any subsequent finishing operations must be carried out so as not to incorporate the evaporation retarder into the surface mortar.

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

4.3.6 Texturing of surface

Unless specified otherwise in Annexure R84/1, texture the surface both longitudinally and transversely in accordance with Annexure R84/3 to produce average texture depths as given in Table R84.11.

Table R84.11 - Specified Average Texture Depths

Direction	Texture Depth	Test Method (1)
Longitudinal (2, 3)	0.40 ± 0.05 mm	RMS T192
	or alternatively, 0.55 ± 0.05 mm	RMS T240
Transverse (3, 4)	0.45 ± 0.05 mm	RMS T192
	or alternatively, 0.65 ± 0.15 mm	RMS T240

Notes:

(1) Texture testing is exempt from the requirement in RMS Q for NATA registration.

(2) Testing of longitudinal texture (alone) is required only where transverse texturing is not specified; Annexure R83/1 refers.

(3) The specified values for "transverse" are for total texture including that from longitudinal texturing where it has been specified.

Areas with less than the specified transverse texture to conform to this Specification.

4.3.7 Curing

The base must be cured by the application of a sprayed curing compound applied soon after texturing, and in accordance with the following conditions:

(a) The curing compound must form a continuous and unbroken film, and be applied uniformly in two applications:

(i) the first within 15 minutes of the surface reaching the "low sheen" bleed water condition, and

(ii) the second 10 to 30 minutes later or as recommended by the manufacturer.

(b) On fixed-formed surfaces, the first application must be within 30 minutes of stripping and the second must be 15 to 45 minutes later.

(c) Spraying equipment must comply with Annexure R84/3. Fully operational spraying equipment will be a pre-condition for paving to proceed;

(d) Each application must be at the rate stated on the test certificate for curing efficiency, subject to a minimum value of 0.20 L/m^2, except that:-

For areas sprayed by other than a mechanical sprayer, the application rate must be 25% higher than the rate stated on the test certificate for curing efficiency, subject to a minimum value of 0.20 L/m^2.

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.

(e) The application rate must be tested in accordance with Annexure R84/3. Any section on which the application does not conform must be resprayed within six (6) hours of testing, at an application rate not less than twice the deficiency in the original application. The respray must be tested as specified for the first application.

(f) The curing film must be maintained intact in a continuous and unbroken membrane until an insitu strength of 30 MPa is achieved. Any damage to the curing membrane must be made good by handspraying of the affected area.

Additionally, any adjoining hardened concrete of age less than 7 days adjoining the commencement of each paving run (and noting that film damage may not be readily apparent), must be resprayed with a single application for a minimum distance of 7 m and extended to areas trafficked by persons during placement at the construction joint.

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

4.3.8 Protection of Work

4.3.8.1 Temperature

Undertake continuous surface temperature monitoring for the first 24 hours after placement to ensure that the temperature of the concrete does not fall below 5°C. The true surface temperature must be measured at two or more locations within each day's paving, using purpose-made surface thermometers.

Details of the procedures and equipment proposed for the protection of concrete from low air temperatures, must be submitted as part of the PROJECT QUALITY PLAN. Failure to maintain the temperature of the concrete at or above 5°C will constitute a Nonconformity under the Contract.

4.3.8.2 Rain

Protect the work from rain damage, and details of the procedures and equipment proposed must be submitted as part of the PROJECT QUALITY PLAN. The protective equipment must be kept on site ready for use at short notice by experienced personnel.

Concrete must be deemed nonconforming if it is exposed to rain within the period from tipping to application of curing compound (or suitable alternative protection such as covering). Beyond this time, rain-exposed surfaces must be assessed under the finished surface criteria of this specification.

4.3.8.3 Anchor slabs

Regardless of temperature levels, the base above anchors must be thermally protected for a minimum of 24 hours after placement by covering with impermeable sheeting. The covering must include vertical edges and not less than one-half of any adjoining base slab which was cast at the same time. The covers must be adequately fastened around all edges to prevent air flow under them.

4.3.8.4 Trafficking of the Base

Trafficking of the base (including foot traffic) must be strictly controlled according to the insitu concrete strength and to minimise damage to the curing compound. Non essential traffic must not have access until an in-situ compressive strength of 30 MPa is reached.

Essential traffic must be controlled 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) Other vehicles must not have access until 20 MPa compressive strength is reached and all joints have been permanently sealed, and then the following limits will apply:

axle loads - 5.0t single, 8.0t tandem, 9.0t triaxle

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

(c) Higher axle loadings, limited in accordance with Road Transport Regulations, may be applied after 30 MPa compressive strength is reached and all joints have been permanently sealed.

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

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

Insitu strength assessment must be made in accordance with Annexure R84/3 and at a frequency selected by the Contractor to suit his construction program. Upon determination of the insitu strength of any lot, all concrete placed prior to that lot using the same concrete mix may be assumed to have achieved an equivalent strength.

Any test cylinders used for assessing in-situ concrete strength must be moulded, cured and tested in accordance with RMS T367.

If cores taken for compaction testing are used, strength testing must be subject to the conditions of Clause 5.3.

A HOLD POINT will apply to trafficking of the base at both the 20 MPa and the 30 MPa compressive strength levels.

HOLD POINT	
Process Held:	Trafficking of base
Submission Details:	In-situ strength test results of the base
Release of Hold Point:	The Principal will consider the submitted results, prior to authorising the release of the Hold Point within 2 working days of receipt of the results.

Any damage caused to any part of the work by the Contractor's operations must be rectified to produce a dense, homogeneous concrete base with the specified surface finish and texture. The cost of rectifying such damage must be borne by the Contractor.

Failure to comply with this clause will constitute a Nonconformity on the base concrete under the Contract.

4.4 CONCRETE PAVING TRIAL

Prior to normal concrete base paving, construct a trial section of concrete base using the nominated materials, concrete mix, equipment and methods. Concrete strength testing for the trial must be conducted in accordance with Annexure R84/3.

Give the Principal 7 days written notice of his intention to commence:

(a) the trial paving;

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

For mechanical paving, a trial section of between 50 and 100m in length must be constructed in one continuous operation. Separate trials are required for each paver.

For manual paving, a trial section of between 15 and 50m in length must be constructed, with a $20m^3$ minimum volume.

If the trial is conducted at a paving width of less than 70 per cent 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 (excluding results for compressive and flexural strength), and concrete pavement training records in accordance with Specification RMS G2-C2.
Release of Hold Point:	The Principal will inspect the trial and consider the submitted documents, prior to authorising the release of the Hold Point.

If the trial section conforms with the Specification, it will be accepted as part of the work. If the relative compaction of the trial section is less than 98.0%, the trial section must be removed and a new trial section constructed, 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 the first.

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

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

(b) the concrete base fails substantially to comply with the Specification.

4.5 JOINTS AND EDGES

Detritus from sawcutting operations must be managed in accordance with Specification RMS G35 or RMS G36, as applicable.

4.5.1 Sealants

Sealants must be handled and installed 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 (air and concrete) at installation;

(c) condition (both moisture and cleanliness) of the joint faces at installation, together with guidelines for their assessment;

(d) requirements for priming of the face;

(e) tooling requirements;

(f) minimum trafficking age.

The dimensions of the cured sealants must be in accordance with the Drawings and must be tested in accordance with Annexure R84/3.

4.5.2 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 paving 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-metre straight-edge;

(c) be constructed at 90°± 5° to the longitudinal joint, with the joint face corrugated and square (±5°) to the finished top surface of the base;

(d) 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, the length of bar inserted must be not less than 0.25 m, and a suitable epoxy mortar must be used giving an anchorage strength of at least 85% of the yield strength of the bar;

(e) be formed by sawcutting if the concrete has previously hardened, with the face of the joint scabbled to expose the coarse aggregate (excluding the upper and lower 50 ± 5 mm), in lieu of corrugations. The roughened surface and projecting reinforcement must be cleaned, with all loose material and excess water removed;

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

(g) have the face of the joint debonded in accordance with Annexure R84/3 to prevent intimate microtexture bond.

4.5.3 (Not Used)

4.5.4 Expansion Joints

Expansion joints must be provided as shown on the Drawings, to a position tolerance of 25 mm, and 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-metre straight-edge;

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

(c) be treated with joint filler, complying with RMS 3204, and joint sealant installed in accordance with Annexure R84/3 Clause A4.5.2, except that references to backer rod will apply only where shown on the Drawings;

(d) be maintained at all times free of incompressible and foreign materials. At free edges, the sealant must extend down the full vertical face of the joint. At other edges, the filler must prevent the ingress of concrete to the joint space during subsequent work.

4.5.5 Longitudinal Joints

Longitudinal joints must be provided as shown on the Drawings, to a position tolerance of 25 mm, and 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-metre straight-edge 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 (± 5°) to the finished top surface of the base, and corrugated unless otherwise specified;

(ii) have the face of the joint debonded in accordance with Annexure R84/3 to prevent intimate microtexture bond.

(iii) 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.

(d) for induced joints;

(i) be provided by sawcutting to a width of 3 mm in accordance with Annexure R84/3.

(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 (ie each side of the joint assessed separately).

(iii) be cleaned and sealed in accordance with Annexure R84/3. Sealing must include the full vertical face at the ends of sawcuts.

4.5.6 Isolation Joints

Isolation joints must be provided as shown on the Drawings, to a position tolerance of 25 mm, and must:

(a) where indicated on the drawings, 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-metre straight-edge;

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

(c) be treated with joint filler, complying with RMS 3204, and joint sealant installed in accordance with Annexure R84/3, except that references to backer rod will not apply;

(d) be maintained at all times free of incompressible and foreign materials. At free edges, the sealant must extend down the full vertical face of the joint. At other edges, the filler must prevent the ingress of concrete to the joint space during subsequent work.

4.5.7 Mismatched Joints

Mismatched joints may only be constructed as shown on the Drawings. Untied joints must not be allowed to form mismatched joints.

4.5.8 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-metre straight-edge, after due allowance for any planned curvature;

(c) have face geometry complying with Clause 4.5.4, but having corrugations and tiebars only if and as specified on the Drawings.

Each outer edge must be tested for alignment conformity at random locations and at a frequency not less than the following, commencing with trial paving and thereafter independent of the boundaries to Lots:

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

(b) one test per 50 lin m of edge.

Upon detection of nonconformity, the testing frequency must revert to (a).

4.6 KERB AND GUTTER

Kerbs and/or gutters must be constructed in accordance with R15 and as shown on the Drawings, and subject to the following conditions:

(a) kerbs of type SA, SB, SC, SE, SK, and SL must not to be extruded unless specifically allowed on the Drawings;

(b) concrete for the above kerb types must comply either with this specification or with AS 1379 for normal-class concrete with strength grade N32, 20 mm aggregate, unless specified otherwise in the Drawings or RMS R53;

(c) kerb longitudinal joints to comply with Clause 4.5.4 (including debonding of formed joints), but the rounding of the kerb or gutter lip must not be greater than 5 mm, even if a larger rounding is shown on the kerb Drawings;

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

(e) at all kerb joints, the first-placed joint face to 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 an isolation joint in accordance with the Drawings.

4.7 SPECIAL SLABS

4.7.1 (Not Used)

4.7.2 (Not Used)

4.7.3 Bridge Approach Slabs

Bridge approach slabs as shown on the Drawings must be constructed at bridge abutments.

4.8 TERMINAL AND SLAB ANCHORS

Terminal and slab anchors must be constructed as shown on the Drawings, and subject to the following conditions:

(a) the anchor must be cast at least 48 hours before the overlying pavement base;

(b) the trench must be trimmed to neat lines, be free of loose soil material, and be recompacted at the bottom to at least match the adjacent undisturbed material;

(c) concrete must comply either with this specification or with AS 1379 for normal-class concrete with strength grade N32, 20 mm aggregate, and slump at the point of placement between 40 mm and 80 mm;

(d) concrete must be placed and compacted using internal vibration in accordance with Clause 4.3.2;

(e) anchor stirrups must be lapped (as defined) to the base reinforcement, which must not have other laps within 1.1 m of the anchor axis;

(f) at the junction with an existing flexible pavement, a straight sawcut to the full depth of any asphaltic concrete must be made 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;

(g) anchors must be marked by imprint into the surface of the pavement base with the letter "A". The stamp must be placed 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 ± 1 mm below the circular surround.

5 END PRODUCT CRITERIA

5.1 CONCRETE CRACKING

Detail in the PROJECT QUALITY PLAN the inspection schedule for cracking in base concrete. Cracking is categorised in the form of:

(a) 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 (ie not an induced joint).

(b) Planned cracks other than induced joints - full depth discrete transverse cracks without branches or convergences over the full width between longitudinal joints or edges. These cracks do not require any treatment.

Plastic shrinkage cracks, with a cumulative length of one metre or less in any 5 m x 5 m square area of base, must be filled with a suitable low viscosity penetrating epoxy resin, within 7 days of casting of the concrete.

Planned cracks forming induced longitudinal joints must be treated in accordance with Clause 4.5.4.

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

5.2 CONCRETE COMPACTION

5.2.1 Conformity for Compaction

Lot definition for compaction is the same as that in Clause 5.3.1, except for Transition Zones in slipformed work.

For the purpose of compaction testing, Transition Zones must be treated as separate lots of work according to the following rules:

(i) At each transverse construction joint in slipformed work, two discrete Transition Zones will occur, one on each side of the joint, each for a length of 3 m or as otherwise nominated under Clause A4.3.3(viii).

(ii) Transition points which are remote from transverse construction joints, will be treated as if the transition point is a joint (ie two lots as in (i) above).

Testing for compaction must be undertaken in accordance with Annexure R84/3.

A lot will conform for compaction if:

(a) the relative compaction is at least 98.0%, determined as the percentage ratio of the core unit mass of the lot to the rolling cylinder unit mass (RCUM) for the lot; and

(b) the within-core variability does not exceed 40 kg/m^3, determined in accordance with Annexure R84/3.

For nonconforming lots:

(A) If the relative compaction is between 97.0% and 98.0%, the lot will be accepted if the 28-day compressive strength of core specimens from that lot conforms to Clause 5.3.

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

(C) If the only nonconformity is the within-core variability, the lot will be accepted subject to Corrective Action being taken in the compaction process, in accordance with Clause 4.3.1 or 4.3.2 as appropriate.

5.2.2 Repair of Core Holes

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

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 estimated compressive strength of 15 MPa.

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

5.2.3 Core Testing for Unit Mass

The unit mass of the cores must be determined in accordance with Annexure R84/3.

5.3 CONCRETE COMPRESSIVE STRENGTH

5.3.1 Lot Definition

A 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 hand-paved base.

5.3.2 Cylinder Strength Testing

For each lot of base, two pairs of cylinder test specimens must be moulded for compressive strength testing, one at 7 and the other at 28 days. 7-day testing is covered by Clause 4.2.1.

Testing for cylinder strength must be undertaken in accordance with Annexure R84/3. Moulding of specimens must be in accordance with Table R84.7.

5.3.3 Core Strength Testing

If required in accordance with Clause 5.2.1(A), testing for core strength must be undertaken in accordance with Annexure R84/3.

5.3.4 Conformity for Compressive Strength

5.3.4.1 Test Cylinders

If the 28-day compressive strength of test cylinders for any lot is less than $0.9f_{cMin}$, the lot represented by the test cylinders must be removed and replaced in accordance with Clause 5.6.

Concrete with a 28-day cylinder strength between $0.9f_{cMin}$ and f_{cMin} occurring during the progress of the contract will be accepted subject to a deduction, provided that it represents less than 5% of the area of the appropriate slip formed, hand-paved or transition zones base placed up to and including that lot. Such concrete will be subject to a deduction 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

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

A nonconforming lot 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 lot is greater than or equal to f_{cMin}, and

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

(c) the total area of such a lot comprises less than 5% of the area of base placed up to and including that lot, and

(d) the deficiency in strength will be based on the lowest corrected core strength result from that lot, and

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

Nonconforming lots which are not accepted must be removed and replaced in accordance with Clause 5.6.

5.4 GEOMETRY AND THICKNESS

5.4.1 Alignment Tolerances

Within 4 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 4.5 for the outer edges of the base, and for joints.

If nonconformity is detected, immediately implement Corrective Action in accordance with the Quality Management System Requirements.

5.4.2 Level Survey

Within 24 hours of placing an area of concrete base, survey the surface levels for conformity of the base surface and thickness. Rectification of nonconformity must comply with Clause 5.7.

The level at any point on the top of the base must not vary by more than 20 mm above or 0 mm below the design level (+20, -0 mm).

Levels must be assessed within lots which correspond to those established under Clause 5.3.1. Departures from the design level must be rounded to the nearest 5 mm. A lot will be nonconforming if it contains any individual nonconforming levels and must be assessed in accordance with Annexure R84/3.

5.4.3 Thickness Assessment

Thickness must be assessed within lots which correspond to those established under Clause 5.3.1. Base thickness at individual survey points selected in accordance with Annexure R84/3 Clause A5.4.2.1 must be calculated as the difference between the finished base level and the base invert level using survey results complying with Clause 3.2.

The calculated thickness must be adjusted to allow for the design surface longitudinal and transverse slopes between the two surveyed points. The Contractor's PROJECT QUALITY PLAN must include the method of determining the thickness with adjustment.

Base thickness must also be measured on the cores taken for compaction testing. The measured thickness must be adjusted in accordance with Clause A3.2.4 to remove the contribution of the interlayer treatment.

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 to 2.5 m, the core result must be accepted and the survey result culled from the assessment. If the frequency of such occurrences is higher than 3 in any group of 10 consecutive comparisons, the surveys must be deemed to be nonconforming.

In areas where the thickness calculated from survey results is non-conforming, and no representative cores are available for comparison, the Principal may authorise the drilling of 40 mm diameter cores. Do not take additional cores for the purpose of thickness assessment without the prior approval of the Principal.

The mean thickness for each lot must be calculated using all results for the lot (to the nearest 1 mm) which have not been culled. The mean must be rounded to the nearest 5 mm.

For the purpose of assessing thickness conformity, individual deficiency results must then be rounded to the nearest 5 mm.

5.4.4 Conformity for Thickness

Lots must be assessed for thickness in accordance with Table R84.12.

Table R84.12 - Assessment Criteria for Thickness

Text Reference	Thickness deficiency (mm)				Status/ Action
	Mean (mm)		Individual (mm)		
			Result	Frequency	
Conformity with Cl 5.4.3	Nil	⇦ and ⇨	5 and ≥ 10	≤ 2 Nil	Conforming
Nonconformity	Nil	⇦ and ⇨	5 and 10 to 15	> 2 Nil	Nonconforming 12% deduction
Nonconformity	Nil	⇦ and ⇨	5 and ≥ 20	> 2 Nil	Nonconforming, 45% deduction
Nonconformity	Nil	⇦ and ⇨	10 to 15 and ≥ 20	≥ 1 Nil	Nonconforming, 45% deduction
Nonconformity	5	⇦ and ⇨	≥ 20	Nil	Nonconforming, 24% deduction
Nonconformity	≤ 10	⇦ and ⇨	≥ 20	≥ 1	Nonconforming, remove and replace
Nonconformity	10	⇦ and ⇨	≥ 20	Nil	Nonconforming, 60% deduction
Nonconformity	≥ 15				Nonconforming, remove and replace

5.5 SURFACE PROFILE

5.5.1 Transverse Profile

Deviations under a 3 m straight-edge laid in the transverse direction 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, the straight-edge must be placed so that the cantilever length does not exceed 0.75 m.

Conformity with the straight-edge criteria must be tested as follows, commencing with trial paving:

(a) within each day's paving at random locations at a minimum frequency of:

  (i) one test per 15 lin m of paving run, until four conforming results are recorded; and thereafter

(ii) one test per 50 lin m of paving run.

Upon detection of a nonconformity, testing frequency must revert to (i);

(b) across longitudinal joints, at a minimum frequency of:

(i) one test per 15 lin m of joint, until four conforming results are recorded; and thereafter

(ii) one test per 50 lin m of joint.

(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

Deviations under a 3 m straight edge laid in a longitudinal direction must not exceed 5 mm.

As a minimum requirement, the longitudinal surface profile must be tested in accordance with RMS T369 and assessment must be undertaken in the following areas:

(a) within 15 m each side of transverse construction joints;

(b) at approach sections (as defined).

The limit of profile testing must be extended (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 but assessment for payment deduction purposes will be limited to the first level recorded beyond the limit of contract;

(c) at all slab replacements, including 10 m beyond the replacement in each direction.

The requirements for surface correction will be as follows.

(i) For areas which are high by 10 mm or more, grinding will be mandatory. Such grinding may be used under Clause 5.5.3 to reduce the level of deduction or to increase the level of incentive payment.

(ii) For areas which are high by less than 10.0 mm, grinding may be carried out at the Contractor's discretion. 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 must be carried out in accordance with Clause 5.7.

5.5.3 Roughness

5.5.3.1 Testing

After completion of grinding under Clause 5.5.2, the ride quality of the finished surface must be assessed by the measurement of roughness using a vehicle-mounted:

(a) NAASRA Roughness Meter in accordance with RMS T182; or

(b) laser profilometer in accordance with RMS T187.

The timing of roughness testing must also comply with Clause 4.3.8.4. Roughness must be measured within the sections nominated in Table R84.13, at a testing speed of:

(i) 50 km/h where the posted speed limit is less than 80 km/hr; and

(ii) 80 km/h where the posted speed is 80 km/h or greater.

The roughness value for any lot must be the average of three survey runs over that 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 Clause 5.5.2(b). No area will be assessed for deduction on both tests.

Table R84.13 - Pavement Roughness Categories (PRC)

Nominated pavement section		PRC
Through carriageways	trafficked lanes (3)	1
	shoulders (2)	3
Ramps (2)	within gore areas:(4)	3
	beyond gore areas:(4) - speed limit ≥ 80 km/h - speed limit < 80 km/h	2 3
Minor roads (2)	speed limit ≥ 80 km/h	3
	speed limit < 80 km/h	4
Project specific areas (1)		
Under asphalt surfacing (5)		5

Notes:

(1) Values to be provided, if applicable, by the Principal. Some areas may not be assessable. Annexure R83/1 refers.

(2) Shoulders on ramps and minor roads are not to be separately assessed.

(3) See Clause 5.5.3 for possible exemption of approach sections.

(4) Unless otherwise specified, the gore kerb nose will be the limit of the gore area.

(5) The Principal may elect to add further areas which will be asphalt surfaced at a later date under separate contract; see Annexure R83/1.

Through carriageways refer to Parkways and Arterial roads.

5.5.3.2 Assessment

In accordance with Clause 5.5.3.1, base must be assessed for roughness (according to Table R84.14) and/or profile (according to Table R84.15).

Segments of base which score a positive (+) value will earn an incentive payment. Segments which score a negative (-) value are deemed non-conforming but may be accepted subject to a deduction as follows.

An incentive/deduction value for roughness must be calculated for each segment in accordance with Table R84.14, Pay Items R84P10 and R84P11.1, and Annexure R84/3 except that:

(a) Approach sections as classified under Clause 5.5.2(b) which are tested for profile in lieu of roughness will be subject to a deduction in accordance with Table R84.15 and Pay Item R84P11.1;

(b) Sections which are tested for both profile and roughness (as per Clauses 5.5.2(a) and (c)) will be assessed only on the basis of roughness;

(c) An incentive/deduction will not apply to any area of a segment which is removed, for whatever reason, at no cost to the Principal;

(d) For base which is non-conforming for criteria other than roughness:

(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;

(e) Replacement base (as covered by Clause 5.6) must be assessed for both incentive and deduction.

Surface grinding in accordance with Clause 5.7 must be carried out where specified in Table R84.14.

Table R84.14 - Incentive/Deduction Levels

NAASRA Roughness **R** (counts per km)	**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	+ 3.0	+ 3.0	+ 3.0	+ 3.0	0
20 ≤ R < 25	+ 2.0	+ 2.0	+ 2.0	+ 2.0	0
25 ≤ R < 30	+ 1.0	+ 1.0	+ 1.0	+ 1.0	0
30 ≤ R < 35	+1.0	+ 1.0	+ 1.0	+ 1.0	0
35 ≤ R < 40	0	0	0	+ 1.0	0
40 ≤ R < 45	– 2.0	0	0	+ 1.0	0
45 ≤ R < 50	– 2.0	– 1.0	0	0	0
50 ≤ R < 55	– 4.0	– 3.0	– 2.0	0	0
55 ≤ R < 60	– 8.0	– 5.0	– 2.0	0	0
60 ≤ R < 65	– 16.0	– 8.0	– 4.0	– 1.0	0
65 ≤ R < 70	Grind	– 12.0	– 8.0	– 4.0	– 2.0
70 ≤ R < 75	Grind	– 16.0	– 16.0	– 8.0	– 4.0
75 ≤ R < 80	Grind	Grind	Grind	– 12.0	– 8.0
80 ≤ R ≤ 85	Grind	Grind	Grind	– 16.0	– 12.0
R > 85	Grind	Grind	Grind	Grind	– 16.0

Notes:
(1) Categories defined in Table R83.13.

Table R84.15 - Deduction for Surface Profile

Profile Index **(PI)** (mm/km)	Deduction (%)			
	PRC 1 (1)	**PRC 2** (1)	**PRC 3** (1)	**PRC 4** (1)
≤ 450	0	0	0	0
451 – 500	– 2.0	– 2.0	0	0
501 – 550	– 4.0	– 4.0	– 2.0	0
551 – 600	– 6.0	– 6.0	– 4.0	– 2.0
601 – 650	– 8.0	– 8.0	– 6.0	– 4.0
> 650	– 10.0	– 10.0	– 8.0	– 6.0

Notes:
(1) Categories defined in Table R83.13.

5.6 REMOVAL AND REPLACEMENT OF CONCRETE BASE

Detritus from sawcutting operations must be managed in accordance with Specification RMS G35 or RMS G36, as applicable.

5.6.1 General

Where nonconforming base is to be removed and replaced, submit the proposed method with the nonconformity report at least 7 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.

Replacement of nonconforming base must be in full slab widths between longitudinal joints and/or external edges.

Paving must be carried out by the slipform method where practicable.

5.6.2 Removal and Disposal of Base

At each end of the section to be removed a transverse sawcut must be made:

(a) in a straight line and continuous between adjacent longitudinal joints and at an angle of not less than 85^{o} to the longitudinal joint, and

(b) to a depth of 50 ± 5 mm; and

(c) at a location not closer than 500 mm to an existing transverse crack in the concrete which is to remain.

(d) without oversawing into the adjacent base or the underlying subbase.

The concrete must be removed 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, and

(ii) not less than 1.0 m of every longitudinal bar is left protruding and undamaged beyond those joints.

At each longitudinal edge of the nonconforming base the concrete must be removed:

(A) to an existing longitudinal joint or edge, and

(B) in such a way that the exposed face complies with the criteria for longitudinal construction joints as defined in this specification.

Any additional internal sawcuts must be made without oversawing into the adjacent base or the underlying subbase.

Dispose of the removed base concrete at a location acceptable to the Principal.

5.6.3 Replacement of Base

Prior to construction of the replacement base, the subbase must be prepared and debonded in accordance with RMS R82.

All work involved in the replacement of base must comply with this Specification, including the following requirements:

(a) All joints and cracks which become exposed must be sealed with silicone sealant, to prevent the ingress of mortar and other incompressibles.

(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), assessed and treated in accordance with Clauses 4.5.1 and 4.5.4, 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. The length of the joint across the full width of the base must be sealed with a silicone sealant in accordance with Annexure R84/3.

5.7 RECTIFICATION OF FINISHED SURFACE AND RIDE QUALITY

Areas requiring grinding must be rectified with purpose-built equipment employing gang-mounted diamond saw blades in accordance with Annexure R84/3. Impact methods such as rotomilling must not be used.

Grinding must not be carried out until all necessary slab replacements have been completed within the area to be ground.

Where grinding is required, it must be carried out over the full width of a traffic lane.

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

Grinding must be carried out in such a way that positive lateral drainage is provided by maintaining a uniform slope without steps across the ground surface. Grinding must be transitioned at all edges of the work to maintain drainage and to provide acceptable ride quality. Deviations on the finished

surface must be measured (both within the grinding work and across boundaries) and must not exceed 5 mm under a 3-metre straight-edge when measured in any direction.

The surface must also be re-assessed in accordance with Clauses 5.4 and 5.5 for conformity. Sealants and transverse texturing must be restored to comply with this Specification.

Where surface correction results in water pounding on any part of the carriageway (including shoulders), transverse grooving must be carried out to the extent necessary to remedy the pounding.

6 MEASUREMENT AND PAYMENT

Payment will be made for all activities associated with completing the work detailed in this Specification, including Annexure R84/3, where relevant to base, in accordance with the Pay Items in the following Schedule.

A lump sum price for any of these items will not be accepted.

The Contractor will only be paid for the actual quantity of steel and concrete placed. If the quantities are reduced by the Principal in accordance with Clause 3.1, payment will be made at the schedule rate for the reduced quantities only.

Schedule of Pay Items

Pay Item	Description	Unit
R84P1	**Supply and Place Concrete in Base** The width and length will be as specified on the Drawings or directed by the Principal. The thickness will be the thickness specified or as directed by the Principal across each section. The additional base above terminal anchors, taken from the Drawings, shall be included in the measurement. A separate rate must be provided 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.	**m^3**
R84P2	**Finish, Cure and Texture Base** The unit of measurement will be square metres of surface of the base. The width and length will be as specified on the Drawings or as directed by the Principal. The sides of the slabs will not be included in the measurement of surface area.	**m^2**
R84P3	**Supply and Place Wire Reinforcing Fabric** The width and length will be as specified on the Drawings or as directed by the Principal. The areas that contain laps must only be measured once.	**m^2**

Pay Item	Description	Unit
R84P4	**Supply and Place Steel Bar Reinforcement** The mass will be 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 and bridge approach slabs. The pay item excludes tiebars.	**tonne**
R84P5	**Longitudinal Joints** The measurement will be 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.	**metre**
R84P6	**Expansion Joints and Isolation Joints** The distance will be measured along the line of the joint. The pay item includes the provision of dowels, where specified.	**metre**
R84P7	**Not Used**	
R84P8	**Terminal and Slab Anchors** The volume will be taken from the Drawings or as directed by the Principal. The depth will be measured from the top of the subbase. The pay item includes excavation for the anchor.	**m^3**
R84P9	**Bridge Approach Slabs** The width, thickness and length will be as specified on the Drawings or as directed by the Principal. No account will be taken of the allowable tolerances. The pay item includes finishing, curing and texturing of the slab.	**m^3**
R84P10	**Incentive for Ride Quality** The width and length will be as specified in Clause 5.5.3. The incentive will be applied to pay item R84P1 after conversion to a square metre rate based on the thickness as specified or as directed by the Principal across each test segment.	
R84P11	**Deductions** Pay Items R84P11.1 to R84P11.4 apply to non-conforming work where there is a specified disposition for acceptance that includes deductions. The value will be negative.	
R84P11.1	**Ride Quality** This Pay Item includes deductions for non-conforming works as defined in Clause 5.5.3. The deduction will be applied to pay item R84P1 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	Description	Unit
R84P11.2	**Compaction** This Pay Item includes deductions for non-conforming works as defined in Clauses 5.2 and 5.3.	
R84P11.3	**Compressive Strength** This includes deductions for non-conforming works defined in Clause 5.3.4.	
R84P11.4	**Thickness** This includes deductions for non-conforming works defined in Clause 5.4 and Annexure R84/3.	
R84P12	**Provision of Base Protective Covers** The measurement will be of base covered per night. Payment will be made only for temperature protection which is warranted by, and complies with, Clause 4.3.8.1. Payment will be limited to the first night after concrete placement, unless an extension of protection is approved by the Principal. Payment will not be made for covering over anchors (Clause 4.3.8.3) or for rain protection (Clause 4.3.8.2).	**m^2**

ANNEXURE R84/1 – DETAILS OF WORK

4.3.6 Texturing of Surface

Table A1.2 is to be read in conjunction with Table R84.11. It lists pavement areas which must be textured differently to that specified in Clause 4.3.6.

Table A1.1 - Schedule of Texturing Exceptions

Control/chainage	Texture type(s)	Texture Depth	Test Method

5.5.3.1 Roughness Testing

Table A1.1 is to be read in conjunction with (and provides information supplementary to) Table R84.13.

Table A1.2 - 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	N.A.

Notes:
(1) Nominations are to be limited to areas which are not covered in Table R83.13.

ANNEXURE R84/2 – QUALITY MANAGEMENT SYSTEM

Supply certain information, as specified in the following locations:

(a) Control of cement and flyash; Clause 2.4

(b) Admixture selection; Clause 2.5

(c) Certification for curing compounds (both nominated and delivered); Clause 2.6

(d) Joint sealant details and certification; Clauses 2.7

(e) Subbase level survey; Clause 3.2

(f) Consistence; Clause 3.6

(g) Concrete mix design and constituent details; Clause 3.8.1

(h) Dowel debonding and support system (if applicable); Clause 4.1.3

(i) Materials handling, batching and mixing proposals; Clause 4.2.2

(j) Admixture incorporation method; Clause 4.2.2(c)

(k) Control of batching time under Clause 4.2.2(d) and retempering under Clause A4.2.2(f) and nomination of Contractor's representative under Clause A4.2.2(f)(vi)

(l) Determination of maximum forming time; Clause 4.2.2(h)

(m) System to indicate the malfunction of individual vibrators; Clause 4.3.1 and Annexure R84/3

(n) Equipment and methods for spreading and paving; Clauses 4.3.1 4.3.2, and 4.3.3

(o) Details of staff training; Clause A4.3.3

(p) Monitoring location of batches/loads of concrete placed; Clause 4.3.3 and Annexure R84/3

(q) Meteorological data and measures to restrict evaporation; Clause 4.3.5

(r) Protection of work from low temperatures (Clause 4.3.8.1) and rain (4.3.8.2)

(s) Notice of trial paving and subsequent paving; Clause 4.4

(t) Crack inspection schedule; Clause 5.1

(u) Locations for coring; Clause 5.2.1

(v) Method of calculating adjusted thickness from survey; Clause 5.4.3

ANNEXURE R84/3 – REQUIREMENTS FOR TECHNICAL PROCEDURES

A1 GENERAL

A1.1 SCOPE

This Annexure details supplementary requirements for construction of concrete base. This Specification applies where referenced in the relevant technical specification.

The clause numbers in this Annexure, after the prefix "A", correspond with the relevant clause number in the concrete base specification. There are gaps in the clause numbers.

A2 MATERIALS

A2.1 AGGREGATE - GENERAL

A2.1.1 Alkali - Reactive Aggregate

Assessment must be by both of the following methods:

(a) petrographic examination in accordance with ASTM C-295, and

(b) assessed and classified for AAR using either the accelerated mortarbar test in accordance with RMS T363 or the concrete prism test method in accordance with RMS T364.

This testing may be carried out by a laboratory which is not NATA registered for this test, if approved by the Principal.

The required action to be taken on the test results is detailed in Tables A3.1 and A3.2.

Table A3.1 - Required Action for Coarse Aggregate and Manufactured Fine Aggregate

% Expansion at 21 days	Required Action (1)
< 0.10	No Action
$\geq 0.10,\ < 0.15$	Limit total alkali in the mix to 2.8 kg/m^3 or use Mix Category 3 (Table R84.6)
$\geq 0.15,\ < 0.25$	Limit total alkali in the mix to 2.1 kg/m^3 or use Mix Category 3 (Table R84.6)
$\geq 0.25,\ < 0.40$	Use Mix Category 3 (Table R84.6)
≥ 0.40	Use Mix Category 3 (Table R84.6) and re-test. The accelerated test method must be performed with the proposed combined cementitious mix. The upper limit for acceptance must be 0.1%

Notes:

(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.

Table A3.2 - Required Action for Natural Fine Aggregate

% Expansion at 21 days	Required Action (1)
< 0.15	No action
≥ 0.15, < 0.20	Limit total alkali in the mix to 2.8 kg/m^3 or use Mix Category 3 (Table R84.6)
≥ 0.20, < 0.30	Limit total alkali in the mix to 2.1 kg/m^3 or use Mix Category 3 (Table R84.6)
≥ 0.30, < 0.45	Use Mix Category 3 (Table R84.6)
≥ 0.45	Use Mix Category 3 (Table R84.6) and re-test. The accelerated test method must be performed with the proposed combined cementitious mix. The upper limit for acceptance must be 0.1%

Notes:

(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.

A2.1.2 Soluble Salts

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

(a) Test Method for concrete constituents:

(i) Conduct chloride testing in accordance with:

- AS 1012 Part 20 for aggregates;
- AS 1478 Appendix D for water and admixtures dissolved in water;

thence calculate the total content and percentage.

(ii) Conduct sulphate 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;

thence calculate the total content and percentage.

(iii) Notes:

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

(B) For water, the source proposed for the Works must be tested.

(b) Test Method for hardened concrete:

Conduct chloride and sulphate testing in accordance with AS 1012 Part 20. The water used in the concrete must be from the source proposed for the Works.

A2.2 TO A2.5 (NOT USED)

A2.6 CURING COMPOUND

A2.6.1 Reference Sample

The sample for reference testing must be tested for the following properties. Testing must be in accordance with AS 3799 and the results must comply with the tolerances specified therein.

(i) non-volatile content;

(ii) the efficiency index;

(iii) density;

(iv) drying time;

(v) viscosity; and

(vi) the infrared spectrum as determined in accordance with RMS T1005.

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

A2.6.2 Initial Delivery

From the first delivery to the project, a random sample must be tested for the following properties. Testing must be in accordance with AS 3799 and the results must comply with the tolerances specified therein.

(i) non-volatile content;

(ii) density;

(iii) drying time;

(iv) viscosity; and

(v) the infrared spectrum as determined in accordance with RMS T1005.

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.

A2.6.3 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:

(i) non-volatile content;

(ii) density; and

(iii) viscosity.

A3 DESIGN

A3.1 NOT USED

A3.2 SURVEY AT THE TOP OF THE UNDERLYING LAYER

A3.2.1 Survey Prior to Placing Base

The base invert level must be the level at the top of the subbase including the thickness of any debonding treatment, determined:

(i) in accordance with RMS R82, if the base and subbase are constructed under the same contract, or

(ii) by survey jointly between the Contractor and the Principal, in accordance with RMS G71, if the subbase has been constructed by others.

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

A3.2.2 Survey Reports Prior to Placing Base

Levels must be reported to the nearest millimetre and surveyed using a flat based staff of base area between 300 and 4000 mm^2, at spacings of 10.0 m longitudinally and at the cross-section offsets shown in Figure A3.1, with a tolerance of 0.5 m.

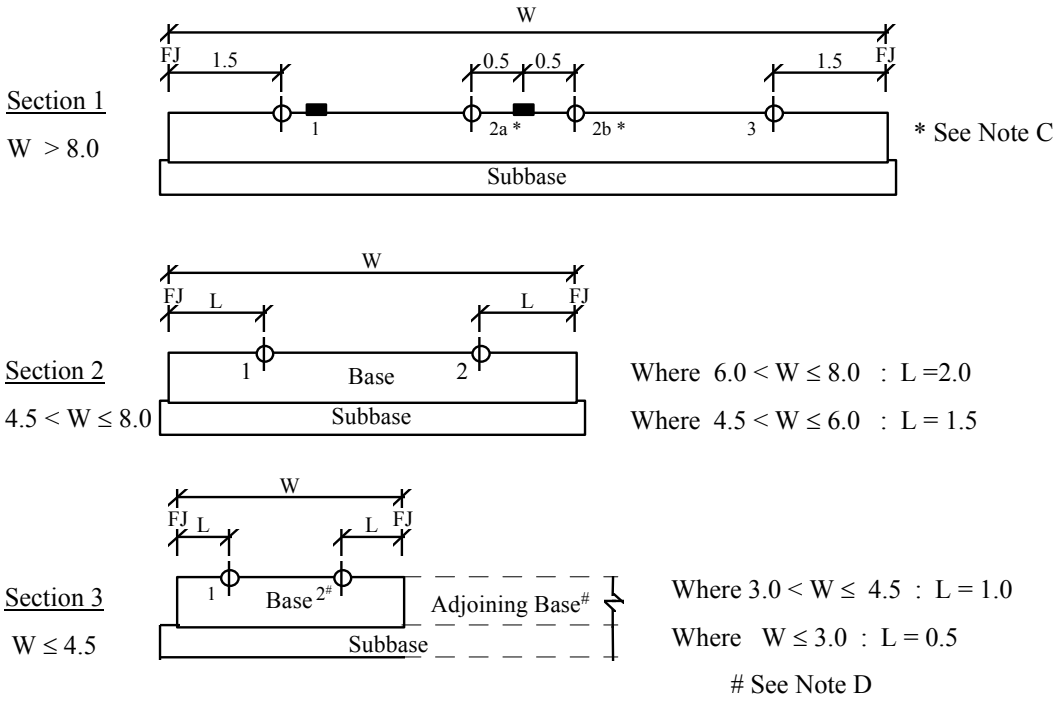


Figure A3.1 - Survey locations (not to scale)

Notes:

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

(B) Induced longitudinal joints should be ignored for the purpose of locating survey points and are not shown in Figure A3.1.

(C) In Section 1, the Contractor must nominate to take survey either at point 2a or 2b.

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

(E) 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.

(F) Key: FJ - Formed joint or edge

W - Paving width between formed joints or edges

■ - Lane lines

ϕ - Survey points

A3.2.3 Redesign of Pavement Levels

Review of the approved design surface levels must be in accordance with the following criteria.

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

(ii) 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 3.0% may be varied within the range 3.0% ± 0.3%), and

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

Additionally, the revised design must be such that:

(iv) water will not pond on the carriageway,

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

(vi) 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.

A3.2.4 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 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 debonding treatment comprises a sprayed bituminous seal, the thickness of the treatment must be taken as the Average Least dimension (ALD) of the cover aggregate, determined in accordance with RMS R106. This thickness must be added to the levels determined at the top of subbase and the resultant levels must be taken as the bottom level of the Base for the purpose of determining thickness thereof.

A3.3 MIX PARTICLE SIZE DISTRIBUTION

Combined aggregate particle size distribution:-

(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.

Note: The specified particle size distributions are based on materials of equal bulk densities in a saturated surface dry condition. Where bulk densities are unequal, the specified combined particle size distribution must be adjusted accordingly.

A3.4 TO A3.7 (NOT USED)

A3.8 NOMINATED CONCRETE MIXES

A3.8.1 Trial Mix

To determine the compressive strengths F_7 and F_{28} for each trial batch, a minimum of three (3) specimens must be tested at age 7 days and a minimum of three (3) specimens tested at age 28 days. Specimens must comply with Clause 3.5, with compaction by internal vibration. F_7 and F_{28} must be the average of all individual results not more than 2.0 MPa from the median value at each age.

To determine the flexural strength for each trial batch, a minimum of five (5) specimens must be tested at age 28 days and a minimum of three (3) specimens tested at age seven days. Specimens must comply with Clause 3.5, with compaction by either internal or table vibration. The flexural strengths F_{f28} and F_{f7} must be the average of all individual results not more than 0.5 MPa from the median value at each age.

To determine the indirect tensile strength for each trial batch of Base, a minimum of three (3) specimens must be tested at age 28 days. Specimens must be 100 mm diameter cylinders[iii] which comply with the requirements for compressive strength specimens under Clause 3.5, with compaction by internal vibration. The indirect tensile strength F_{t28} must be the average of all individual results. The indirect tensile strength will not be used for conformity purposes.

[iii] Notwithstanding the requirement of AS 1012.8 Clause 1.5.2(b)(iii).

A4 PROCESS CONTROL

A4.1 PLACING STEEL REINFORCEMENT

A4.1.1 General

A4.1.1.1 Placing

Reinforcing bar and wire mesh fabric must be accurately placed to the dimensions and details shown on the Drawings.

Reinforcement must be secured in place by wiring the bars and/or fabric together with annealed steel wire having a diameter of not less than 1.2 mm. Tack welding may be used instead of wire ties on reinforcing bars.

Reinforcement must be supported in position using concrete, plastic or wire chairs. The use of timber or pieces of aggregate to support reinforcement is not permitted. The support must not be of a design which is likely to impede compaction of the enveloping concrete.

The arrangement and spacing of chairs must be such that the reinforcement will be supported in 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.

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

A4.1.1.2 Splicing

Unless otherwise shown on the Drawings, the minimum length of lapped splices must be as follows:-

(a) Grade 400 & 500 - 35 bar diameters

(b) Grade 230S - 25 bar diameters

(c) Plain bars and hard-drawn wire - 45 bar diameters

Splices in reinforcing fabric must conform with AS3600 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 (ie the bottom sheet has transverse wires uppermost and the top sheet has them underneath).

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

In welded splices, bars may only be welded by an electrical method. Welding must comply with AS 1554.3. The welded splice must meet requirements of tensile and bend tests specified for the parent metal.

A4.1.2 Tiebars

Testing must be conducted for tiebar location and anchorage, including concrete compaction, as follows:

A4.1.2.1 Pull-out Testing

Tiebars which have been inserted (in lieu of pre-placement) into a formed slab edge (formed by either slipform or fixed-form method) must be tested for anchorage strength. Tiebars must be capable of withstanding a tensile pull-out stress equal to 85% of their yield stress. Testing must be terminated at the 85% level.

Pull-out testing must be carried out at the following minimum frequency, independent of transverse construction joints, and commencing 5 m from the project start of base paving:

(i) One (1) test per 20 lin m of joint until 4 consecutive conformities are achieved, and thereafter

(ii) at a rate of 1 per 50 lin m of joint until a further four consecutive conformities are achieved, and thereafter

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

In any paving trial, a minimum of 5 bars must be tested.

Upon encountering a nonconformity 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, whereupon testing must revert to frequency (i).

Nonconforming bars must be replaced 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. Replaced bars must be tested at a frequency of 1 in 2.

A4.1.2.2 Location and Compaction Testing

For tiebars which have been inserted (in lieu of pre-placement) at induced joints, test for location conformity using a metal detector and take cores to ensure that the method of placement provides full compaction of concrete around the bars:

(i) For location: at a frequency equal to that for anchorage testing as detailed above.

(ii) For compaction:

(A) In the trial base: one core per 40 lin m of joint, or part thereof.

(B) Elsewhere: one core per 400 lin m of joint

Cores must be located to intersect a tiebar but must be offset from the longitudinal joint by 250 ± 100 mm and must not be closer than 1.5 m to a transverse contraction joint nor 3.0 m to a transverse construction joint.

Compaction must be tested and assessed in accordance with Clause 5.2, except that Clause 2 of Test T368 must be replaced by the following requirement:

"All voids which exceed 5.0 mm in any direction must be fully filled."

Results must be included in the assessment of Lot conformity under Clause 5.2.

A4.2 PRODUCTION AND TRANSPORT OF CONCRETE

Production and transport must be such as to:

(a) prevent segregation or loss of materials;

(b) supply a homogeneous product; and

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

For slipform paving, the mixing, agitation and transport equipment must have an operational capacity which allows continuous paving at the Contractor's target paving speed. In no case must the capacity be less than that required to maintain a continuous paving speed of one (1) metre per minute with adequate allowance for mixer efficiency and control testing.

A4.2.1 Strength Testing of Production Mixes - Flexural and 7-Day Compressive

A4.2.1.1 7-Day Compressive Strength

7-day compressive strength testing must be undertaken at the same frequency as specified for 28-day compressive testing in accordance with Clause A5.3 of this Annexure.

Test results must be submitted to the Principal within two (2) 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):

$$\frac{F_7}{F_{28}} x\ f_{cMin} + S \qquad \text{(MPa)}$$

where F_7 is the 7-day compressive strength in the trial mix (Clause 3.8.1 refers), F_{28} is the 28-day compressive strength at in the trial mix, f_{cMin} is as specified in RMS R84 Clause 3.5 and S is the standard deviation.

When production results become available for f_c and f_{c7}, the factor F_7/F_{28} must be replaced by f_{c7}/f_c . This must be done initially upon receipt of 30 test values and thereafter at the Contractor's discretion but preferably on the basis of not fewer than 30 new values.

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

The Contractor's target value must be not less than 2S above the lower warning limit.

A4.2.1.2 Frequency of Moulding of Flexural Test Specimens

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.

Flexural test specimens must be moulded in sets of three (3) for the determination of the flexural strength at 7 days and 28 days. All specimens within a set must be moulded from the same sample of concrete, and corresponding 7-day and 28-day flexure sets must be moulded from the same batch.

For purposes of traceability and correlation, flexure specimens must be moulded from batches of concrete from which cylinders are moulded for 28-day compressive strength under Clause 5.3.1.

For the purpose of this clause, concrete delivered by agitators must be considered to be of a different mix to that delivered by tippers.

Specimens must be moulded for each concrete mix at the minimum frequencies listed in Table A3.3 and procedures must be in accordance with Table R84.7.

Table A3.3 – Minimum Frequency of Flexural Test Specimens

	Minimum Frequency (Sets)	
	7-day testing	28-day testing
Paving Trial	As per Clause A4.4	
and thereafter		
from the first 5 lots using that mix [(a)]	1 per lot	1 per lot
and thereafter		
for daily outputs ≤ 200 m^3	1 per 100 m^3	1 per 100 m^3
for daily outputs > 200 m^3	1 per 400 m^3	1 per 400 m^3

Notes:

(a) The lots must be those determined in accordance with Clause 5.3.1 of this Specification.

A4.2.1.3 Flexural Test Specimens

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

Test specimens for determining the flexural strength of concrete must be standard beams of nominal size 100 × 100 × 350 mm complying with Clause 3.5, with compaction by internal or table vibration.

All specimens within a set must be moulded from the same sample of concrete.

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.

Specimens must be moulded in accordance with Table R84.7 and be inspected, conditioned and tested in accordance with AS 1012.11.

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

(i) Mass testing must be in the saturated-surface-dry condition and without dressing of voids; RMS T368 refers.

(ii) The unit mass for a set of beams will be the average of results not more than 20 kg/m^3 from the median value. The average must be rounded to the nearest 10 kg/m^3.

Unit mass results for flexure specimens must be reported regularly to the Principal but must not be used in the calculation of the RCUM.

A4.2.1.4 Assessment of 7-day Flexural Strength

The 7-day flexural strength results must be reported to the Principal within two (2) working days of testing but will not be used for conformity assessment.

A4.2.1.5 Assessment of 28-day Flexural Strength

A statistical check must be made 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 must be 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 A5.3.4.

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

The results must be assessed in accordance with Table R84.10. Action as follows must be taken if the rolling mean flexural strength falls below f_{fMin} or the rolling standard deviation exceeds 0.5 MPa.

(i) 0.95 f_{fMin} ≤ 28-day rolling mean flexural strength < f_{fMin}:

  (A) Promptly implement Corrective Action to ensure conformity as specified; and

  (B) monitor and report the results of 7-day flexural strengths for the impact of the Corrective Action.

(ii) 28-day rolling mean flexural strength < 0.95 f_{fMin}:

  Observe the HOLD POINT specified.

(iii) 28-day rolling standard deviation > 0.5 MPa:

  (A) Promptly implement Corrective Action to ensure conformity as specified; and

  (B) monitor and report the results of 7-day flexural strengths for the impact of the Corrective Action.

Test results must be submitted to the Principal within two working days of testing.

A4.2.2 Mixing, Transport, Consistence and Air Content

Aggregates which have become intermixed or contaminated with foreign matter must not be used in the Works.

Cementitious materials must be weighed separately.

Volumetric batching of water must employ a measuring device calibrated in one litre increments.

Liquid metering equipment for admixtures must measure the volume, or mass, of liquid to an accuracy of ±5% of the value shown on the indicating device except that, for water metering equipment, the accuracy must be ±2%.

In the case of batch mixers, after the completion of batching, the entire batch of concrete must be discharged from the mixer before any further charging takes place, with the exception of conforming retempering.

Mixing, transport and consistence must comply with AS 1379, Sections 3 and 4 and Appendix A, subject to the following provisions:

(a) Mixer uniformity testing - general

For the purpose of conducting the mixer uniformity test, the mixer must be charged in accordance with the manufacturer's instructions and to the maximum volume (or throughput) proposed to be used in the Works. The volume (or throughput) at test must not thereafter be exceeded unless a further uniformity test is conducted.

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

(b) Uniformity testing of central mixers

Where concrete is to be produced and mixed by a central mixer, mixer uniformity tests must be conducted 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 3.4.2. Mixes of all types (including subbase, base and kerbs) and to all clients must be included in the above volumetric total.

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

Tests must be conducted on three consecutive batches 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.

Report mixing speed and mixing time or, for continuous mixers, the throughput rate.

The whole of a single batch (or run)must be discharged and sampled by one of the following procedures:

(i) By discharge into a moving vehicle whose tray length is not less than 8 m. Sampling must be from the truck prior to tipping. Samples must be obtained using a shovel or scoop but the top 100 mm of concrete must be excluded.

(ii) 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 and 10 m onto ground which is either sealed or pre-dampened to prevent absorption of water from the mix. Sampling must be from ground in accordance with AS 1012.1.

In each case, the batch (or run) must be sampled at three (3) points approximately 15 per cent, 50 per cent and 85 percent along the discharged length of the mix. A sample of approximately 50 litres must be taken from each point. Samples must be individual and not composites; AS 1012.1 Clause 3 refers.

(c) Uniformity testing of mobile batch mixers

All mobile batch mixers must display an identification plate (or equivalent certification) in accordance with AS 1379 to certify compliance with mixer uniformity criteria. All mixers must have been tested within the past 24 months for slump, air content and mass per unit volume, and the results must have complied with the limits given in AS 1379 Appendix A. The date of latest test must be shown on the identification plate.

In accordance with AS 1379 Clause 3.4.1(c), further tests must be carried out:-

(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 the specification, these criteria apply even where mobile mixers are used to transport centrally-mixed concrete.

(d) Uniformity testing of continuous mixers

Continuous mixers must be assessed in accordance with AS 1379 except that three (3) individual samples must be taken (in lieu of two [2]), each separated by an interval equivalent to at least 2 m^3 of throughput.

(e) Compliance for uniformity

(i) Central batch mixers and continuous mixers:

The mixer will be deemed to have passed the uniformity test if the difference 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 consecutive batches. Additionally, no slump value must lie outside the specified range.

(ii) Mobile batch mixers:

Assessment must be in accordance with AS 1379.

(f) 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 prior to the completion of discharge of the batch, and strictly in accordance with the following conditions:

(i) Immediately after retempering, the mixing mechanism must be operated at the designated mixing speed for not less than the mixing time determined under Clause 4.2.2(a), or for any longer period or for such additional time as necessary to re-establish uniformity of the mix.

(ii) The retempering and the quantity of water added (accurate to one litre) must be recorded on the identification certificate for that batch. If water is added after the commencement of discharge, the remaining quantity of concrete at that time must also be recorded.

(iii) Immediately after condition (i) has been satisfied, the slump must be checked for compliance.

(iv) If a maximum water-to-cement ratio has been specified, the quantity of water added must be such that the specified ratio is not exceeded.

(v) Retempering must only be permitted within the following times as measured from the completion of batching and as appropriate for temperature of concrete as follows:

- For temperature $\leq 25°C$: 40 minutes
- For temperature $> 25°C$: 30 minutes

Concrete temperature must be measured at the commencement of discharge of a batch at intervals not exceeding 60 minutes throughout the paving operation. The latest value must apply.

(vi) Retempering must only take place in the presence of the Contractor's representative previously nominated to the Principal for this purpose and only at either the batch plant, the testing station, or the point of placement.

(vii) Test cylinders for compressive strength must be made from the retempered mix, in accordance with this Specification. These cylinders must be additional to the routine testing requirements.

(g) Transport of mixes for manual paving

Agitator vehicles must be used to deliver concrete which will be manually placed.

However, subject to the approval of the Principal, tipper trucks may be used for plain concrete slabs where slump and haul lengths are such that segregation does not occur and compaction and finishing of the mix are not compromised.

(h) Slump Testing

Test samples must be obtained in accordance with AS 1012.1 and slump must be tested in accordance with AS 1012.3 Method 1. The minimum frequency of routine testing must be as follows:

(i) Initial daily slumping:

Test every load prior to discharge until 8 consecutive conforming loads are tested. Calculate the standard deviation (SD) of these 8 loads.

If SD ≤ 8.0 mm: go to Process Slumping.

If SD > 8.0 mm: continue slumping every load until any 8 consecutive loads have a SD ≤ 8.0 mm

(ii) Process slumping:

Slump every fourth (4th) load. Every intermediate load must be visually checked prior to discharge, and the slump must be tested for any load which appears, in the opinion of either party, to be nonconforming. Visual checks must be recorded as, for example, V_{30}, V_{40} etc for Visual 30 mm and 40 mm respectively.

If a nonconforming slump is measured, all loads thereafter must be slump tested (prior to discharge) until the SD of 6 consecutive loads is ≤ 8 mm, at which time testing may revert to each 4th load.

Slump every load from which samples are taken for other tests on the concrete or its constituents.

Additional slump testing must also be conducted as required in accordance with (f) above.

Sampling must be as follows:

(A) For tipper delivery: the test sample must be obtained prior to discharge using a shovel or scoop. The top 100 mm must be excluded.

(B) For agitator delivery: the test sample must be an individual sample (ie not composite) obtained in accordance with AS 1012.1.

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

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

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

(i) Air Content Testing

Testing must be carried out daily at the following minimum frequency:

(A) one per load until three (3) conforming results are obtained, and thereafter;

(B) one per 50 m^3 until four (4) 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 batches 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, one repeat test must be made immediately from another portion of the same sample.

If the value obtained from the repeat test falls within the specified limits the concrete represented by the sample must be accepted as conforming.

If a nonconforming result is obtained at any stage of testing, the frequency must revert to (A).

Air entrained concrete with an air content higher than the specified range will be deemed 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 will be deemed nonconforming. However, such concrete may be incorporated into the Works conditional on the conformity of the compressive strength of cores from that specific load which have been obtained and tested in accordance with this Specification. This testing must be in addition to routine random sampling, unless that particular load has been chosen in the random selection process.

A4.3 PAVING CONCRETE

A4.3.1 Slipform (Mechanical) Paving

The slipform paver used must be a self-propelled machine capable of paving at a speed of one metre per minute or less as required to enable the continuous operation of the paver and obtain the required degree of compaction. It 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.

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

Operate, and document in the PROJECT QUALITY PLAN, a system to indicate the malfunction of each individual vibrator.

A4.3.2 Not Used

A4.3.3 Placing and Paving Operations

Place, pave and finish concrete so as to:

(a) avoid segregation or loss of materials;

(b) avoid premature stiffening;

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

(d) expel entrapped air and closely surround all reinforcement and embedments; and

(e) provide the specified thickness and surface finish.

Details of the equipment and methods to be used for placing, spreading and finishing the concrete must be submitted as part of the PROJECT QUALITY PLAN.

Ensure that the workers engaged in paving operations have undergone the Concrete Paving Crew Training in accordance with RMS G2-C2. Details of such training must be submitted as part of the PROJECT QUALITY PLAN.

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

(i) maximum paving speed (ie instantaneous, not average),

(ii) target (optimum) paving speed,

(iii) vibrator spacing, frequency and amplitude, and ranges thereof,

(iv) gross operating mass per lineal metre of paving width.

For manual paving, the following parameters must be nominated:

(v) the size and number of vibrators,

(vi) the spacing of vibrator insertions.

For transition zones, the following information must be provided:

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

(viii) the distance between the transverse construction joint and the point of effective slipform vibration, at both the start and finish of paving runs[iv],

(ix) the size and number of manual vibrators,

(x) the spacing and duration of vibrator insertions,

(xi) the method of sideforming to prevent edge slump,

(xii) proposals to ensure suitable workability for manual placement of the mix within the transition zone.

A4.3.4 (Not Used)

iv The length of "start" transitions may be different to the "finish" transitions, depending on the paving techniques employed.

A4.3.5 Prevention of Moisture Loss

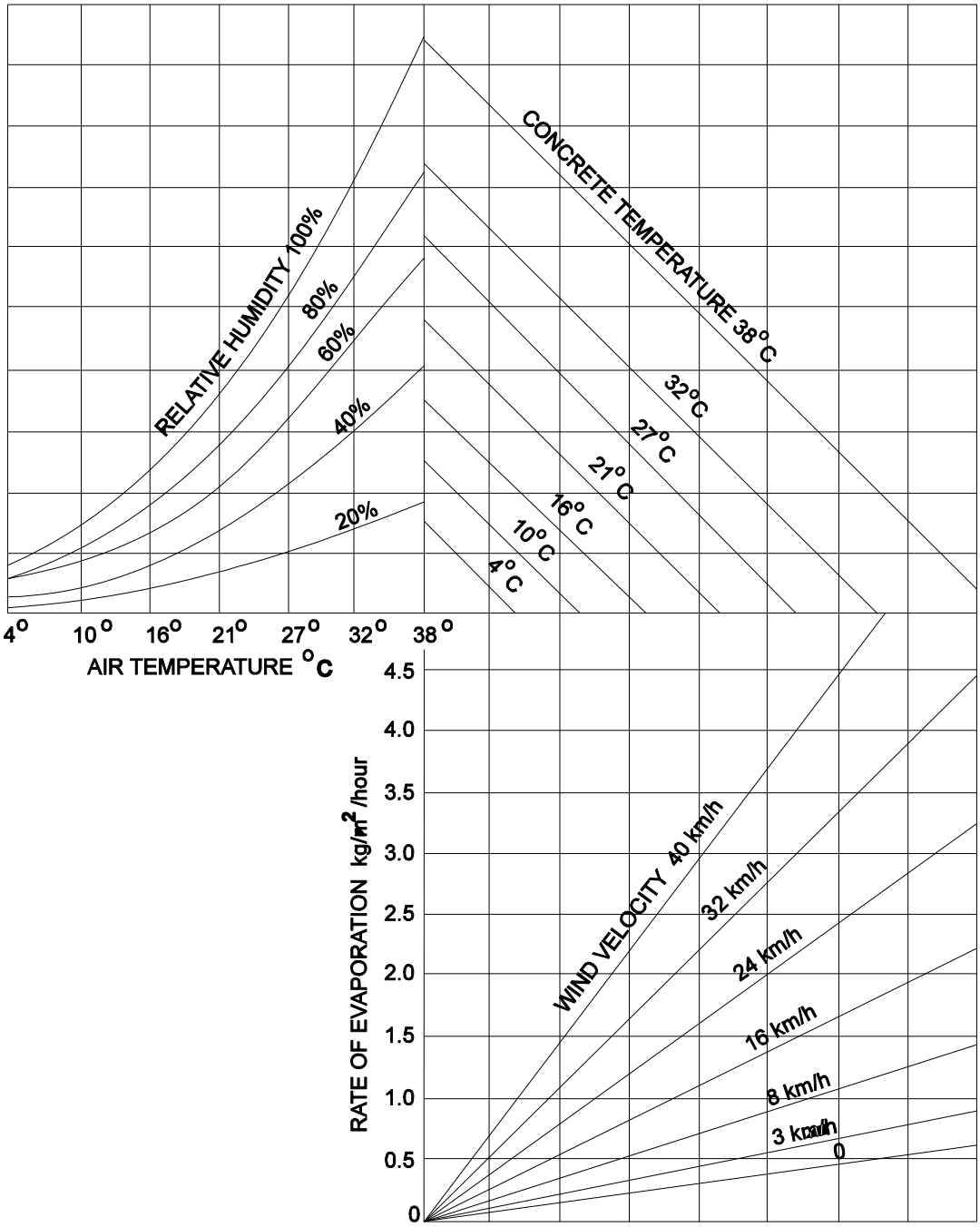


Figure A3.2 - Evaporation from Concrete Freshly Placed on Site*

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

With air temperature at 27°C, relative humidity at 40%, concrete temperature at 27°C, and a wind velocity of 26 km/h, the rate of evaporation will be 1.6 kg/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

A4.3.6 Texturing of Surface

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

A4.3.6.1 Longitudinal

Longitudinal texturing must be effected with a hessian-drag, or equivalent. The length of the drag must be adjusted to produce the specified texture, and the drag must be replaced when worn or ineffective for producing a uniform consistent texture.

A4.3.6.2 Transverse

As soon as possible after longitudinal texturing, the surface of the freshly placed concrete must be transversely textured by means of a mechanical device for grooving plastic concrete. The transverse texturing equipment must utilise rectangular-shaped tines of flat spring steel, approximately 0.6 mm thick and 3 mm wide. The tines must be randomly spaced 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 combs must be at least 750 mm.

For paving widths exceeding 4.5 m, the texturing must be carried out by means of a machine spanning the concrete slab and guided for direction by the paver guide wires, or by rails in the case of fixed-form construction. Provision must be made for downward adjustment to compensate for tyne wear.

A4.3.6.3 Saw-cut grooves

Where required, saw-cut grooves must be:

(a) 3 mm wide and 3 mm deep;

(b) at a random pattern;

(c) with a spacing neither less than 10 mm nor more than 18 mm; and

(d) with a mean spacing between 12 mm and 15 mm.

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

A4.3.7 Curing

The curing compound application rate must be checked as follows:

(a) by calculating the average application rate from the total measured quantity of compound applied over each paving run, and by

(b) testing the local amount of curing compound as measured on test mats placed on the pavement. The application rate must be calculated as the mean of the local rates falling on three felt mats, each approximately 0.25 m^2 in area and placed randomly within an area of 100 m^2 on the surface to be treated. Testing must be carried out at a minimum frequency of once per 2,000 m^2.

(c) Where the edge of a slab is sprayed by mechanical means, the local application rate on the edge must be tested in accordance with (b) at a minimum frequency of once (ie three mats) per 3000

m^2 of upper surface paving. The three mats must be placed randomly within a total edge length of 20 lin m.

The application rate within a test section will be deemed to be conforming if both the average rate and the mean local rate equal or exceed the specified rate, and if no single local rate is more than 5% below the specified rate.

All curing compound sprayers must incorporate a device for continuous agitation and mixing of the compound in its container during spraying. After shut-off of the spray nozzles there must be no dripping of the curing compound on the concrete surface.

Curing compound must be applied in a fine spray and by the following means:

(i) For paving widths < 2.5m:

by hand lance, with either single or multiple nozzles.

(ii) For paving widths ≥ 2.5m:

by spray bar or hand lance fitted with a minimum of three (3) nozzles spaced to give a uniform cover over a minimum width of 1.0 m in a single pass, except that:

(iii) for slipformed paving widths > 4.5 m:

it must be applied 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.

Spray bars and lances must be fitted with protective hoods to minimise the drift of curing compounds to workers and roadside areas.

A4.3.8 Protection of Work

A4.3.8.4 Trafficking of the Base

For trafficking purposes, the insitu concrete strength must be assessed using cylinders which have been moulded, cured and tested in accordance with RMS T367. Alternatively, it may be assessed from cores taken for the purposes of Clause 5.2, subject to the following:

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

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

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

A4.4 CONCRETE PAVING TRIAL

For slipform paving trials, concrete testing must be conducted as follows:

(a) From each of six different batches of concrete, a pair of cylinders must be tested for 7-day compressive strength and a pair for 28-day compressive strength. All specimens must be tested for unit mass and compressive strength in accordance with this Specification, including a check on 7-day concrete uniformity in accordance with Clause 4.2.1.

(b) From each of three of the batches sampled under (a), a set of three (3) flexure beams must be tested for 7-day strength and a set for 28-day strength.

The representative cylinder unit mass (RCUM) must be calculated in accordance with Clause A5.2.1.1 and at least four (4) cores must be extracted from each paving trial, including one from each transition lot, for compaction testing.

For manual paving trials, concrete testing must be conducted as above except that cylinders must be moulded from not fewer than four (4) batches instead of six (6).

A4.5 JOINTS AND EDGES

A4.5.1 Sealants

Sealant dimensions must be tested at random locations at the minimum frequency specified below.

(a) Joint width

Width must be checked at the time of completing the widening cut.

(b) Sealant recess

The recess below the top surface must be checked prior to removal of the sealant under sub-clause (c).

(c) Sealant depth

Lots must correspond with those selected under Clause 5.3, as follows:

(i) two (2) tests per 50 lin m of joint until 6 consecutive conforming samples are obtained, and thereafter;

(ii) at a rate of one (1) per 50 lin m.

Upon encountering a nonconformity at any time, testing must revert to frequency (i).

The depth (or thickness) must be checked by removal of a continuous section of cured sealant of length not less than 30 mm. The sample must be dissected transversely at two random cross-sections and the meniscus depth measured to the nearest millimetre. The sample will be deemed to comply if both test sections comply with the Drawings.

A4.5.2 Transverse Construction Joints

Intimate bond at the microtexture level can induce spalling at arrises and hence must be avoided. Therefore, 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, it must be reinstated or repaired prior to the placement of adjoining concrete and the repair material must not be placed integrally with the adjoining concrete.

The first-placed face must be re-sprayed with curing compound not more than ten (10) days prior to placing the abutting concrete. All aspects of the treatment must be in accordance with Clause 4.3.7 except that the compound must be a wax emulsion complying with RMS 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 reinforcement must not be sprayed.

A4.5.3 (Not Used)

A4.5.4 (Not Used)

A4.5.5 Longitudinal Joints

A4.5.5.1 Condition of Formed Joints and Debonding

Intimate bond at the microtexture level can induce spalling at arrises and hence must be avoided. Therefore, 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, it must be reinstated or repaired prior to the placement of adjoining concrete and the repair material must not be placed integrally with the adjoining concrete.

The first-placed face must be re-sprayed with curing compound not more than ten (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 complying with RMS 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.

A4.5.5.2 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 and must have sufficient standby equipment available on site to maintain continuity of sawing.

A4.5.5.3 Cleaning

The sawcut must be cleaned of all debris soon after sawing and before the residue dries. The cleaning method used must not damage the sawcut or arrises nor leave any substance deleterious to the concrete or to the adhesion of the joint sealants to be used. The method must incorporate a liquid or liquid/air oil-free jet at a sufficiently high pressure to ensure that the faces are dust-free upon drying. Gravity fed liquid from tanks will not be acceptable.

Grit blasting must not be used.

A4.5.5.4 Temporary Sealing

Within two hours of cleaning, the joint must be temporarily sealed by a continuous closed-cell polyethylene backer rod or PVC spline rubber seal as shown on the Drawings. 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 be neither higher than the concrete surface nor more than 5 mm below it.

The temporary sealant must be maintained in sound condition until the joint is sealed permanently. Damaged or disturbed temporary sealants must be removed, the joint recleaned and a new temporary sealant inserted.

A4.5.5.5 Permanent Sealing

Permanent sealant must be installed as for transverse contraction joints (above), except that if the backer rod is damaged, only the damaged length need be replaced.

A5 END PRODUCT CRITERIA

A5.1 NOT USED

A5.2 CONCRETE COMPACTION

A5.2.1 Conformity for Compaction

A5.2.1.1 Moulding and Testing of Cylinders

Determine unit mass reference values for concrete compaction using standard moulded cylinders, and in accordance with the following provisions:

(a) The test cylinders must be those which are moulded for 28-day compressive strength testing. The unit mass must be determined on all cylinder specimens cast for 28-day strength testing but mass testing must be at an age of between four (4) and seven (7) days and must be in accordance with AS 1012.12 Method 2, amended in accordance with sub-clauses (b) and (c) hereunder.

(b) Mass testing must be in the saturated surface-dry condition and without dressing of voids; RMS T368 refers.

(c) The unit mass for a pair of cylinders will be the average of the two results unless they differ by more than 20 kg/m^3, in which case the higher result will represent the unit mass of the pair. Averaged results must be rounded to the nearest 5 kg/m^3.

For each nominated mix in use, a statistical check must be made to determine the rolling cylinder unit mass (RCUM) using the unit mass for pairs as defined under sub-clause (c).

For the paving trial, the rolling cylinder unit mass (RCUM) must be taken as the mean of all 28-day pairs from that trial of the same concrete mix. The mean result must be rounded to the nearest 5 kg/m^3.

Thereafter, the RCUM for any lot must be taken as the mean of the five (5) consecutive pairs of 28-day cylinders of that mix up to and including that lot (including the results from the paving trial, where applicable). Where fewer than five pairs of a nominated mix are available, the RCUM must be taken as the mean of all available pairs from that mix. In each case, the mean result must be rounded to the nearest 5 kg/m^3.

The unit mass of flexure specimens and 7-day strength specimens must not be used in calculations of the RCUM.

A5.2.1.2 Core Specimens

Test specimens for determining the relative compaction of concrete must be cores of nominal diameter 75 - 100 mm, cut from the full depth of the concrete base, in accordance with AS 1012.14 except that the minimum concrete age for coring will be:

(a) four (4) days in the cool season;

(b) two (2) days in the warm season,

subject to the cores being extracted without damage.

The location of coring must comply with Clause A5.2.1.3.

Cores must be placed within 2 hours of securing in either a tank of lime saturated water, or individual plastic bags, sealed to prevent water loss, and stored in the shade.

Cores must not be subjected to temperatures:

(i) in excess of the ambient temperature or 28ºC, whichever is higher, and

(ii) less than 10ºC.

All cores must be tested for unit mass, and all results must be reported.

A5.2.1.3 Frequency and Location of Coring for Compaction

The lots or sublots for determining compaction must be based on the lots created in accordance with Clause 5.3.1 of this Specification. Transition zones must form separate sublots.

(a) In slipformed concrete, take at least one core specimen from each lot (avoiding transition zones).

(b) In manually paved base, two cores must be taken from each of the lots. The core locations must be separated by at least half the length of the sublot.

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

(i) two cores from each sublot until three (3) consecutive conforming sublots (ie not less than 98.0% compaction) are obtained; and then

(ii) two (2) cores from each third sublot, which must be selected on the basis of time sequence, until four consecutive sublots conform; and then

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

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

The location of coring must be chosen in such a way as to exclude joints, steel reinforcement and tiebars from the core except as required under Clause A4.1.2.2 of this Specification or as otherwise required by the Principal to assess process uniformity.

A5.2.2 (Not Used)

A5.2.3 Core Testing for Unit Mass

The unit mass of the cores must be determined in accordance with AS 1012.12.2, qualified as follows;

(a) determine the initial mass (m_1) of the specimen, prior to any 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 cores in accordance with RMS T368 for excessive voids and dress voids where warranted;

(c) determine the immersed mass (m_2) 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 between three (3) and seven (7) days;

(g) adjust the unit mass for the presence of steel reinforcement in accordance with RMS T368;

(h) the full depth of the core must be tested except that:
(i) non-concrete materials such as bitumen must be removed; and
(ii) up to 20 mm of concrete may be removed from each end of the core;

(i) report the height and diameter of the core, as tested;

(j) individual results for unit mass must be rounded to the nearest 10 kg/m^3 in accordance with AS1012.12.

Where two cores are available from a lot/sublot, the unit mass of the lot/sublot will be the average of the test results unless they differ by more than 20 kg/m^3, in which case the lower result will apply. Averaged results must be rounded to the nearest 10 kg/m^3.

Where three or more cores are available from a lot/sublot, the unit mass of the lot/sublot will be the average of the test results and must be rounded to the nearest 5 kg/m^3. However, if the lowest result differs from the average by more than 30 kg/m^3, the lowest result will apply.

A5.2.4 Within-core Variability

Cores must be tested for variability in unit mass between the upper and lower parts of the core. The variability must not exceed 40 kg/m^3 when calculated as the difference between the two values using the measured unit mass values rounded to the nearest 10 kg/m^3.

Where more than one core is available from a Lot/sublot, the lowest unit mass core must not be chosen to test within core variability.

Cores which have been extracted under Clause 5.2.1 must be tested for variability at a frequency of one in three commencing at the pavement trial until three consecutive conforming results are obtained, and thereafter at a frequency of one in five unless a non-conformity occurs in which case the frequency must return to one in three. Cores for testing must be selected on the basis of time sequence of paving.

The core must be prepared for testing by sawing into two cylinders of equal length with a tolerance of ± 20 mm. The two parts must be jointly conditioned and tested. Each specimen must be assessed in accordance with RMS T368 for excessive voids and, if warranted, must be dressed prior to testing.

A5.3 CONCRETE COMPRESSIVE STRENGTH

A5.3.2 Cylinder Strength Testing

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

The following provisions also apply:

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

(b) The frequency of sampling must be in accordance with Clause 5.3.2 and sampling must comply with AS 1012.1. For agitator delivered concrete, sampling must occur at the point of discharge after any retempering.

The cylinders must be inspected, capped and crushed in accordance with AS 1012.9. Their unit mass must be determined in accordance with Clause A5.2.1.

If the age of the test specimens is greater than 28 days at the time of compressive testing, the test results must be adjusted for age in accordance with Clause A5.3.4.

The compressive strength (f_c) of concrete represented by a pair of cylinders will be the average test value, except that the higher result will apply if the difference in the results exceeds 10% of the average. However, as soon as ten pair results become available, the following condition will apply. If the mean of such differences for ten consecutive pairs (up to and including that in question) is greater than or equal to 5% of the mean strength value for all twenty cylinders, then the compressive strength for a pair must be taken as the average of the two results.

A5.3.3 Core Strength Testing

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

(a) for slipformed base, three cores must be taken at locations separated by at least one quarter of the length of the lot;

(b) for manually paved base, two cores must be taken at locations separated by at least one third of the length of the lot;

(c) for transition lots, one core must be taken;

(d) cores must be wet-conditioned immediately prior to testing in accordance with AS 1012.14, except that Clause 6.4(d)(i)(B) therein must be amended by replacement of 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.

The test results must be adjusted for age and shape in accordance with clause A5.3.4.

A5.3.4 Conformity for Strength

Correction factors, AF for age and SF for shape, are given in Tables A3.4 and A3.5 respectively. For intermediate ages factor AF must be determined on a pro-rata basis rounded to the nearest second decimal place.

The test strength must be multiplied by factor SF and divided by factor AF to derive the “factored strength”. The correction factors must be applied to the unrounded strength.

Table A3.4 - Age Correction Factors

Age of specimen at time of test (days)	Correction Factor (AF)					
	Compressive Strength				Flexural Strength [2]	
	Cylinders		Cores		Beams	
	Flyash content (%) [1]					
	< 10	10 – 25	< 10	10 – 25	< 15	= 15
28	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	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	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	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 binder content.

[2] Not specified for lot acceptance.

Table A3.5 - 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

A5.4 GEOMETRY AND THICKNESS

A5.4.1 (Not Used)

A5.4.2 Level Survey

A5.4.2.1 Survey Procedures

For the purpose of determining finished surface levels on the concrete subbase and base, carry out a survey in accordance with RMS G71.

Levels, reported to the nearest millimetre, must be taken with a flat based staff of base area between 300 m^2 and 4000 m^2, and at the following locations:

(a) (i) at cross-section offsets shown in Figure A3.1;

(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.

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

When the Contractor adopts a survey procedure which produces an as-built level model of both the top of 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 design levels (after applying the approved design adjustment), refer to Clause A3.2.4) and differences. Highlight all levels and differences that are out of tolerance and locations specially surveyed for apparent nonconformity. Actual levels that are above design levels must be shown as +ve differences and actual levels that are below design levels must be shown as -ve differences. The mean of differences shall be the algebraic sum of the differences excluding locations specially surveyed for apparent nonconformity.

A5.4.2.2 Assessment of Nonconforming Levels

Base surface levels must be assessed for conformity on the basis of individual survey results as follows:

(a) Nonconforming lots must be intensively surveyed for assessment against the design thickness criteria specified in Clause A3.2.4.

(b) Submit a nonconformity report, attaching the survey report and the relevant assessment of thicknesses.

A5.5 SURFACE PROFILE

A5.5.1 (Not Used)

A5.5.2 (Not Used)

A5.5.3 Roughness

A5.5.3.1 (Not Used)

A5.5.3.2 Assessment of Incentive/Deduction Value for Roughness

The method of calculating the incentive/deduction value for ride quality follows:

(i) Each nominated pavement test section must be divided into segments 100 m long.

On multiple lane carriageways, each traffic lane must be tested and assessed separately.

Any segment less than 100 m must be included with the segment immediately preceding it, and an average roughness must be determined for the total segment.

(ii) Transverse construction joints must be included 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.

(iii) Testing must be conducted within each traffic lane and within the planned wheelpaths, except that the testing line must be adjusted to comply with sub-clause (iv).

(iv) The testing wheels must not run closer than 0.3 m to a formed longitudinal joint except in ramp gore areas as per (v) hereunder.

(v) Ramp gore areas must be tested in the wheelpath which a vehicle would typically follow when loading on or off the through carriageway.

Unless otherwise specified, the gore kerb nose (between the ramp and the through carriageway) will constitute the limit of the gore area.

Longitudinal joints within the ramp gore must be ignored for the purpose of roughness testing.

For gore areas which widen to dual ramp lanes, the roughness result must be the average of separate runs along wheelpaths leading to each lane.

(vi) The incentive/deduction for any segment (with the exception of ramp gores) must apply to the width of the slab bounded by longitudinal joints.

For the left (slow) lane of a typical dual lane carriageway, the incentive/deduction must apply to the slab width bounded by the formed shoulder joint and the induced central joint. For the adjacent right (fast) lane, the result must apply to the width bounded by the central induced joint and the outer median edge, including any integrally placed median shoulder.

(vii) The incentive/deduction within gore areas must apply to the total width of the traffic lanes bounded by outer edgelines.

(viii) Where a longitudinal joint runs down the middle of a traffic lane, the joint must be ignored for the purpose of roughness testing, subject to compliance with sub-clause (iv). The result so obtained must apply to the combined width of the two adjoining slabs bounded by the next longitudinal joints.

(ix) Where shoulders are too narrow to fully contain the test vehicle, the vehicle must run with two wheels within the test lane and the other wheels within the adjacent lane. The result so obtained will hereafter be referred to as a “composite” result.

Where the adjacent lane was constructed under the contract, the composite result must be applied to the shoulder in accordance with this Specification.

Where the adjacent lane was constructed by others, no incentive/deduction will apply to the shoulder.

A5.6 NOT USED

A5.7 RECTIFICATION OF FINISHED SURFACE AND RIDE QUALITY

Grinding must be carried out with purpose-built equipment employing gang-mounted diamond saw blades. Impact methods such as rotomilling must not be used.

Grinding equipment must be capable of grinding to a width of not less than 1.0 m in a single pass and must create a line-type texture as follows:

(a) grooves must be uniformly spaced and must number between 170 and 200 per metre of width to suit the particular concrete and to produce grooves as per (b);

(b) the height between the peaks and troughs must be 2 ± 1 mm.

ANNEXURE R84/4 – MINIMUM FREQUENCY OF TESTING

Clause	Characteristic Analysed	Test Method	Minimum Frequency Of Testing
Supply of Concrete for Base			
3.3	Particle size distribution of combined aggregate: - by calculation or - by wet-sieving (3)	AS 1141.11 By calculation T329 (3)	 One per 1500 m^3 of concrete
	Fine aggregate:	---	---
2.3	- Material < 75 micrometre	AS 1141.12	Manufactured or unwashed natural sand: One per 1000 tonnes. Washed natural sand: One per 5000 tonnes.
4.2.1	- Particle size distribution; deviation from nominated particle size distribution	AS 1141.11	One per 400 tonnes
2.2	- Water absorption	AS 1141.5	Once within 12 months prior (4)
2.2	- Bulk density	AS 1141.4	In the trial mix
2.2	- Soundness	AS 1141.24	One per 4000 tonnes
2.2	- Organic impurities	AS 1289.4.1.1	One per 2000 tonnes
2.2	- Sugar content	AS 1141.35	One per 10000 tonnes
	Coarse aggregate:	---	---
4.2.1	- Particle size distribution; deviation from nominated particle size distribution	AS 1141.11	One per 400 tonnes
2.3	- Bulk and particle density	AS 1141.4, AS 1141.6	In the trial mix
2.3	- Water absorption	AS 1141.6	Once within 12 months prior (4)
2.3	- Material < 75 micrometre	AS 1141.12	One per 5000 tonnes
2.3	- Particle shape	AS 1141.14	One per 2000 tonnes (1)
2.3	- Average Least Dimension	T235	One per 2000 tonnes (1)
2.3	- Wet strength	T215	One per 2000 tonnes (2)
2.3	- Wet/dry strength variation	T215	One per 2000 tonnes (2)
2.3	- Weak particles	AS 1141.32	One per 5000 tonnes
2.3	- Light particles	AS 1141.31	One per 5000 tonnes
2.3	- Iron unsoundness (slag)	AS 1141.37	One per 5000 tonnes
2.3	- Falling or dusting unsoundness (slag)	AS 1141.61	One per 5000 tonnes
2.3	- Fractured faces	T239	One per 1000 tonnes

Clause	Characteristic Analysed	Test Method	Minimum Frequency Of Testing
2.1	Alkali-aggregate reactivity	See Clause 2.1	Once within 12 months prior (4)
2.1	Soluble salts	See Clause 2.1	Once per 30,000 m^3 of concrete
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
Notes: (1) Provided that all of the six previous tests have met specification requirements for both particle shape and average least dimension then a reduced frequency of 1 per 4000 tonnes should apply. (2) 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 should apply; - where all wet/dry variation results are < 25% : 1 per 10,000 tonnes - where all wet/dry variation results are < 30% : 1 per 4,000 tonnes (3) Only the +1.18 mm fraction need be tested; Annexure R84/3 Clause A3.3.2 refers. (4) Within 12 months prior to the date of closing of tenders, or else in conjunction with the trial mix.			
Placing Concrete in Base			
2.6	Conformity of curing compound	AS 3799, as supplemented by RMS 3202 Annexure R84/3	As per RMS 3202 Annexure R84/3 Clause A2.6
4.1.2	Pull-out test on tiebars		As per Clause 4.1.2
4.3.6	Average depth of longitudinal surface texture		
	(a) Longitudinal texture	RMS T240 or T192	Only where transverse tining is not specified, one per 2000 m^2 of base.
	(b) Total surface texture	RMS T240 or T192	One per 2000 m^2 of base
4.3.7	Application rate of curing compound	See Clause 4.3.7	One per 2000 m^2 of base
4.5.1	Joint & sealant dimensions	As per the Drawings	As per Clause A4.5.1
4.3.8.4	In-situ compressive strength (for trafficking purposes)	Cylinders as per RMS T367, or Cores as per Clause 4.3.8.4	Moulding frequency of two (2) pairs per 250 m^3 As per Clause 4.3.8.4
	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

Clause	Characteristic Analysed	Test Method	Minimum Frequency Of Testing
4.2.1	Flexural strength	AS 1012.11	As per Annexure R84/3 Clause A4.2.1
5.2	Relative compaction of concrete	AS 1012.12 Method 2, as amended	As per Annexure R84/3 Clause A5.2.2
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	Surface profile	See Clause 5.5	As per Clause 5.5
5.5.3	Roughness	T182 or T187	As per Clause 5.5.3

ANNEXURE R84/5 – DEFINITIONS

1 DEFINITIONS

Agitator An item of plant or equipment which maintains the plastic concrete in the mixed state. Consistent with common usage, this term is also used (for convenience) in lieu of "*mobile batch mixer*".

Anchor slab The base slab which lies over an anchor

Approach sections Pavement which is located within 15 m of bridges (or other structures) where the concrete base is discontinuous, or within 15 m of contract limits.

Batch A quantity of concrete containing a fixed amount of ingredients and produced in a discrete operation.

Batching The process of combining the concrete ingredients in fixed proportions by mass or by volume, including charging and mixing.

Cement Material complying with RMS 3211.

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 comply with the requirements of 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 the batch is discharged from the mixer.

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

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

(d) For a continuous mixer discharging into a tipper truck, this will be the time at which discharge commences into the truck.

(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.

Delivery Time The elapsed time measured from the completion of batching to the arrival at site within 100 m of the point of placement.

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 (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	An edge or joint which relieves contraction stresses in joints and/or sections which are aligned approximately parallel with that edge. A relief edge is provided by an untied joint, by a free edge or by an expansion or isolation joint.
Fixed-form paving	Also referred to as "manual" and "hand" paving. Paving between fixed formwork and using manually operated equipment such as internal vibrators and vibrating screeds.
Formed joint	All joints except for induced joints. This includes slipformed and fixed-formed joints and edges.
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 (where applicable).
Haul Time	The elapsed time measured between the completion of batching and the completion of discharge of the mix.
Joint	A planned discontinuity in the concrete, other than an edge, and which conforms with Clause 4.5.
Joint, mismatched	A joint which terminates on the edge of a slab. Only tied joints are allowed to mismatch.
Lap (in reinforcement)	A splice in which the bars are in contact over the full lapped length, with sufficient ties to ensure contact in the hardened concrete.
Load	A single truckload of concrete comprising one or more batches.
Lot	As defined in RMS Q, refer to RMS R84 Clause 5.3.1.
Mixers	Mixer types as per AS 1379 Clause 4.2
Mixing Time	Applicable to batch mixers only; the mixing time for each batch must be measured from the time all the ingredients are in the mixing drum until the time mixing at the specified rate, or after specified revolutions, ceases.
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.
Process mean	$\overline{\overline{X}}$; see Section 3 - Symbols
Range	In the context of Clause 4.2.1, "range" is defined as the difference between the highest and lowest values within a five-point group.
Relative compaction	percentage ratio of the core unit mass of the lot/sublot to the rolling cylinder unit mass (RCUM) for the lot/sublot. In the case of SFCP, it shall be the percentage ratio of the core unit mass of the lot/sublot to the rolling beam unit mass (RBUM) for the lot/sublot.

Retempering	The addition of water to a batch after "completion of batching", followed by remixing of the concrete before placement.
Rolling cylinder unit mass (RCUM)	The rolling mean for five consecutive pairs of 28-day cylinders prior to and including the relevant lot/sublot, or for fewer than five pairs, the mean value of the pairs available.
Rolling statistical results	Calculated using groups of consecutive results, with progression in single increments.
Skew, Road	Applicable at locations such as bridge abutments, it is the complement of the Bridge Skew (i.e. 90° – Bridge Skew).
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” and “machine” paving. Paving by a purpose-built machine with the capacity to spread, compact, screed and finish the concrete in accordance with Annexure R84/3 Clause A4.3.1 and without fixed formwork. (Note that for specialised applications, a slipformer can be used over fixed forms, which work is deemed to comply with this definition.)
Squared standard deviation	s^2; see Section 3 - Symbols
Test result	The result from a single test specimen or sample.
Test value	The value calculated from single test “results” to represent the lot/sublot (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”.
Trafficked slab	A slab (bounded by longitudinal joints) which lies either totally or in part within the trafficked carriageway as defined by lane lines.
Transition zone	Hand vibrated concrete which is cast with otherwise machine paved concrete, such as transverse construction joints in machine paved work. Clause 5.3.1 refers.
Transition point	The point at which vibration on a paving machine commences or ceases effective compaction. Clause 5.1 refers.
Wet curing	Curing at ambient temperature in which the concrete surface is effectively covered with water or placed 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

2 ABBREVIATIONS

ACRS	Australian Certification Authority for Reinforcing Steels
CSIRO	Commonwealth Scientific and Industrial Research Organisation, Australia
NATA	National Association of Testing Authorities, Australia
RMS	Roads and Maritime Services
SMZ	Selected Material Zone
LCS	Lean-mix concrete subbase
PCP	Plain concrete pavement (base)
PCP-R	Discrete reinforced slabs within PCP
CRCP	Continuously reinforced concrete pavement (base)
JRCP	Jointed reinforced concrete pavement (base) - dowelled
SFCP	Steel fibre reinforced concrete pavement (base)

3 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
f_{fMin}	The specified minimum 28-day flexural strength in the Work
f_f	The actual 28-day flexural strength in the Work
$\overline{\overline{X}}$	Process mean calculated on a rolling basis using 100 values (ie k=100). Prior to 100 values becoming available, all available values must be used.
S	Process standard deviation calculated on a rolling basis using 100 values (ie k=100). Prior to 100 values becoming available, all available values must be used.
s^2	Squared standard deviation calculated on a rolling basis using 100 values (ie k=100). Prior to 100 values becoming available, all available values must be used.

s_R	Five-point rolling standard deviation.

Notes:

(1) The leading uppercase “F” refers to results in the trial mix.
The leading lowercase “f” refers to results in the work.

ANNEXURE R84/6 – SCHEDULE OF HOLD AND WITNESS POINTS

Clause	Type	Description
3.2	Hold	High subbase levels
3.2 & RMS 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
4.3.8.4	Hold	Trafficking of base
4.4	Hold	Base paving subject to paving trial
RMS G71 (& 5.4.2)	Hold	Survey Report verifying base conformity
5.6.1	Hold	Removal and replacement of nonconforming concrete base

ANNEXURE R84/7 – SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of RMS Q Annexure Q/E.

Clause	Description of the Identified Record
2.6	Certify by written report that the curing compound complies with this Specification, and submit NATA endorsed test results
2.7	Certify that the proposed sealant complies with the Specification and provide all relevant test results
2.7	Certify compliance of each production batch of sealant.
2.8	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 Lot plus proposal for Corrective Action to achieve conformity
4.3.8.4	In-situ strength test results of the base
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 R84/8 – COMPARISON WITH RMS R83 (NOT PART OF CONTRACT)

This Annexure is included for information only and does not form part of the Contract.

RMS R84 has a many requirements common with RMS R83 Jointed Concrete Base. The following is a summary of clauses where RMS R83 and RMS R84 differ significantly.

The references to RMS R83 clauses and annexures in RMS R83 become references to RMS R84 clauses and annexures in RMS R84; these are not shown in the following summary.

Clause	Topic	Differences in Requirements
1.1	Scope	Minor differences in scope description.
3.1	Reinforcement	Description of the use of reinforcement omitted in RMS R84.
3.5	Concrete Strength	Maximum concrete strengths specified in RMS R84, test methods are different.
4.1.1	Placing Steel	Locations and their tolerances are different.
4.2.1	Production Mixes	Control charts for concrete strength extended in RMS R84.
4.7	Special Slabs	Requirements for Odd and Mismatched Slabs omitted in RMS R84.
5.1	Concrete Cracking	Major differences between RMS R83 and RMS R84.
5.5.3.2	Roughness Assessment	Pay Item numbers different.
5.6.2	Removal of Base	Major differences between RMS R83 and RMS R84.
6	Payment	Pay Items different, measurement of steel specified in RMS R84.
Annexure	**R84/3**	
A4.5.2	Joints	Transverse contraction joint requirements omitted in RMS R84.
A5.2.1(c)	Coring	Figure showing areas where coring is prohibited omitted in RMS R84.
Annexure	**R84/5**	
	Definitions	Slab, Odd shaped slab, Mismatched slab omitted in RMS R84.