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REVISION REGISTER

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<th>Ed/Rev Number</th>
<th>Clause Number</th>
<th>Description of Revision</th>
<th>Authorised By</th>
<th>Date</th>
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CEMENTS, BINDERS AND FILLERS

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IC-DC-3211
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FOREWORD

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BASE SPECIFICATION

This document is based on Specification RMS 3211 Edition 4 Revision 11.
RMS SPECIFICATION D&C 3211
CEMENTS, BINDERS AND FILLERS

1 SCOPE

This Specification sets out the technical requirements for the supply of:

(a) manufactured general purpose cements, blended cements, supplementary cementitious materials and other supplementary materials for use in concrete;

(b) binders for earthworks and granular pavement materials; and

(c) added fillers for asphalt.

2 REFERENCED DOCUMENTS

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure 3211/M.

3 DEFINITIONS AND ACRONYMS

3.1 Definitions

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

The following definitions apply to this Specification:

**Added Filler:** A material which is introduced from an external source, the majority of which passes a 0.075mm AS sieve.

**Amorphous silica:** A very fine pozzolanic material composed mostly of non-crystalline silica.

**Available lime:** Alkaline constituents which are readily soluble in a sucrose solution as determined by AS 4489.6.1, using the calculation for calcium hydroxide.

**Binder:** A powdered manufactured material used in small amounts in stabilisation to change the properties of existing material.

**Cement:** A hydraulic binder composed of general, special purpose or blended cement used alone or combined with one or more supplementary cementitious materials.

**Flue dust:** An inorganic mineral material derived from the cement manufacturing process. Also known as “baghouse dust” or “cement kiln dust”.

**Fly ash:** The solid material extracted from the flue gases of a boiler fired with pulverized coal.
Ground limestone: A calcium carbonate-rich rock dust derived from the grinding of sound unfired limestone and complying with this specification.

Hydrated Lime: Essentially calcium hydroxide in the form of a white powder produced by the addition of sufficient water to slake quicklime.

Powdered glass: A powdered form of glass that is usually a by-product of the domestic glass recycling industry.

Quicklime: Calcium hydroxide which can be readily slaked by reaction with water.

3.2 Acronyms

ASTM: American Society for Testing and Materials

ATIC: Australian Technical Infrastructure Committee (Australasian Procurement and Construction Council Inc)

GGBFS: Ground Granulated Iron Blast-Furnace Slag

ID: Identification number

ISSA: International Slurry Surfacing Association

JAS-ANZ: Joint Accreditation System for Australia and New Zealand

LoI: Loss on ignition

OSM: Other supplementary materials

SCM: Supplementary cementitious materials

4 Supplier’s Quality Management System

The Supplier must establish and maintain a Quality Management System complying with AS/NZS ISO 9001 as a means of ensuring that the product conforms to this Specification. The Quality Management System must be certified by a third party organisation accredited by JAS-ANZ.

Provide evidence verifying compliance with this Clause.

5 General

5.1 Storage

Store the cement, binder or filler materials in silos, bins or sheds to keep the contents dry and free from contamination.

Use them in the date order they were delivered with the earliest delivered batches to be used first. Reject materials containing lumps or signs of moisture absorption. Retest before use any bagged and bulk cement that are older than 3 months.
5.2 RECYCLED MATERIALS

For recycled materials that are the subject of “resource recovery exemptions” granted by the NSW Environment Protection Authority, both you and your suppliers must comply with the conditions attached to any exemption as a “consumer” or a “producer”, as appropriate, and provide evidence demonstrating such compliance including all record keeping requirements.

6 CEMENTS FOR CONCRETE

6.1 CEMENTS

Blended cements for concrete may comprise a mix of general or special purpose cement and one or more of fly ash, ground granulated iron blast-furnace slag and amorphous silica. Blended cements may be blended either by the cement supplier or at the concrete batching plant.

Manufactured general or special purpose cement and blended cements must conform to AS 3972.

The components of cements blended at a concrete batching plant must conform to this Specification.

Make available evidence of conformity. Provide test reports of reportable properties and characteristics of cement in conformity with Clause 6.2 of AS 3972.

Limestone as a mineral addition must conform to AS 3972.

6.1.1 Cement Types

- General purpose cement (Type GP)
- Blended cement (Type GB)
- General purpose limestone cement (Type GL)
- High early strength cement (Type HE)
- Low heat cement (Type LH)
- Shrinkage limited cement (Type SL)

6.2 SUPPLEMENTARY CEMENTITIOUS MATERIALS

Supplementary cementitious materials (SCMs) may be supplied separately from general or special purpose cement to the concrete batching plant.

Where SCMs are supplied separately:
(a) Make available evidence of conformity;
(b) Provide test reports for each SCM.

6.2.1 Fly Ash

Fly ash must be fine grade to AS 3582.1.
For uniformity of supply, loss on ignition (LoI) calculated using the 30 most recent successive test results must conform to those shown in Table 3211.1.

### Table 3211.1 – Fly Ash Uniformity Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Formula</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon content (by loss on ignition)</td>
<td>$LoI_{avg} + 3SD$</td>
<td>$\leq 4%$</td>
</tr>
<tr>
<td>Fineness</td>
<td>$Fineness_{avg} + 3SD$</td>
<td>$\leq 100%$</td>
</tr>
<tr>
<td></td>
<td>$Fineness_{avg} - 3SD$</td>
<td>$\geq 75%$</td>
</tr>
<tr>
<td></td>
<td>$CoV$</td>
<td>$\leq 3.0%$</td>
</tr>
</tbody>
</table>

where:

- $LoI_{avg} = \text{Mean of the test results}$
- $SD = \text{Standard deviation of the test results expressed as a decimal}$
- $Fineness_{avg} = \text{Mean of the test results}$
- $CoV = \text{Coefficient of variation of the test results} = \frac{SD}{Fineness_{avg}} \times 100\%$

#### 6.2.2 Ground Granulated Iron Blast-Furnace Slag

Ground granulated iron blast-furnace slag (GGBFS) must conform to AS 3582.2.

For uniformity of supply, fineness calculated using the 30 most recent successive test results must conform to the following:

$$(Fineness_{avg} - 3SD) \leq Fineness_{sample} \leq (Fineness_{avg} + 3SD)$$

where:

- $Fineness_{sample} = \text{Individual test result}$
- $Fineness_{avg} = \text{Mean of the test results}$
- $SD = \text{Standard deviation of the test results expressed as a decimal}$

#### 6.2.3 Amorphous Silica

Amorphous silica must conform to AS/NZS 3582.3.

Where amorphous silica is added at the concrete batching plant, use in slurry form only. For slurried or densified amorphous silica, sample and test from the raw materials used to make these products.

### 6.3 OTHER SUPPLEMENTARY MATERIALS

#### 6.3.1 Powdered Glass

Powdered glass must conform to Table 3211.2. Sample and test powdered glass in conformity with this clause and Table 3211/L.1 in Annexure 3211/L.
### 6.4 Specific Requirements for Low Heat and Sulphate Resisting Concretes

Use the following cements:

(a) Type LH for low heat only;

OR

(b) Type GP or Type SL cement with a minimum of 25% fly ash (by weight as cement replacement) mixed at the concrete batching plant;

OR

(c) High GGBFS cement with minimum 65% GGBFS (by mass as cement replacement).

### 6.5 Product Pre-registration, Traceability, Sampling and Testing

Cements and SCMs for concrete must be pre-registered in accordance with ATIC-SPEC SP43.

A current list of registered cementitious materials may be found on the website at:


Select “Cementitious Materials Registration Scheme (CMRS)”.

Use only materials approved for use in the Works.

Sample, test and record results in conformity with Annexure 3211/L.

For each delivery of each material to be incorporated into the Works, conform to EITHER Clause 6.5.1 OR Clause 6.5.2.

Provide analytical test data demonstrating compliance of the product delivered, NATA endorsed in conformity with Specification RMS D&C Q6.

#### 6.5.1 Traceability Records

Provide a delivery docket with the following information, as applicable:

### Table 3211.2 – Powdered Glass Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Limit</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>% passing 300µm sieve</td>
<td>≥ 99.9%</td>
<td>AS 1141.11</td>
</tr>
<tr>
<td>% residue passing 45µm sieve</td>
<td>≤ 35%</td>
<td>AS 2350.9</td>
</tr>
<tr>
<td>Loss on ignition</td>
<td>&lt; 0.5%</td>
<td>AS 3583.3</td>
</tr>
<tr>
<td>Fineness index</td>
<td>&gt; 330 m²/kg</td>
<td>AS/NZS 2350.8</td>
</tr>
<tr>
<td>Sugar</td>
<td>None present</td>
<td>AS 1141.35</td>
</tr>
<tr>
<td>Chloride content</td>
<td>&lt; 0.1%</td>
<td>AS 3583.13</td>
</tr>
</tbody>
</table>
(i) Product name and/or identification code;
(ii) ATIC pre-registration number;
(iii) Date, time and place of loading of the material into the supply vehicle;
(iv) NATA sample ID (or laboratory ID) identifying which test results must be representative of the despatched load; and
(v) Analytical test data representative of the product delivered, NATA endorsed in conformity with RMS D&C Q6, demonstrating compliance with this Specification.

6.5.2 Full Compliance Certification of the Material Delivered
Where all the information in Clause 6.5.1 is not provided with the material delivery, sample, test and record results in conformity with Clause L2.1.3 of Annexure 3211/L.

6.5.3 Initial Sampling
Deliver to the RMS Representative a minimum 5 kg representative grab sample of cement to be used in the Works, with items (i) through (v) listed in Clause 6.5.1, packaged and labelled as detailed in AS/NZS 2350.1, in conformity with Clause L2.1.3 of Annexure 3211/L, within one week after the start of the Works.

6.5.4 Clinker Source Changes
When a source of clinker, or raw feed for clinker production, is relocated outside of an existing production facility, whether situated within or outside Australia, of less than five square kilometres in area contiguously, the ATIC pre-registration of the cement affected will be considered void.

At any time where this occurs:
(a) collect new samples and re-test in accordance with Annexure 3211/L; and
(b) carry out new trial mixes to the relevant specifications using the modified cement,

submit the test results from the above to either the Project Verifier or RMS Materials Register (as appropriate) for acceptance at least 14 days prior to the commencement of production of concrete using the modified cement.

7. BINDERS FOR EARTHWORKS AND GRANULAR PAVEMENT MATERIALS

7.1 GENERAL
Where a blended binder is specified, blend all components uniformly prior to delivery to the site of the Works. The proportions of the nominated blended binders must not vary by more than ± 3% from those nominated.

7.2 HYDRATED LIME
Hydrated lime must conform to Table 3211.3. Sample and test hydrated lime in conformity with this Clause and Table 3211/L.2 in Annexure 3211/L.
### 7.3 QUICKLIME

Quicklime must conform to Table 3211.4. Sample and test quicklime in conformity with this Clause and Table 3211/L.3 in Annexure 3211/L.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Available lime content, calculated as</td>
<td>AS 4489.6.1</td>
<td>≥ 85.0%</td>
</tr>
<tr>
<td>calcium hydroxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Sieve residue: % retained 300 µm sieve</td>
<td>AS 4489.2.1</td>
<td>≤ 2.0%</td>
</tr>
<tr>
<td>(c) Moisture content before use</td>
<td>AS 4489.8.1</td>
<td>≤ 1.0%</td>
</tr>
</tbody>
</table>

### 7.4 GROUND GRANULATED IRON BLAST-FURNACE SLAG

Ground granulated iron blast-furnace slag must conform to AS 3582.2 and the following additional requirements:

(i) The source material prior to milling must be of cementitious grade, and must have glass content greater than 85% when determined by the point count method specified in ASTM C295;

(ii) Mineral gypsum must be added during the milling process to provide appropriate setting times;

(iii) The sulphuric anhydride content of the final product, determined by testing in accordance with AS 3583.8, must not exceed 3.0%;

(iv) The fineness index of the final product, determined by testing in accordance with AS/NZS 2350.8, must be not less than 350 m²/kg.

### 7.5 FLY ASH

Fly ash must be fine or medium grade to AS 3582.1. Test results must indicate the grade of fly ash in the nominated mix design.
7.6  **CEMENTS**

Refer to Clause 6.1.

7.7  **POWDERED GLASS**

Refer to Clause 6.3.1.

7.8  **OTHER BINDERS**

Other binders as approved under the RMS Technology Program may be used.

7.9  **PRODUCT CONFORMITY**

Binders for earthworks and granular pavement materials must be supplied with test reports, NATA endorsed in conformity with RMS D&C Q6, verifying product conformity with Clause 8.6.

Unless specified above, sample, test and record results in conformity with Annexure 3211/L.

Each delivery must be clearly marked with:

(i)  Name of the supplier;
(ii) Product name and/or number;
(iii) Type being supplied;
(iv) Batch number and date of manufacture; and
(v)  Source of supply.

Certification must relate only to the composition on which the tests were made and must be valid for not more than three months. Provide new certification whenever changes in source of raw material or production process occur.

8  **ADDED FILLERS FOR ASPHALT**

8.1  **GENERAL**

Each type of filler from each source must be mineral material, dry, free from lumps, organic material or other deleterious matter, and conform to AS 2150.

8.2  **CEMENT WORKS FLUE DUST**

Collect cement works flue dust (also known as “baghouse dust”) from a cement manufacturing plant in the process of manufacturing cement conforming to this Specification.

The loss on ignition determined in accordance with AS 3583.3 must not exceed 6%.

The water soluble fraction determined in accordance with AS 1141.8 must not exceed 20%.
Determine and report the methylene blue value (MBV) of the portion of materials passing 0.075 mm AS sieve by AS 1141.11 in accordance with RMS T659.

8.3 GROUND LIMESTONE

Ground limestone must contain more than 75% by mass of CaCO$_3$. If the CaCO$_3$ content is less than 80%, the clay content as determined by the methylene blue test in accordance with RMS T659 must be less than 1.20% and the total organic carbon (TOC) content determined in accordance with EN 13639 must be less than 0.50% by mass.

The particle size distribution determined in accordance with AS 1141.11 must conform to Table 2 of AS 2150.

Loss on ignition determined in accordance with AS 4489.7.1 must not exceed 6%.

8.4 FLY ASH

Fly ash must be fine or medium grade to AS 3582.1.

8.5 HYDRATED LIME

Hydrated lime must conform to Table 3211.5.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Available lime content, calculated as calcium hydroxide</td>
<td>AS 4489.6.1</td>
<td>≥ 80.0%</td>
</tr>
<tr>
<td>(b) Sieve residue: % retained 300 µm sieve</td>
<td>AS 4489.2.1</td>
<td>≤ 2.0%</td>
</tr>
<tr>
<td>(c) Moisture content before use</td>
<td>AS 4489.8.1</td>
<td>≤ 1.0%</td>
</tr>
</tbody>
</table>

8.6 PRODUCT CONFORMITY

Sample and test fillers for asphalt materials in conformity with Clause 8 and Table 3211/L.5 of Annexure 3211/L.

9 MATERIALS REQUIREMENTS FOR SPECIFIC APPLICATIONS

In addition to the requirements stated previously, cement, binder and filler materials for specific applications must comply with the requirements in the relevant Annexure, as follows:
<table>
<thead>
<tr>
<th>Annexure</th>
<th>Associated RMS Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annexure 3211/A</td>
<td>D&amp;C B80  Concrete Work for Bridges</td>
</tr>
<tr>
<td>Annexure 3211/B</td>
<td>D&amp;C B82  Shotcrete Work</td>
</tr>
<tr>
<td></td>
<td>D&amp;C R68  Shotcrete Work Without Steel Fibres</td>
</tr>
<tr>
<td>Annexure 3211/C</td>
<td>D&amp;C R82  Lean-Mix Concrete Subbase</td>
</tr>
<tr>
<td>Annexure 3211/D</td>
<td>D&amp;C R83  Concrete Pavement Base</td>
</tr>
<tr>
<td>Annexure 3211/E</td>
<td>D&amp;C R53  Concrete (for General Use), Mortar and Grout</td>
</tr>
<tr>
<td></td>
<td>D&amp;C R81  No Fines Concrete Subbase</td>
</tr>
<tr>
<td></td>
<td>D&amp;C R132 Safety Barrier Systems</td>
</tr>
<tr>
<td></td>
<td>D&amp;C 3222 No-Fines Concrete (for Subsurface Drainage)</td>
</tr>
<tr>
<td>Annexure 3211/F</td>
<td>D&amp;C R50  Stabilisation of Earthworks</td>
</tr>
<tr>
<td></td>
<td>D&amp;C R71  Construction of Unbound and Modified Pavement Course</td>
</tr>
<tr>
<td></td>
<td>D&amp;C R73  Construction of Plant Mixed Heavily Bound Pavement Course</td>
</tr>
<tr>
<td></td>
<td>D&amp;C R75  Insitu Pavement Stabilisation using Slow Setting Binders</td>
</tr>
<tr>
<td></td>
<td>D&amp;C R90  Roller Compacted Concrete Subbase</td>
</tr>
<tr>
<td></td>
<td>D&amp;C 3221 Roller Compacted Concrete</td>
</tr>
<tr>
<td>Annexure 3211/G</td>
<td>D&amp;C R116 Heavy Duty Dense Graded Asphalt</td>
</tr>
<tr>
<td></td>
<td>D&amp;C R119 Open Graded Asphalt</td>
</tr>
<tr>
<td></td>
<td>D&amp;C R121 Stone Mastic Asphalt</td>
</tr>
<tr>
<td></td>
<td>D&amp;C R123 Thin Open Graded Asphalt Surfacing</td>
</tr>
<tr>
<td></td>
<td>D&amp;C 3266 Coldmix Asphalt</td>
</tr>
</tbody>
</table>
ANNEXURE 3211/A –D&C B80

Provide a monthly summary of test reports for all properties listed in Annexure 3211/L for general or special purpose cement, blended cements and SCMs.

A1 CEMENTS

(i) Type SL (shrinkage limited with autoclave expansion determined in accordance with ASTM C151 less than 0.8%); OR
(ii) Type GB (general purpose blended); OR
(iii) Type GP plus SCM(s).

A2 SCMs

(i) Fly ash;
(ii) GGBFS;
(iii) Amorphous silica.

A3 BLENDED CEMENTS

Blended cements must contain general purpose cement and one supplementary cementitious material (binary blended cement) or two supplementary cementitious materials (ternary blended cement) conforming to the ranges in Clause A5.

Blending of cement must be achieved either at the cement manufacturer's facilities and/or at the concrete batching plant. Where amorphous silica is added at the concrete batching plant, it must be added in a slurry form only.

A4 RMS D&C B80 SPECIAL APPLICATIONS

(i) Minimise alkali aggregate reactions as required in RMS D&C B80 Clause 2.5; AND/OR
(ii) For Exposure Classification C; AND/OR
(iii) When required in Annexure B80/A.

A5 PROPORTION OF SCMS IN BATCHED CONCRETE

<table>
<thead>
<tr>
<th>SCM</th>
<th>Min (% by mass)</th>
<th>Max (% by mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General</td>
<td>Special</td>
</tr>
<tr>
<td></td>
<td>Applications</td>
<td>Applications*</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>GGBFS</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Amorphous Silica</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

* refer Clause A4
### Table 3211/A.2 – Range of SCMs in Ternary Blend Cement for Concrete where TWO SCMs Used

<table>
<thead>
<tr>
<th>SCM I</th>
<th>SCM II</th>
<th>Combination A (% by mass)</th>
<th>Combination B (% by mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Max % SCM I</td>
<td>Min % SCM I</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>Amorphous Silica</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>GGBFS</td>
<td>Amorphous Silica</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>GGBFS</td>
<td>Fly Ash</td>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

**Note:** Linearly interpolate the percentage of SCMs in Combinations A and B in Table 3211/A.2 (see example in Figure 3211/H.1 of Annexure 3211/H).

Ternary blends other than those specified in Table 3211/A.2 may be used, subject to the provision of test results proving conformity of the concrete mix to the Nordtest limits specified in Table B80.6.
ANNEXURE 3211/B - D&C B82 AND D&C R68

Provide a monthly summary of test reports for all properties listed in Annexure 3211/L for general or special purpose cement and blended cements and SCMs.

B1 CEMENTS

(i) Type SL (shrinkage limited with autoclave expansion determined in accordance with ASTM C151 less than 0.8%); OR

(ii) Type GB (general purpose blended); OR

(iii) Type GP plus SCM(s).

B2 SCMS

(i) Fly ash;

(ii) GGBFS;

(iii) Amorphous silica.

B3 BLENDED CEMENTS

Blended cements must contain general purpose cement and one supplementary cementitious material (binary blended cement) or two supplementary cementitious materials (ternary blended cement) conforming to the ranges in Clause B5.

Blending of cement must be achieved either at the cement manufacturer’s facilities and/or at the concrete batching plant. Where amorphous silica is added at the concrete batching plant, it must be added in a slurry form only.

B4 SPECIAL APPLICATIONS

(i) Minimise alkali aggregate reactions as required in Clause 2.5 of RMS D&C B80; AND/OR

(ii) For Exposure Classification C; AND/OR

(iii) When required.

B5 PROPORTION OF SCMS IN BATCHED CONCRETE

Table 3211/B.1 – Range of Single SCM in Binary Blend Cement for Shotcrete

<table>
<thead>
<tr>
<th>SCM</th>
<th>Min (% by mass)</th>
<th>Max (% by mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General</td>
<td>Special</td>
</tr>
<tr>
<td></td>
<td>Applications</td>
<td>Applications*</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>GGBFS</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Amorphous Silica</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

* refer Clause B4
### Table 3211/B.2 - Range of SCMs in Ternary Blend Cement for Shotcrete where TWO SCMs Used

<table>
<thead>
<tr>
<th>SCM I</th>
<th>SCM II</th>
<th>Combination A (% by mass)</th>
<th>Combination B (% by mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Max % SCM I</td>
<td>Min % SCM I</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>Amorphous Silica</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>GGBFS</td>
<td>Amorphous Silica</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>GGBFS</td>
<td>Fly Ash</td>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

**Note:** Linearly interpolate the percentage of SCMs in Combinations A and B in Table 3211/B.2 (see example in Figure 3211/H.1 of Annexure 3211/H).
ANNEXURE 3211/C – D&C R82

C1 CEMENTS
(i) Type SL (shrinkage limited); OR
(ii) Type SL plus SCM(s).

C2 SCMS
(i) Fly ash; AND
(ii) GGBFS.

C3 PROPORTION OF CEMENTITIOUS MATERIALS IN BATCHED CONCRETE

Comply with the following requirements:
(i) The minimum mass of cementitious material must be 250 kg/m³;
(ii) The minimum SL cement content must be 90 kg/m³;
(iii) Limits for SCM for blends must be as detailed in Tables 3211/C.1 and 3211/C.2:

Table 3211/C.1 - Range of Single SCM in Binary Blend

<table>
<thead>
<tr>
<th>SCM</th>
<th>Min (% by mass)</th>
<th>Max (% by mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly Ash</td>
<td>40</td>
<td>75</td>
</tr>
<tr>
<td>GGBFS</td>
<td>10</td>
<td>70</td>
</tr>
</tbody>
</table>

Table 3211/C.2 - Range of SCMs in Ternary Blend where TWO SCMs Used

<table>
<thead>
<tr>
<th>SCM I</th>
<th>SCM II</th>
<th>Combination A (% by mass)</th>
<th>Combination B (% by mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Max % SCM I</td>
<td>Min % SCM II</td>
</tr>
<tr>
<td>GGBFS</td>
<td>Fly Ash</td>
<td>50</td>
<td>40</td>
</tr>
</tbody>
</table>

Note: Linearly interpolate the percentage of SCMs in Combinations A and B in Table 3211/C.2 (see example in Figure 3211/H.1 of Annexure 3211/H).
ANNEXURE 3211/D - D&C R83

D1 CEMENTS
(i) Type SL (shrinkage limited); OR
(ii) Type SL plus SCM(s).

D2 SCMs
(i) Fly ash; AND/OR
(ii) GGBFS

D3 PROPORTION OF CEMENTITIOUS MATERIALS IN BATCHED CONCRETE

Comply with the following requirements:
(i) For workability - The minimum mass of cementitious material must be as detailed in Table 3211/D.1.

Table 3211/D.1 - Minimum Mass of Cementitious Material (by Mix Type)

<table>
<thead>
<tr>
<th>Mix Type</th>
<th>Minimum Mass (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCP, JRCP, CRCP</td>
<td>300</td>
</tr>
<tr>
<td>SFCP</td>
<td>350</td>
</tr>
</tbody>
</table>

(ii) For carbonation resistance - The minimum proportion of cement, $SL_{\text{min}}$, is determined as follows:

$$SL_{\text{min}} \geq 100 - 0.55 \left[ FA + 0.5 \times GGBFS \right]$$

where:

- $SL_{\text{min}}$ = Minimum SL cement (% by mass)
- $FA$ = Mass of fly ash (kg/m³)
- $GGBFS$ = Mass of GGBFS (kg/m³)

(iii) For AAR prevention - Where SCMs are used in blends, the limits must be as detailed in Table 3211/D.2.

Table 3211/D.2 - Range of SCM Limits (Binary and Ternary)

<table>
<thead>
<tr>
<th>SCM</th>
<th>AAR Class</th>
<th>Limits $^{(1), (2)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min (%)</td>
<td>Max (%)</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>Non-reactive</td>
<td>15 – (0.5 x $GGBFS$%)</td>
</tr>
<tr>
<td></td>
<td>Reactive</td>
<td>20 – (0.5 x $GGBFS$%)</td>
</tr>
<tr>
<td>GGBFS</td>
<td>Non-reactive</td>
<td>10 – (2.0 x $FA$%)</td>
</tr>
<tr>
<td></td>
<td>Reactive</td>
<td>40 – (2.0 x $FA$%)</td>
</tr>
</tbody>
</table>
where:

\[
FA\% = \text{Percentage of fly ash by mass of total cementitious material}
\]

\[
GGBFS\% = \text{Percentage of GGBFS by mass of total cementitious material}
\]

Notes:

(1) It is acceptable to use mixes without SCMs. However, where they are used, these limits apply. For example, if fly ash is used with non-reactive aggregates, proportions between 1% and 14% are not acceptable.

(2) By mass, relative to total cementitious material.
ANNEXURE 3211/E - D&C R53, D&C R81, D&C R132, AND D&C 3222

E1 CEMENTS

(i) Type GP (general purpose); OR
(ii) Type GP plus SCM(s); OR
(iii) Type GL (general purpose limestone); OR
(iv) Type GB (general purpose blended).

Blended cements (items (ii) and (iv) above) must conform to the ranges in Clause E4.

E2 SCMS

(i) Fly ash;
(ii) GGBFS;
(iii) Amorphous silica.

E3 OSMs

(i) Powdered glass.

E4 PROPORTION OF SCMS AND OSMs IN BATCHED CONCRETE

Table 3211/E.1 - Range of Single SCM or OSM

<table>
<thead>
<tr>
<th>SCM or OSM</th>
<th>Min (% by mass)</th>
<th>Max (% by mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly Ash</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>GGBFS</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>Amorphous Silica</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Powdered Glass</td>
<td>5</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 3211/E.2 - Range of SCMs or OSMs in Ternary Blend where TWO SCMs or OSM Used

<table>
<thead>
<tr>
<th>SCM or OSM I</th>
<th>SCM or OSM II</th>
<th>Combination A (% by mass)</th>
<th>Combination B (% by mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly Ash</td>
<td>Amorphous Silica</td>
<td>Max % SCM I</td>
<td>Min % SCM II</td>
</tr>
<tr>
<td>GGBFS</td>
<td>Amorphous Silica</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>GGBFS</td>
<td>Fly Ash</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>Powdered Glass</td>
<td>Fly Ash</td>
<td>20</td>
<td>25</td>
</tr>
</tbody>
</table>

Note: Linearly interpolate the percentage of SCMs or OSM in Combinations A and B in Table 3211/E.2 (see example in Figure 3211/H.1 of Annexure 3211/H).
ANNEXURE 3211/F - D&C R50, D&C R71, D&C R73, D&C R75, D&C R90 AND D&C 3221

F1 BINDERS

(i) Hydrated lime;
(ii) Quicklime;
(iii) GGBFS;
(iv) Fly ash (fine or medium grade);
(v) Type GP (general purpose) cement;
(vi) Type GB (general purpose blended) cement;
(vii) Special purpose cements: HE, LH, or SL;
(viii) Blends of cements;
(ix) Powdered glass;
(x) Other binders (approved by RMS Technology Program).
ANNEXURE 3211/G - D&C R116, D&C R119, D&C R121, D&C R123 AND D&C 3266

G1 ADDED FILLERS

(i) Flue dust;
(ii) Ground limestone;
(iii) Fly ash;
(iv) Hydrated lime;
(v) Other mineral fillers.

Where the above materials are added as fillers in asphalt they must:

(a) when tested in accordance with AS 1141.17, have dry compacted voids of not less than 40%; and

(b) when tested in accordance with RMS T659, have a methylene blue value (MBV) of not more than 10 mg per gram of sample provided that the sample for this test must exclude hydrated lime or fly ash.
ANNEXURE 3211/H – EXAMPLE OF TERNARY BLENDS

Figure 3211/H.1 demonstrates a typical interpolation for ternary blends of SCMs, other supplementary materials or binders.

Figure 3211/H.1 - Example SCMs Combination (Fly Ash / Amorphous Silica) for Concrete

ANNEXURE 3211/I – (NOT USED)
ANNEXURE 3211/J – SAMPLE SUBMISSION FORM

ATIC - Cementitious Materials For Concrete Independent Verification

<table>
<thead>
<tr>
<th>ATIC Pre-registration Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-registration Number</td>
</tr>
<tr>
<td>Sample type</td>
</tr>
<tr>
<td>Individual</td>
</tr>
<tr>
<td>Composite</td>
</tr>
<tr>
<td>(tick as applicable)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cement or Blend Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Type or Name</td>
</tr>
<tr>
<td>Manufacturer</td>
</tr>
<tr>
<td>Place of Loading</td>
</tr>
<tr>
<td>Date of Loading</td>
</tr>
<tr>
<td>Time of Loading</td>
</tr>
<tr>
<td>Batch Number</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Name</td>
</tr>
<tr>
<td>Project Location</td>
</tr>
<tr>
<td>Deed No.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Submission Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispatching Organisation</td>
</tr>
<tr>
<td>Contact Name</td>
</tr>
<tr>
<td>Contact Phone No.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printed Name</td>
</tr>
<tr>
<td>Signature</td>
</tr>
<tr>
<td>Driver</td>
</tr>
<tr>
<td>Plant Operator</td>
</tr>
</tbody>
</table>

Send this form with the sample to:

RMS Southern Laboratory  
Attention: Laboratory Manager  
21 York Place  
Russell Vale NSW 2517
ANNEXURE 3211/L – COMPLIANCE REQUIREMENTS

L1 SCOPE

This Annexure sets out the means by which compliance must be demonstrated.

Include in the test reports specification limits and evidence of compliance.

L2 MINIMUM SAMPLING AND TESTING FREQUENCY PLANS

L2.1 Cements for Concrete

To demonstrate compliance of materials with AS 3972 and AS 3582 Parts 1, 2 and 3, respectively, the minimum sampling and testing frequency plans for the following materials must be as set out in ATIC -SPEC SP43 Appendix A (Compliance Requirements), amended as specified in Clause L2.1.1.

(i) General purpose and blended cements to AS 3972;
(ii) Fly ash to AS 3582.1;
(iii) GGBFS to AS 3582.2, and
(iv) Amorphous silica to AS/NZS 3582.3

The minimum sampling and testing plan for powdered glass must be as set out in Table 3211/L.1.

Table 3211/L.1 - Powdered Glass

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Method</th>
<th>Minimum Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particle size</td>
<td>AS 1141.11</td>
<td>Each 500t or weekly</td>
</tr>
<tr>
<td>Residue on 45µm sieve</td>
<td>AS 2350.9</td>
<td>Each 500t or weekly</td>
</tr>
<tr>
<td>Loss on ignition</td>
<td>AS 3583.3</td>
<td>Each 500t or weekly</td>
</tr>
<tr>
<td>Specified properties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fineness</td>
<td>AS/NZS 2350.8</td>
<td>Each 500t or weekly</td>
</tr>
<tr>
<td>Sugar</td>
<td>AS 1141.35</td>
<td>Each 500t or weekly</td>
</tr>
<tr>
<td>Chloride ion content</td>
<td>AS 3583.13</td>
<td>Each 500t or weekly</td>
</tr>
<tr>
<td>Relative water requirement</td>
<td>AS 3583.6</td>
<td>Each 500t or weekly</td>
</tr>
</tbody>
</table>
**L2.1.1 Modifications to ATIC-SPEC SP43 Appendix A**

<table>
<thead>
<tr>
<th>Clause</th>
<th>Modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2 – Conformity Assessment</td>
<td>Delete Clause A2</td>
</tr>
<tr>
<td>Table A1:</td>
<td>Delete: Chloride ion content (SCM); to AS 3583.13  &lt;br&gt; Delete: Autoclave expansion to limits given in ASTM C151; to AS/NZS 2350.17 or AS 3583.4  &lt;br&gt; Add: Autoclave expansion; to ASTM C151 and AS 3583.4</td>
</tr>
<tr>
<td>A3.15 – Blend Verification</td>
<td>Delete: Wording from “to ± 3% proportions ….” to “.... from a grab sample”  &lt;br&gt; A blend tolerance of ± 3% must be observed for each of the nominated cementitious materials.  &lt;br&gt; Each cementitious material must conform to the relevant Australian Standard.  &lt;br&gt; Verification of blend accuracy by chemical composition must be conducted on a weekly grab sample.</td>
</tr>
<tr>
<td>A3.16 – Sampling Plan</td>
<td>Delete: Clause A3.16</td>
</tr>
<tr>
<td>A3.17 – Type Testing (TT)</td>
<td>Delete: Clause A3.17</td>
</tr>
</tbody>
</table>

**L2.1.2 Sampling**

Sampling of materials must be carried out in conformity with the relevant Australian Standards to obtain individual samples randomly chosen as distinct from composite samples.

The RMS Representative may surveil sampling and testing and obtain samples at any stage and location for audit testing.

**L2.1.3 Sampling at Point of Delivery**

Where required in Clause 6.5, material samples must comprise 5 kg samples taken from the discharge line of the supply tanker when discharging to the inlet pipe of the batching plant silo or of the spreading plant. The sample must be taken towards the end of the tanker discharge. Samples must be obtained in a safe manner that eliminates contamination from previous deliveries or other sources.

If bulker bags or similar are used to deliver materials, obtain a minimum 5 kg sample from every bag or container at point of delivery.

Forward each 5 kg sample with records, packaging and labelling as detailed in AS/NZS 2350.1 to the RMS Southern Laboratory, 21 York Place, Russell Vale NSW 2517 (telephone 02 4222 3242). Include the product ATIC pre-registration number in the records. The batch plant operator must certify that the sample has been taken from the material as delivered to the batch plant.

Each sample will be stored for a minimum of three months prior to disposal.

All samples (including that initially specified) must be clearly labelled using the sample submission form in Annexure 3211/J.
L2.1.4 Retesting

In the event of a test failure, retesting is allowed. All test results must be supplied.

Should a failure on retesting occur, use of the material in question must be suspended until the cause of failure has been identified and corrected.

L2.2 Binders for Granular Pavements

L2.2.1 Hydrated Lime

The minimum sampling and testing plan for hydrated lime must be as set out in Table 3211/L.2.

Table 3211/L.2 – Hydrated Lime

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Method</th>
<th>Minimum Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available lime</td>
<td>AS 4489.6.1</td>
<td>1 per 600 tonne per source of supply</td>
</tr>
<tr>
<td>Residue on sieving</td>
<td>AS 4489.2.1</td>
<td>1 per 600 tonne per source of supply</td>
</tr>
<tr>
<td>Moisture content</td>
<td>AS 4489.8.1</td>
<td>1 per 600 tonne per source of supply</td>
</tr>
</tbody>
</table>

L2.2.2 Quicklime

The minimum sampling and testing plan for quicklime must be as set out in Table 3211/L.3.

Table 3211/L.3 – Quicklime

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Method</th>
<th>Minimum Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available lime</td>
<td>AS 4489.6.1</td>
<td>1 per 600 tonne per source of supply</td>
</tr>
<tr>
<td>Particle size (% passing )</td>
<td>AS 4489.2.1</td>
<td>1 per 600 tonne per source of supply</td>
</tr>
<tr>
<td>Active slaking time</td>
<td>AS 4489.3.1</td>
<td>1 per 600 tonne per source of supply</td>
</tr>
<tr>
<td>Temperature rise on slaking</td>
<td>AS 4489.3.1</td>
<td>1 per 600 tonne per source of supply</td>
</tr>
</tbody>
</table>

L2.2.3 Fly Ash

The minimum sampling and testing plan for fly ash (in granular pavements) must be as set out in Table 3211/L.4.

Table 3211/L.4 – Fly Ash

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Method</th>
<th>Minimum Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fineness</td>
<td>AS 3583.1</td>
<td>1 per Deed</td>
</tr>
<tr>
<td>Loss on Ignition</td>
<td>AS 3583.3</td>
<td>1 per Supplier’s production day</td>
</tr>
</tbody>
</table>

L2.3 Ground Granulated Iron Blast-Furnace Slag

Where not specified by AS 3582.2, testing must be as set out in Table 3211/L.5.
Table 3211/L.5 – GGBFS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Method</th>
<th>Minimum Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass content of slag</td>
<td>AS 4489.6.1</td>
<td>1 per 600 tonne per source of supply</td>
</tr>
<tr>
<td>Sulphuric anhydride content</td>
<td>AS 3583.8</td>
<td>1 per 600 tonne per source of supply</td>
</tr>
<tr>
<td>Fineness index</td>
<td>AS 2350.8</td>
<td>1 per 600 tonne per source of supply</td>
</tr>
</tbody>
</table>

L.2.4 Added Fillers for Asphalt

The minimum sampling and testing plan for added fillers for asphalt must be as set out in Table 3211/L.6.

Table 3211/L.6 – Added Fillers for Asphalt

<table>
<thead>
<tr>
<th>Characteristic Analysed</th>
<th>Test Method</th>
<th>Minimum Frequency Of Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry compacted voids (combined filler)</td>
<td>AS 1141.17</td>
<td>One per 10,000 tonnes or part thereof of asphalt production and at change in source of mineral matter.</td>
</tr>
<tr>
<td>Methylene blue value (combined filler excluding hydrated lime)</td>
<td>RMS T659</td>
<td>One per 10,000 tonnes or part thereof of asphalt production and at change in source of mineral matter.</td>
</tr>
<tr>
<td>Particle size distribution (cement works flue dust and ground limestone)</td>
<td>AS 1141.11</td>
<td>One per 500 tonnes of production of each added filler type</td>
</tr>
<tr>
<td>Fineness (fly ash)</td>
<td>AS 3583.1</td>
<td>One per 500 tonnes of fly ash production</td>
</tr>
<tr>
<td>Water soluble fraction (fly ash and cement works flue dust)</td>
<td>AS 1141.8</td>
<td>One per 500 tonnes of production of each added filler type</td>
</tr>
<tr>
<td>Loss on ignition (fly ash and cement works flue dust)</td>
<td>AS 3583.3</td>
<td>One per 500 tonnes of production of each added filler type</td>
</tr>
<tr>
<td>Available lime (hydrated lime)</td>
<td>AS 4489.6.1</td>
<td>One per 500 tonnes of hydrated lime production</td>
</tr>
<tr>
<td>Sieve residue (hydrated lime)</td>
<td>AS 4489.2.1</td>
<td>One per 500 tonnes of hydrated lime production</td>
</tr>
<tr>
<td>Moisture content (hydrated lime)</td>
<td>AS 4489.8.1</td>
<td>One per 500 tonnes of hydrated lime production</td>
</tr>
</tbody>
</table>

L.3 COMPLIANCE

Obtain evidence of compliance with this Specification.
ANNEXURE 3211/M – REFERENCED DOCUMENTS

RMS Specifications

RMS D&C Q6  Quality Management System (Type 6)
RMS D&C B80  Concrete Work for Bridges
RMS D&C B82  Shotcrete Work
RMS D&C R50  Stabilisation of Earthworks
RMS D&C R53  Concrete (for General Use), Mortar and Grout
RMS D&C R68  Shotcrete Work Without Steel Fibres
RMS D&C R71  Construction of Unbound and Modified Pavement Course
RMS D&C R73  Construction of Plant Mixed Heavily Bound Pavement Course
RMS D&C R75  In situ Pavement Stabilisation Using Slow Setting Binders
RMS D&C R81  No Fines Concrete Subbase
RMS D&C R82  Lean-Mix Concrete Subbase
RMS D&C R83  Concrete Pavement Base
RMS D&C R90  Roller Compacted Concrete Subbase
RMS D&C R116  Heavy Duty Dense Graded Asphalt
RMS D&C R119  Open Graded Asphalt
RMS D&C R121  Stone Mastic Asphalt
RMS D&C R123  Thin Open Graded Asphalt Surfacing
RMS D&C R132  Safety Barrier Systems
RMS D&C 3221  Roller Compacted Concrete
RMS D&C 3222  No Fines Concrete (for Subsurface Drainage)
RMS D&C 3266  Coldmix Asphalt

RMS Test Methods

RMS T659  Methylene Blue Adsorption Value of Road Construction Material

Australian Standards

AS 1141  Methods for sampling and testing aggregates
  AS 1141.8  Water-soluble fraction of filler
  AS 1141.11  Particle size distribution by sieving
  AS 1141.17  Voids in dry compacted filler
  AS 1141.35  Sugar
AS 2150  Hot mix asphalt - A guide to good practice
AS 2350  Methods of testing portland, blended and masonry cements
  AS/NZS 2350.1  Method 1: Sampling
AS/NZS 2350.8 Method 8: Fineness index by air permeability method
AS 2350.9 Method 9: Determination of residue on the 45 µm sieve
AS/NZS 2350.17 Method 17: Determination of soundness of masonry cement

AS 3582 Supplementary Cementitious materials for use with portland and blended cement
AS 3582.1 Part 1: Fly ash
AS 3582.2 Part 2: Slag – Ground granulated iron blast-furnace
AS/NZS 3582.3 Part 3: Amorphous silica

AS 3583 Methods of test for supplementary cementitious materials for use with portland and blended cement
AS 3583.4 Method 4: Determination of autoclave expansion
AS 3583.8 Method 8: Determination of sulfuric anhydride content
AS 3583.12 Method 12: Determination of available alkali
AS 3583.13 Method 13: Determination of chloride content

AS 3972 General purpose and blended cements
AS 4489 Test methods for limes and limestones
AS 4489.2.1 Method 2.1: Fineness - Wet sieving
AS 4489.3.1 Method 3.1: Slaking - Dewar flask
AS 4489.6.1 Method 6.1: Lime index - Available lime
AS 4489.7.1 Method 7.1: Loss on ignition - Quicklime, hydrated lime and limestone
AS 4489.8.1 Method 8.1: Free moisture - Convection oven

AS/NZS ISO 9001 Quality management systems – Requirements

ASTM Standards
ASTM C295 Standard Guide for Petrographic Examination of Aggregates for Concrete

Euro Norm Standards
EN 13639 Determination of Total Organic Carbon in Limestone

Australian Technical Infrastructure Committee (ATIC)
ATIC-SPEC SP43 Cementitious Materials for Concrete