TRANSPORT FOR NSW (TfNSW)

QA SPECIFICATION 3201

CONCRETE SUPPLY FOR PAVEMENT MAINTENANCE

REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/Rev 0	All	Draft for trial use.	GM, RNIC	28.09.04
Ed 2	4.1.5 Annexure M2	"Agitating Speed" replaced by "Mixing Speed". Definition of "Agitation Speed" deleted. Definition of "Mixing Speed" added. Amendment to definition of "Mixing Time".	GM, RNIC	26.05.06
Ed 3	Notes 1 2	Rearranged & numbered. Mix selection tables combined & simplified. Note re Alkali-Aggregate Reaction added. New clause 1.1 re Intended use added. Requirement of meeting AS 1379 added. Definition of RMS Mix Codes added. Mix Codes suffixes revised to (a) distinguish S25A10 for spraying (becomes S25A10SH) from S25A10 for slipform, and (b) allow for introduction of SP40HC. Added requirements for concrete supplier PQP, documentary evidence, 30 minutes workable time.	GM, IC	29.08.07
	2	Tables 1 to 4: • Revised Mix Code suffixes • Deleted N25, added N40 and SP40HC. • Differentiated S25A10SH from S25A10 • Added Early Age Strength to SP40H • Corrected cementitious in SP6 to match R82 • Moved cementitious materials so they adjoin.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 3 (cont'd)	2 (cont'd)	• Tightened air entrainment tolerance to 1% • Deleted " — " footnote symbol and substituted (*) or (i) to clarify meaning.		
	3	Moved Table 6 so it applies only to Special-class concrete Confined Clause 3.4.6 to unsurfaced Base concrete. Deleted AAR clause and substituted Clauses 3.4.7 to 3.4.9 which are consistent with B80.		
	4.1.2	Added min. & max. temperature.		
	4.1.4	Requirement for Work Method Statement.		
	4.1.5	Clause simplified and clarified.		
	4.1.6	Clause tightened and renumbered to 4.1.7.		
	Annex D.2.3	Less than 75 kg/m3 of steel fibre permitted provided equivalent performance can be demonstrated		
Ed 3/Rev 1	Global	Format corrected.	GM, IC	24.10.07
Ed 3/Rev 2	Global	Updated cross references to suit new M spec. nos.	GM, IC	05.08.08
Ed 4/Rev 0	Global	General technical review, and revision of some technical requirements. Format revised.	GM, IC	04.02.13
Ed 4/Rev 1	Guide Notes	New Clause 4.2.16 added to Guide Notes.	GM, CPS	20.08.15
	Tables 1, 3 & 4	New mix code added to Table 1. Admixture row amended in Tables 3 & 4. Note (i) to tables amended with new Note (ix) added.		
	2.3.3	New Clause 2.3.3 added.		
	Annex A	New Clause A.2 added for non-chloride admixtures.		
	Annex M	Referenced documents updated.		
Ed 4/Rev 2	Global	References to "Roads and Maritime Services" or "RMS" changed to "Transport for NSW" or "TfNSW" respectively.	DCS	22.06.20
Ed 5/Rev 0	Global	New edition, totally reorganised and rewritten. Major technical changes are highlighted below.	EDCS	11.05.21
	5.3	Combined particle size distribution requirement in Table 2 revised to match R83 requirements.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 5/Rev 0 (cont'd)	5.3	Requirement for minimum percent of natural sand, quartz and chert in fine aggregate deleted. Durability criteria of fine aggregate added. Aggregate exposure classification requirement deleted.		
	6.2	Mixes for general use (covered in spec R53) deleted.		
	6.3	Calcium chloride mixes now only allowed for overnight slab replacement work involving not more than two adjoining PCP or one adjoining JRCP slab. New HES base and subbase mixes with CSA cement added. Requirement for air entrainment removed.		

GUIDE NOTES

(Not Part of Contract Document)

Specification TfNSW 3201 Edition 5

Edition 5 has been totally reorganised and rewritten to improve clarity and remove duplication, and incorporate a number of changes to the technical requirements.

The Revision Register provides a summary of the main changes in Edition 5. Due to the reorganisation and the rewording of the content, in many cases different parts of a clause in Edition 4 have been moved to separate locations in Edition 5. Such relocations are not detailed in the Revision Register.

GN1 Relationship to Other TfNSW Technical Documents

3201 is used in conjunction with the following technical documents:

(a) Specification 3211 "Cementitious Materials, Binders and Fillers".

(b) Specification M258 "Slab Replacement (Concrete Pavement)".

(c) Specification R83 "Concrete Pavement Base".

(d) Standard Drawings for Rigid Pavement Maintenance (Volumes MP, MJ and MC).

The TfNSW Project Manager and Surveillance Officer should be familiar with the specific requirements and underlying reasons for the concrete pavement maintenance work.

GN2 Scope

3201 covers the supply of concrete for pavement slab replacement works, which is delivered to work sites from commercial batch plants, and accordingly cross refers to AS 1379.

3201 incorporates many requirements for concrete that are specified in Specifications R82 and R83. It extends the mix options available to include high early strength concrete and steel fibre reinforced concrete (SFRC).

3201 does not include requirements for formwork, concrete placing or curing. This is covered under M258.

3201 is not suitable for structural bridgeworks or major culverts. Specification B80 is the applicable specification.

Concrete mixes for general concrete maintenance work other than concrete pavements are removed from Edition 5 of 3201, as the requirements are specified in Specification R53. For such mixes, refer to R53. If early opening to traffic is required for kerbs, channels (gutters) and layback replacement, refer to Standard Drawing for "Developer Works Standard Kerb Details".

GN3 Mix Code

Mix codes in this Specification are aligned with AS 1379 for strength grade. In addition, a suffix and/or prefix is also included in the strength grade code to indicate other criteria under the Specification.

GN4 Mix Design

The various mixes which are suitable for pavement maintenance work is shown below in Table GN.1.

Table GN.1 – Concrete Mixes and Suitability

Concrete Pavement Type	Work Constraint or Issues	Mix Code & Description [1]	Suitability
PCP, PCP-R and JRCP	Lane closure of 2 days or more. Hand placing.[2] Joints.[2]	**SP40**: Special-class 40 MPa concrete for pavement.	Generally not suitable for slab with corner angle less than 84°.
All types of base course except SFCP	Lane closure of less than 12 hours. Hand placing.[2] Joints.[2]	**SP40HC1**: Special-class 40 MPa concrete for pavement with additional early age strength requirements. $CaCl_2 \leq 0.8\%$.	Generally not suitable for slab with corner angle less than 84°. Not more than 2 adjoining PCP slabs or one adjoining JRCP slab.[3]
All types of base course except for SFCP and CRCP	Lane closure of less than 12 hours. Hand placing.[2] Joints.[2]	**SP40HC2**: Special-class 40 MPa concrete for pavement with additional early age strength requirements. Up to 2% $CaCl_2$ permitted.	Generally not suitable for slab with corner angle less than 84°. Not more than 2 adjoining PCP slabs or one adjoining JRCP slab.[3]
PCP, PCP-R, JRCP, CRCP	Lane closure of less than 12 hours.[2] Joints.[2]	**SP40HES**	Generally not suitable for slab with corner angle less than 84° (no limit on number of adjoining slabs).
All types of base course	No time constraint on placement. Hand placing.	**SFP5.5**: SFRC with flexural strength of 5.5 MPa.	Small repairs in all base types. Can be used for corner angle down to 75°.
SFCP (such as roundabouts)	Lane closure of 24 hours or more.	**SFP5.5**: SFRC with flexural strength of 5.5 MPa.	
	Lane closure of less than 12 hours.		Seek advice from Rigid Pavements Manager.
Subbase	No time constraint.	**SP6**: Lean-mix concrete with compressive strength greater than 6 MPa.	
Subbase	Lane closure of less than 12 hours. Joints.	**SP10HES**	Recommended for widening work, and for slab replacement works where ROL permits.

Notes:

PCP Plain concrete pavement (base)
PCP-R Reinforced plain concrete pavement (discrete slabs)
JRCP Jointed reinforced concrete pavement (base)
CRCP Continuously reinforced concrete pavement (base)
SFCP Steel fibre reinforced concrete pavement (base)
ROL Road occupancy licence

[1] Refer Clauses 6.2 and 6.3.

[2] Quality issues arising from hand placing and joints.

[3] Mixes containing calcium chloride ($CaCl_2$) accelerating admixtures can accelerate the corrosion of tiebars and reinforcement. The concrete strength of slabs using these mixes is much lower than that for R83 mixes at opening to traffic. Hence, these mixes are only recommended for individual slab replacement works, and

should not be used where more than 2 adjoining PCP slabs or more than one adjoining JRCP slabs are replaced.

GN5 40 MPa Mix - SP40

While SP40 mix is not used as an "accelerated" mix, it is possible to accelerate its strength gain to a moderate degree by applying a combination of measures which will not compromise its integrity.

The impact of these measures would be such as to reduce the time elapsed to opening required from, say, 5 days down to 3 or 4 days.

$CaCl_2$ must not be added to this mix, as it greatly increases the risk of premature failure. If a faster set is required, then other mixes (SP40HC1, SP40HC2 or SP40HES) should be used.

Such recommended measures include the following:

(a) Batch the mix at a reduced water/cement (w/c) ratio. Note, however, that:

  (i) Unless sophisticated mix designs and advanced admixtures are used, w/c ratio lower than about 0.35 should not be attempted.

  (ii) Low w/c ratio mixes may be difficult to texture when finishing. It is recommended that the TfNSW Project Manager conduct trials before their full use for slab replacement works.

(b) Adjust the slump by addition of high-range water reducing admixture (HWR) or high-range water reducing admixture with a retarding effect on set time (HWRRe).

  The normal slump range for manual paving is 55 mm to 75 mm, but adjustment by addition of HWR at the Site may not be as precise as with water. Small increases in HWR dosage can have large effects on slump. Slumps in the higher range will increase the risk of downhill flow on grades. Slumps in the lower range are acceptable as long as the vibration (both internal and surface) is thorough enough to fully compact the concrete.

  HWRRe may be preferable in hot conditions to retard the setting rate. This may reduce the strength within the first 24 hours, but should have a diminishing effect at later ages.

(c) Consider the Hunter Region's practice of using flood-lights as radiant heaters.

  Cover the work with thermal blankets (such as black polythene sheeting or similar) as soon as possible without risking damage to the curing compound or the surface texture. This will increase daytime slab temperatures and minimise overnight temperature losses.

  The covers must be thoroughly secured around all edges to prevent air movements.

  The covers should not be removed during very cold conditions, because the resulting thermal shock could induce structural cracking. Removal between mid-morning and mid-afternoon is preferable.

GN6 40 MPa Mixes with $CaCl_2$ Accelerating Admixtures - SP40HC1 and SP40HC2

GN6.1 General

$CaCl_2$ accelerates both the setting rate (aluminate reaction) and the strength gain (silicate reaction).

However, it accelerates the corrosion of steel reinforcement and tiebars. It can also adversely affect shrinkage and cause cracking.

Mixes containing doses of $CaCl_2$ greater than 0.8% greatly accelerate the corrosion of tiebars and reinforcement. Hence, it is not recommended for CRCP pavements. $CaCl_2$ must not be used with steel fibres which will quickly corrode because of their large surface area per unit mass.

Guidelines on dosage are provided in Clause GN6.8 of the Guide Notes.

Minimum cement content is specified in Table 3201.4. After achieving confidence in the proposed maturity testing for early strength, the requirement for minimum cement content will be reviewed and may be removed from the next revision of this Specification.

GN6.2 Minimising Corrosion

Steel corrosion increases with permeability of the concrete, especially in mixes containing $CaCl_2$; hence it is important that:

(a) The w/c ratio is kept low. Use admixtures, i.e. HWR, to achieve the desired slump/workability. However, sufficient water must be provided to enable adequate cement hydration.

(b) Compaction is thorough.

(c) Steel cover is adequate.

(d) The mix design minimises the dosage of $CaCl_2$. This is possible through the use of advanced admixtures.

GN6.3 Use of Fly Ash in Accelerated Mixes

Fly ash (as low as 50 kg/m^3) can assist later strength development arising from its pozzolanic reaction and reduce the free lime in hardened concrete, thereby improving durability. However, it may not be beneficial for early age strength development at low temperatures.

Accelerating admixtures can reduce the durability of concrete. This is another good reason for using fly ash in accelerated mixes, especially with potentially reactive aggregates.

GN6.4 Slump Control

For best results, the HWR should be added at the batch plant, but there may be situations where site addition is preferred.

$CaCl_2$ must not be added until just before the concrete is to be placed, as unexpected delays may occur at the Site. If $CaCl_2$ is added too early, then it will be very difficult to place and finish the concrete.

As with all mix additions (including water), it is critical that the batch be remixed after adding the HWR or $CaCl_2$ for the full mixing period of 3½ minutes.

Retempering should only be done under strict supervision. With accelerated mixes, if the slump falls at Site, it is better to use additional HWR rather than water.

GN6.5 Addition of Admixtures

The mixing of admixtures is usually far more successful (thorough) if admixtures are diluted with water prior to their addition to the bowl. If admixtures are added in its concentrated form, there is a risk of producing uneven reactions within the mix.

The water used for dilution will obviously increase the w/c ratio and this should be allowed for during initial batching so that the w/c ratio of the concrete at the point of discharge does not exceed the specified w/c ratio.

Provide personnel (at both the batch plant and in the field) with clear written guidelines for the incorporation of admixtures. Issues to be addressed include:

(a) Dosage rates (and their method of calculation).

(b) Sequence of addition.

(c) Whether simultaneous addition is accepted or recommended (for example, whether the HWR can be combined with the $CaCl_2$ solution in order to minimise the volume of added water).

(d) The upper limit of water which can be added.

(e) The 3½ minute minimum re-mixing time after the addition of extra ingredients (for example, admixtures and/or water) specified in 3201.

GN6.6 Compatibility of Accelerating Admixtures

Water reducing admixture (WRA) should not be mixed with HWR because of the resultant retarding effect.

HWRRe should also be avoided in accelerated mixes because of its retarding effect.

GN6.7 Heated Mixing Water

Acceleration of setting rate (and strength gain) can be assisted by heating the mixing water. The temperature of concrete should be limited to less than 35°C to avoid the risk of flash set.

GN6.8 Calculation of $CaCl_2$ Dose Rate in SP40HC1 and SP40HC2 Mixes

(a) The dose rate is specified in this Specification as the mass of $CaCl_2$ relative to the cement content, and not the total binder content. Hence, 1% $CaCl_2$ refers to 1 kg of $CaCl_2$ per 100 kg of cement.

(b) Commercial $CaCl_2$ solution is typically supplied at 24%, 30%, 33% or 37% strengths (by weight). Be careful not to confuse between the terms "mass of $CaCl_2$" and "mass of $CaCl_2$ solution".

(c) Calculation of volume of $CaCl_2$ solution required is as follows:

$$V_s = R \div M$$

where: V_s = volume of $CaCl_2$ solution required (litres per 100 kg of cement)

R = nominated $CaCl_2$ dosage rate (%)

M = mass of $CaCl_2$ (kg per litre of $CaCl_2$ solution)

= $CaCl_2$ solution strength × unit mass of solution
(percent by weight) (kg/litre)

The volume of $CaCl_2$ solution required have been calculated for typical dosage rates and are tabulated in Table GN.2.

Table GN.2 – Volume of $CaCl_2$ Solution Required at Typical Dosage Rates

(I)	(II)	(I) × (II)	Volume of Solution, V_s (= R ÷ M) [3]			Water Content, W [4]
$CaCl_2$ Solution Strength [1]	Unit Mass of Solution [2]	$CaCl_2$ Mass, M [2]	$CaCl_2$ Dosage Rate, R			
			0.5%	0.8%	1.0%	
24	1.22	0.295	1.7	2.7	3.4	0.8
30	1.28	0.385	1.3	2.1	2.6	0.8
33	1.30	0.430	1.2	1.9	2.3	0.75
37	1.35	0.500	1.0	1.6	2.0	0.75

Notes:

(1) In % by weight.

(2) In kg of $CaCl_2$ per litre of solution.

(3) In litre per 100 kg of Type GP cement.

(4) In litre per litre of $CaCl_2$ solution.

Example calculation of volume of $CaCl_2$ solution

To calculate the volume of $CaCl_2$ solution to be added per 100 kg cement, using a 30% (strength) solution and 0.8% $CaCl_2$ dosage rate (= R) from nominated mix design, carry out the following steps:

From Table GN.2, for a 30% solution, unit mass = 1.28 kg/L

M = 30% ×1.28 = 0.385 kg of $CaCl_2$ per litre of solution

R = 0.8%, i.e. 0.8 kg/100 kg cement

V_s = 0.8 ÷ 0.385 = 2.08, say 2.1, measured in litres of solution **per 100 kg of Type GP cement in batch**

To calculate the total volume of solution (V_t) to be added **to the batch**, carry out the following steps:

V_t = V_s (L per 100 kg cement) × [batch volume (m^3)] × [cement content (kg/m^3)]/100

For a 3.5 m^3 batch with a cement content of 450 kg/m^3 using a 0.8% dose of 30% solution strength,

V_s = 2.1 litres/100 kg cement (from previous example and Table GN.1)

V_t = 2.1 × 3.5 × 450/100 = 33 litres, say 35 litres.

(d) The mix water must be adjusted for $CaCl_2$ solution added. Otherwise, the limits on w/c ratio and slump could be exceeded. In accordance with Table GN.2, water constitutes 0.8 litres for each litre of added solution of 30% strength.

35 litres of solution includes 35 × 0.8 = 28 litres of water, which is 28 ÷ 3.5 m^3 = 8 litres/m^3

Assuming w/c ratio = 0.45

For w/c ratio = 0.45, the water content = 0.45 × 450 = 202 litres/m^3.

(If the supplier has designed the mix for a w/c limit lower than 0.45, then use that value in the calculation.)

Hence, at batching, the water content must not exceed (202 – 8) = 194 litres/m^3.

Adjustment of slump must be by addition of HWR and not by addition of extra water.

GN7 Non-chloride, Non-corrosive Accelerating Admixture

The Specification has been amended to allow for the use of non-chloride, non-corrosive accelerating admixtures as an alternative to $CaCl_2$ accelerating admixtures.

Non-chloride, non-corrosive accelerating admixtures can be used under this Specification for the production of SFRC.

A trial concrete mix must be specifically designed for the addition of a non-chloride, non-corrosive accelerating admixture using cement, fine and coarse aggregates, and other materials that will be used for the proposed work. The new concrete mix must be trialled under the conditions under which it will be used.

The work crew must be trained in the handling and placement of the new concrete mix, because it cannot be assumed that a new accelerated concrete mix will necessarily behave similarly to accelerated concrete mixes that have been used previously.

GN8 SFRC Mixes

GN8.1 SFRC Standard Mix

$CaCl_2$ must not be used with this mix, as steel fibres will quickly corrode due to their large surface area per unit mass.

The supplier must demonstrate that the nominated concrete mix meets the flexural strength requirements by providing flexural strength test results of the trial mix.

Use of flexural strength tests for production control is expensive. A relationship between flexural strength and compressive strength values for a given concrete mix is to be developed in the laboratory to define an equivalent mean compressive strength, which corresponds to the acceptable flexural strength. In assessing the quality of concrete during production, conformity with the equivalent mean compressive strength is used.

It is critical to ensure that the correct amount of steel fibres has been added to the mix and the fibres are evenly dispersed and do not clump. Checking of batching of steel fibres at the batch plant may be necessary.

While the standard SFRC mix is not used as an "accelerated" mix, it is possible to accelerate its strength gain to a moderate degree without compromising its integrity.

The recommended practices are as follows:

(a) Adjust the slump by the addition of HWR or HWRRe. Refer to Clause GN5 of these Guide Notes.

(b) Batch the mix at a lower w/c ratio. Note, however, that, unless sophisticated mix designs and advanced admixtures are contemplated, w/c ratio must be greater than 0.35 to ensure hydration of the cement.

(c) Consider the practice of using flood-lights as radiant heaters.

GN8.2 SFCP HES Mix Using Calcium Sulfoaluminate (CSA) Cement

SP40HES mixes can also be used in SFCP. The mix design and information on the proposed equipment for mixing of steel fibres must be submitted to TfNSW Rigid Pavements Manager for assessment and trial before use.

GN9 HES Mixes Using CSA Cement

Additional requirements for HES mixes using CSA cement are specified in Annexure 3201/E.

GN10 Addition of Water or Admixture on Site

Addition of water (retempering) or admixtures on Site should only be carried out under strict supervision and in accordance with AS 1379.

It is important that the water added (including that in the admixture) does not cause the w/c ratio to exceed that of approved mix design.

GN11 Alkali-aggregate Reaction (AAR)

Aggregates must be assessed individually for AAR. Weighted assessment is not acceptable as supplementary cementitious materials (SCMs) are generally not added to mitigate the AAR.

Transport for NSW

QA SPECIFICATION 3201

CONCRETE SUPPLY FOR PAVEMENT MAINTENANCE

IC-QA-3201

VERSION FOR:
DATE:

CONTENTS

CLAUSE **PAGE**

FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW 3201 Edition 4 Revision 2.

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

PROJECT SPECIFIC CHANGES

Any project specific changes are indicated in the following manner:

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

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

TfNSW QA SPECIFICATION 3201

CONCRETE SUPPLY FOR PAVEMENT MAINTENANCE

1 SCOPE

This Specification sets out the requirements for the supply of concrete in slab replacement work for concrete pavements, including mix design, production, and delivery of the concrete.

This specification must be used in conjunction with Specification TfNSW M258.

2 STRUCTURE OF THE SPECIFICATION

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

2.1 PROJECT SPECIFIC REQUIREMENTS

Project specific requirements are shown in Annexure 3201/A.

2.2 SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

The schedules in Annexure 3201/C list the **HOLD POINTS** that must be observed. Refer to Specification TfNSW Q for definition of **HOLD POINT**.

The records listed in Annexure 3201/C are Identified Records for the purposes of TfNSW Q.

2.3 FREQUENCY OF TESTING

The minimum frequencies of testing are shown in Annexure 3201/L.

Where a minimum frequency is not specified, nominate an appropriate frequency.

2.4 REFERENCED DOCUMENTS

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

Standards, Specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure 3201/M.

3 DEFINITIONS AND ACRONYMS

3.1 DEFINITIONS

The terms "you" and "your" mean respectively "the Contractor" and "the Contractor's", or "the Supplier" and "the Supplier's", as appropriate.

The term "the Supplier" means the supplier of the product covered by the scope of this Specification.

The following definitions apply to this Specification:

Mix code	An alphanumeric code that uniquely defines the properties of the concrete mix. Refer to Clause 6.2 and Table 3201.3.
Mixing speed	The drum speed in revolutions per minute shown on the mixer identification plate as "Mixing Speed".
Plastic (concrete)	The consistency of freshly mixed concrete before initial set occurs.
Production assessment	An assessment procedure for concrete defined by strength grade, carried out by the supplier and based on the statistical assessment of standard compressive strength tests on concrete, specified by compressive strength and produced by a specific supplying plant, as defined in AS 1379.
Project assessment	An assessment procedure for concrete defined by strength grade, specified at the customer's option, which provides additional test data for the statistical assessment of concrete supplied to a specific project, as defined in AS 1379.
Special-class	Concrete which is specified to have certain properties or characteristics different from, or additional to, those of normal-class concrete and in accordance with AS 1379.

3.2 ACRONYMS

AAR	Alkali-aggregate reaction
ATIC	Australian Technical Infrastructure Committee
MBU	Mobile batching unit
$CaCl_2$	Calcium chloride
CSA (cement)	Calcium sulfoaluminate (cement)
HES (concrete)	High early strength (concrete, using CSA cement)
HWR	High-range water reducing admixture; typically a "superplasticizer"
HWRRe	High-range water reducing admixture with a retarding effect on set time
SFCP	Steel fibre reinforced concrete pavement
SFRC	Steel fibre reinforced concrete

4 QUALITY MANAGEMENT SYSTEM

The Supplier must have in place a Quality Management System complying with AS/NZS ISO 9001 as a means of ensuring that the product(s) conform to this Specification.

Provide evidence verifying compliance with this Clause.

5 MATERIALS

5.1 GENERAL

Materials used in the production of concrete must comply with AS 1379 and the additional requirements in this Specification. Where there is a conflict in the requirements, the requirements in this Specification takes precedence over that in AS 1379.

5.2 CEMENT AND SUPPLEMENTARY CEMENTITIOUS MATERIALS

Cement and supplementary cementitious materials (SCMs) must conform to the requirements of Specification TfNSW 3211.

Requirements for calcium sulfoaluminate (CSA) cement are specified in Annexure 3201/E.

5.3 AGGREGATES

5.3.1 General

Aggregates used in the manufacture of concrete must comply with AS 2758.1, except as qualified in Table 3201.1.

Table 3201.1 - Aggregate Properties

Property	Aggregate	Test Method	Requirements
Water absorption	Individual fine aggregates	AS 1141.5	Maximum 5%
	Individual coarse aggregates	AS 1141.6.1 or AS 1141.6.2	Maximum 2.5% (Maximum 6% for slag aggregate)
Soundness (sodium sulphate)	Individual fine aggregates	AS 1141.24	Maximum 6.0% (1)
Flow cone time (2)	Total fine aggregates	TfNSW T279	Maximum 27 seconds
Wet strength	Individual coarse aggregates	TfNSW T215	Minimum 80 kN
Wet/Dry strength variation	Individual coarse aggregates	TfNSW T215	Maximum 35%
Glass content	Total fine aggregates	TfNSW 3154	Maximum 15%

Note:

(1) Weighted average loss.

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

For base concrete, the combined aggregate particle size distribution must conform to Table 3201.2.

Table 3201.2 - Combined Aggregate Particle Size Distribution

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

Notes:

(1) Values shown within brackets are for guidance only. Provide actual values used in nominated mix design for information only, but the values will not be a consideration for acceptance purposes.

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

(3) Acceptance to be assessed in accordance with the procedure in Specification TfNSW R83 Clause 2.3.

5.3.2 Alkali-aggregate Reaction (AAR)

Carry out a petrographical examination of the aggregates using ASTM C295.

Assess each aggregate using the accelerated mortar bar test in Test Method TfNSW T363, but with the nominated binder in place of general purpose cement. Classify each aggregate in accordance with TfNSW T363 Table T363/A.

From the classification obtained by the testing, deal with the aggregates as follows:

(a) Where the aggregate is classified as “non-reactive”: no further action is required.

(b) Where any of the aggregates in the mix is classified as “slowly reactive”: review the petrographic examination report. Do not use aggregates containing “obviously reactive” components in the petrographic report in the Works. Examples of “obviously reactive” components are as follows:

(i) opaline material;

(ii) unstable silica minerals, such as moderate amounts of tridymite and cristobalite;

(iii) sheared rock containing moderate amounts of strained quartz and microcrystalline quartz.

The Principal will consider the suitability of using “slowly reactive” aggregates in the Works, based on the mortar bar test and the petrographic examination reports.

Alternatively, carry out further testing of the aggregate to Test Method TfNSW T364 using the nominated binder, to verify whether or not it is "non-reactive".

(c) Where any of the aggregates in the mix is classified as "reactive":

either:

(i) Use a different aggregate and repeat testing to TfNSW T363 using the nominated binder;

or

(ii) Carry out further testing of the aggregate to TfNSW T364, using the nominated binder, to verify whether or not it is "non-reactive".

Do not use aggregates that are classified as "reactive" by TfNSW T364.

5.4 WATER

Water used in the production of concrete must be free from materials harmful to concrete and steel reinforcement, and be neither salty nor brackish. The water must conform to AS 1379 and the following:

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

(b) sulfate ion: maximum 400 mg/L, determined by AS 1289.4.2.1.

Water which is drawn solely from a reticulated drinking water supply is deemed to conform to the above.

If the water contains a component from a source other than reticulated drinking water supply, the combined mixing water must conform to the requirements of this Clause.

5.5 ADMIXTURES

Chemical admixtures and their use must conform to AS 1478.1.

Where combinations of two or more admixtures are proposed for use, their compatibility with each other must be certified in writing by their manufacturers.

6 DESIGN OF CONCRETE MIXES

6.1 WORKABILITY

Concrete mixes must remain workable for at least 90 minutes after completion of batching and until it is delivered, placed, compacted and finished.

$CaCl_2$ mixes must remain workable for at least 30 minutes after addition of $CaCl_2$.

Mixes produced in mobile batching units (MBU) must remain workable for at least 30 minutes after discharge from the MBU.

6.2 MIX CODE

Concrete mix codes under this Specification are consistent with AS 1379, as defined in Table 3201.3.

Table 3201.3 – TfNSW Mix Codes for Pavement Maintenance Work

Prefix / Suffix	Symbol	Description
Prefix	SP (1)	Special-class concrete for pavement.
Prefix	SFP (2)	Special-class SFRC for pavement.
Suffix	HC1	High early strength specified. Use of up to 0.8% $CaCl_2$ permitted.
Suffix	HC2	High early strength specified. Use of up to 2.0% $CaCl_2$ permitted.
Suffix	HES	High early strength specified. Use of $CaCl_2$ not permitted. CSA cement is used.
Suffix	H-NC	High early strength specified. Non-chloride, non-corrosive accelerating admixture is used.

Notes:

(1) The two digits after the prefix indicate the compressive strength in MPa (see Table 3201.4).

(2) The two digits after the prefix indicate the flexural strength in MPa (see Table 3201.4).

6.3 MIX DESIGN

6.3.1 Nominated Mix Design

Provide a mix design that complies with the requirements in Table 3201.4 for the specified mix code.

Do not use concrete mixes with $CaCl_2$ accelerating admixture where more than two adjoining Plain Concrete Pavement (PCP) slabs or more than one adjoining Jointed Reinforced Concrete Pavement (JRCP) slabs are to be replaced.

6.3.2 HES Mixes with CSA Cement

Comply with the additional requirements specified in Annexure 3201/E for mixes SP40HES and SP10HES with CSA cement.

6.3.3 Mixes with Non-chloride Non-corrosive Admixture

If so specified in Annexure 3201/A, provide a special-class (pavement) concrete mix design containing a non-chloride, non-corrosive accelerating admixture, as an alternative to using $CaCl_2$ accelerating admixture. Use the mix code SP40H-NC for the concrete mix covered by this Clause (refer also Table 3201.3).

With the exception of the references to $CaCl_2$, this concrete mix design must comply with the requirements of Table 3201.4, and other requirements of this Specification.

The SP40H-NC mix must have a documented track record of successful use in concrete pavement maintenance works, of the same type of work as that for the Contract.

Carry out a trial mix for the SP40H-NC concrete, using non-chloride, non-corrosive accelerating admixture and other constituent materials in accordance with Clause 6.4.

Table 3201.4 – Concrete Mix Requirements

Property	Mix Class and Code						
	SP40	**SP40HC1** (1)	**SP40HC2** (1)	**SP40HES** (1, 2)	**SFP5.5** (1, 3)	**SP6**	**SP10HES** (1, 2)
Compressive strength (MPa)	≥ 40 at 28 days	≥ 40 at 28 days	≥ 40 at 28 days	≥ 40 at 28 days	–	≥ 6, ≤ 17.0 at 28 days	≥ 10.0, ≤ 17.0 at 28 days (4)
Early age compressive / flexural strength (MPa)	–	Compressive strength ≥ 5 at 6 hrs	Compressive strength ≥ 5 at 6 hrs	Compressive strength ≥ 15 at 2 hrs, or flexural strength ≥ 2.6 at 2 hrs	Compressive strength ≥ 3 at 6 hrs	–	Compressive strength: Under concrete base: ≥ 3 at 2 hrs Under asphalt base: ≥ 4 at 2 hrs
Flexural strength (MPa)	–	–	–	≥ 5.0 at 28 days	≥ 5.5 at 28 days	–	–
Type SL cement (kg/m^3)	≥ 320	≥ 430	≥ 430	Nominated in mix design	≥ 300	≥ 90	Nominated in mix design
Fly ash (kg/m^3)	≤ 70	– (5)	– (5)	– (5)	≤ 110	≥ 100	–
Total binder (kg/m^3)	–	–	–	–	–	≥ 250	≥ 100
W/C ratio	≤ 0.5	≤ 0.45	≤ 0.45	≤ 0.45	≤ 0.5	Nominated in mix design	Nominated in mix design
Slump (mm)	55 to 75	55 to 75	55 to 75	± 20 of nominated slump at nominated time (5)	± 20 of nominated slump at nominated time (5)	50 to 70	± 20 of nominated slump at nominated time (5)
Placement method	Hand	Hand	Hand	Hand	Hand	Hand	Hand
Accelerating admixture (6)	Nil	$CaCl_2$ ≤ 0.8%	$CaCl_2$ > 0.8%, ≤ 2.0%	Nil	Nil	Nil	Nil
Project Assessment required (7)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cement	Type SL	Type SL	Type SL	HES	Type SL	Type SL	HES

Notes:

(1) Early strength and 28-day strength requirements must both be met.

(2) Refer to Clause 6.3.2 for HES concrete with CSA cement. Additional requirements on SP40HES and SP10HES mixes are specified in Annexure 3201/E.

(3) Steel fibre reinforced concrete (SFRC) must comply with the additional requirements in Annexure 3201/D.

(4) Maximum compressive strength of 25 MPa is acceptable if the drying shrinkage result tested in accordance with AS 1012.13 is ≤ 300 microstrains at 21 days or ≤ 400 microstrains at 56 days.

(5) Nominate an appropriate value.

(6) Refer to Clause 6.3.3 for mixes containing non-chloride non-corrosive admixtures.

(7) In accordance with AS 1379 Clause 6.5.

6.4 SUBMISSION OF NOMINATED MIX

Submit a nominated mix design with one of the mix codes listed in Table 3201.4, and complying with the applicable requirements for that mix code in Table 3201.4.

Alternatively, you may propose a mix which is currently listed as conforming to this Specification in the TfNSW Register of Concrete Mixes, available at: http://www.rms.nsw.gov.au/business-industry/partners-suppliers/register-of-materials/concrete-mix/conform-conc-mix.pdf.

Prior to commencing production of a new concrete mix or a changed concrete mix, submit to the Principal the following:

(a) Information on constituent materials:

(i) Cement and SCM: product name, ATIC registration number and supplier.

(ii) Aggregates: source, geological type, and AAR action (refer Clause 5.3.2).

(iii) Admixtures: supplier, type, name and dosage recommended by manufacturer.

(iv) Steel fibres (if applicable): supplier, dimension and nominated mix quantity.

(b) Information on the nominated mix:

(i) Constituent quantities, including cementitious material content, per yielded cubic metre of concrete, and w/c ratio.

(ii) Nominated particle size distribution of aggregates.

(iii) Nominated slump.

(iv) Most recent production assessment report. Where production assessment has not been carried out or has been suspended after the last production assessment report, recent test report(s) in lieu is acceptable.

(v) Where the production assessment report or recent test reports are not available, carry out a trial mix in accordance with AS1012.2 and submit the trial mix report.

When testing for strength for each age group during trial mix and project assessment, test a minimum of two specimens.

(c) Information for mix specified by flexural strength:

(i) Test results for flexural strength in accordance with Annexure 3201/D.

(ii) Equivalent mean compressive strength corresponding to specified flexural strength, in accordance with Annexure 3201/D, including test results and calculations.

HOLD POINT	
Process Held:	Production of each new or changed concrete mix.
Submission Details:	At least 5 working days before commencement of production, submit one of the following: **(a) For new mixes:** details and attachments as specified in Clause 6.3; or **(b) For nominated mixes from the TfNSW Register of Concrete Mixes:** a statement stating that the mix conforms to this Specification and is suitable for its intended use.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

7 PRODUCTION AND DELIVERY

7.1 GENERAL

7.1.1 Plant and Equipment

Plant and equipment used for production and delivery of concrete must comply with AS 1379 and this Specification.

7.1.2 Environmental

Unless a wash-out point is provided at the Site, do not dispose of excess concrete or waste water from washing the agitator onto the Site, but dispose of it in accordance with Specification TfNSW G36.

7.2 CONCRETE PRODUCTION AND DELIVERY

7.2.1 General

Production and delivery of concrete must be in accordance with AS 1379.

Concrete must be delivered by an agitator vehicle (mobile mixer). The duration of delivery must be limited to the extent that the requirements of Clause 6.1 are satisfied.

Concrete for use on the Works must be freshly batched and must not contain any left-over concrete from an earlier batch.

The identification certificate (delivery docket) for each delivery must contain the following details:

(a) Name of supplier, and location of batch plant.

(b) Serial number of certificate (sequential and pre-numbered).

(c) Date of supply.

(d) Name of customer.

(e) Project name and location.

(f) Mix identification (mix code).

(g) Maximum nominal size of aggregate.

(h) Specified slump.

(i) Quantity of concrete covered by certificate.

(j) Delivery vehicle identification.

(k) Time clock recording of both commencement and completion times of mixing.

(l) Quantity of water or admixture added after batching.
Quantity of concrete to which water or admixture was added.

(m) Other details: Batch information when requested.

7.2.2 Discharge

The temperature of the concrete at the point of discharge must not be less than 10°C or more than 30°C.

For accelerating admixtures added at the Site, the concrete temperature must be taken before adding the admixture.

When adding admixture(s) at the point of discharge, they must be accurately introduced into the mix by liquid dispensing equipment mounted on the truck. The admixture must be diluted to the level recommended by the manufacturer. Submit a procedure for adding admixtures to the mix at the point of discharge.

On arrival at the Site, mix the concrete at least 3½ minutes at the mixing speed before any concrete is discharged. If any materials (for example, $CaCl_2$, other admixtures, and water for slump adjustment) are later added to the mixer, remix the batch immediately after the addition for at least 3½ minutes at the mixing speed.

Any concrete that is not plastic and has reached initial set is rejected and must not be used in the Works.

For concrete batches with insufficient slump caused by it being a dry mix, but not due to an initial set, you may add water or an appropriate admixture within 60 minutes of completion of batching, in accordance with AS1379, but ensuring that the w/c ratio is not exceeded. Immediately after the addition of water (or admixture), remix the concrete for at least 3½ minutes at the mixing speed. Record the added water or admixture on the identification certificate for that batch, and take samples and test for slump and strength after the addition of water.

Record the location where each load of concrete was used.

8 CONFORMITY

Submit a project assessment report in accordance with AS 1379 for each concrete mix used under this Specification. Concrete must meet the strength and slump requirement of this specification.

Concrete test cylinders must be 100 mm diameter by 200 mm long, unless otherwise specified in Annexure 3201/D3.

ANNEXURE 3201/A – PROJECT SPECIFIC REQUIREMENTS

NOTES TO TENDER DOCUMENTER: (Delete this boxed text after completing Annexure 3201/A)

Complete the table below by filling in the required details.

Table 3201/A.1 – Concrete Mix Details

Contract Reference: ……				
Mix Code (1)	**Concrete Description** (1)	**Delivery Location and Quantity**		
		Road No.	**Road Name and Location**	**Quantity** (m^3)

Note:

(1) Refer to Table 3201.4.

ANNEXURE 3201/B – (NOT USED)

ANNEXURE 3201/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

Refer to Clause 2.2.

C1 SCHEDULE OF HOLD POINTS

Clause	Description
6.4	Production of each new or changed concrete mix

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW Q.

Clause	Description of Identified Record
6.3.1	Nominated concrete mix design
6.4	Information on constituent materials and nominated concrete mix
7.2.1	Identification certificates (delivery dockets)
8	Project assessment report

ANNEXURE 3201/D – STEEL FIBRE REINFORCED CONCRETE

D1 GENERAL

This Annexure sets out the additional requirements for steel fibre reinforced concrete (SFRC).

Provide details of the source, dimensions and nominated mix quantity of steel fibres.

Properties of steel fibres must comply with the requirements in TfNSW R83.

Do not use $CaCl_2$ accelerating admixture in SFRC slabs.

D2 SAMPLING AND TESTING OF SFRC

Test specimens to determine the compressive strength and flexural strength of a nominated mix during the trial mix in accordance with TfNSW R83.

Develop a relationship between flexural strength and compressive strength, based on laboratory trial mix test results. Determine an equivalent mean compressive strength which corresponds to the specified flexural strength.

D3 CONFORMITY

Take samples from the production mix at the Site and conduct cylinder compressive strength test in accordance with TfNSW R83.

Mean compressive strength in the production must be equal to or more than the defined equivalent mean compressive strength in the trial mix.

ANNEXURE 3201/E – HES CONCRETE (WITH CSA CEMENT) - ADDITIONAL REQUIREMENTS

E1 CEMENT

Submit the following information:

(a) Technical data sheet of cement, including cement type.

(b) Composition and performance reference standard for cement. Provide the name of standard and compliance information.

(c) Packing, marking and delivery reference standard for cement. Provide the name of standard and compliance information.

(d) Overseas accreditation of cement, if available. Provide relevant documents.

(e) Safety data sheet of cement, complying with Safe Work Australia requirements.

(f) Relative proportion of each binder types, if more than one binder is used. CSA cement content in total binder must not be less than 60%.

(g) Tests results of aggregates to TfNSW T363 and/or TfNSW T364 using nominated binder.

(h) Cement properties:

  (i) setting time;

  (ii) chloride content;

  (iii) sulfate (SO_3) content;

  (iv) compressive strength at 7 days;

  (v) shrinkage at 7 days and 28 days;

  (vi) Loss of Ignition (LOI);

  (vii) Fineness Index.

(i) Major oxide composition:

  (i) CaO;

  (ii) MgO;

  (iii) SiO_2;

  (iv) SO_3;

  (vi) Al_2O_3;

  (vii) Fe_2O_2;

  (viii) Alkali content (Na_2O equivalent).

E2 CONCRETE STRENGTH TESTING

Submit the mix design and the test results for both compressive strength and flexural strength testing. Submit also the early age concrete strength results.

For project assessment, you may elect to take samples and assess the concrete based on either compressive strength or flexural strength.

Where you elect to assess the concrete based on flexural strength:

(a) Make and cure specimens of nominal size 100 mm × 100 mm × 350 mm in accordance with AS 1012.8.2.

(b) Mould the specimens in accordance with Test Method TfNSW T304.

(c) Test the specimens in accordance with AS 1012.11.

E3 HARDENED BASE CONCRETE

Provide additional information for hardened base concrete in accordance with Table 3201/E.1 in the mix design submission. Where applicable, acceptance criteria have been included in Table 3201/E.1.

Table 3201/E.1 – Hardened Base Concrete Properties

Property	Test Method	Criteria
Chloride ion content	Refer to TfNSW R83 (test on 14-day sample)	Maximum 0.8 kg/m^3 of concrete
Shrinkage of concrete	AS1012.13 (21 days drying period)	Maximum 450 microstrains
pH	AS 1289.4.3.1	Minimum 11.0
Chloride penetration [(1)]		
(a) Accelerated chloride penetration test. Chloride ingress coefficient	NT Build 443 (28-day curing and 35-day submersion in solution)	Maximum 6.0 x 10^{-12} m^2/s
(b) Chloride migration coefficient from non-steady-state migration experiments	NT Build 492 (28-day curing)	Maximum 12 x 10^{-12} m^2/s

Note:

(1) Comply with either test (a) or test (b).

E4 MOBILE BATCHING UNIT (MBU)

Submit the following information of the MBU:

(a) Type and details of the MBU.

(b) Batching method (volumetric or weight batching).

(c) Proposed MBU calibration in accordance with the manufacturer's recommendation.

(d) Mixer uniformity testing of the MBU in accordance with AS 1379.

(e) Homogeneity of the aggregate mix during transport and mixing in the MBU to be demonstrated by dry mixing.

ANNEXURES 3201/F TO 3201/K – (NOT USED)

ANNEXURE 3201/L – MINIMUM FREQUENCY OF TESTING

Clause	Characteristic Tested	Test Method	Minimum Frequency of Testing
Production Assessment			
6.4 (1)	As specified in AS 1379		

Notes:

(1) Include the test results of early age strength test where specified in Table 3201.4.

(2) For project assessment, see TfNSW M258.

ANNEXURE 3201/M – REFERENCED DOCUMENTS

Refer to Clause 2.4.

TfNSW Specifications

TfNSW G36	Environmental Protection
TfNSW Q	Quality Management System
TfNSW R83	Concrete Pavement Base
TfNSW 3154	Granulated Glass Aggregate
TfNSW 3211	Cementitious Materials, Binders and Fillers
TfNSW M258	Slab Replacement (Concrete Pavement)

TfNSW Test Methods

TfNSW T215	Wet/dry strength variation
TfNSW T279	Flow Time and Voids Content of Fine Aggregate by Flow Cone
TfNSW T304	Moulding of Concrete Specimens for Testing in Compression, Indirect Tension and Flexure
TfNSW T363	Accelerated Mortar Bar Test for The Assessment of Alkali-Reactivity of Aggregate
TfNSW T364	Concrete Prism Test for AAR Assessment

Australian Standards

AS 1012	Methods of testing concrete
AS 1012.2	Preparing concrete mixes in the laboratory
AS 1012.8.2	Method for making and curing concrete – Flexural test specimens
AS 1012.11	Determination of the modulus of rupture
AS 1012.13	Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory
AS 1141	Methods for sampling and testing aggregates
AS 1141.5	Particle density and water absorption of fine aggregates
AS 1141.6.1	Particle density and water absorption of coarse aggregates – Weighing–in-water method
AS 1141.6.2	Particle density and water absorption of coarse aggregates – Pycnometer method
AS 1141.12	Materials finer than 75 μm in aggregates (by washing)
AS 1141.24	Aggregate soundness – Evaluation by exposure to sodium sulfate solution
AS 1289	Methods of testing soils for engineering purposes – Soil chemical tests
AS 1289.4.2.1	Soil chemical tests - Determination of the sulfate content of a natural soil and the sulfate content of the groundwater a soil - Normal method

AS 1289.4.3.1	Soil chemical tests - Determination of the pH value of a soil - Electrometric method
AS 1379	Specification and supply of concrete
AS 1478.1	Chemical admixtures for concrete, mortar and grout - Admixtures for concrete
AS 2758.1	Aggregates and rock for engineering purposes – Concrete aggregates
AS/NZS ISO 9001	Quality Management Systems – Requirements

Other Standards

ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete
NT Build 443	Concrete, Hardened: Accelerated Chloride Penetration
NT Build 492	Concrete, Mortar and Cement-Based Repair Materials: Chloride Migration Coefficient from Non-Steady-State Migration Experiments