TRANSPORT FOR NSW (TfNSW)

SPECIFICATION D&C 3221

ROLLER COMPACTED CONCRETE

REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/Rev 0		First issue	GM, IC W Stalder	01.07.11
Ed 1/Rev 1	Global	References to "Roads and Maritime Services" or "RMS" changed to "Transport for NSW" or "TfNSW" respectively. References to "RMS Representative" changed to "Principal".	DCS	22.06.20

Transport for NSW

SPECIFICATION D&C 3221

ROLLER COMPACTED CONCRETE

IC-DC-3221

VERSION FOR:
DATE:

CONTENTS

CLAUSE **PAGE**

FOREWORD

TFNSW COPYRIGHT AND USE OF THIS DOCUMENT

When this document forms part of a deed

This document should be read with all the documents forming the Project Deed.

When this document does not form part of a deed

This copy is not a controlled document. Observe the Notice that appears on the first page of the copy controlled by TfNSW. A full copy of the latest version of the document is available on the TfNSW Internet website: http://www.rms.nsw.gov.au/business-industry/partners-suppliers/specifications/index.html

BASE SPECIFICATION

This document is based on Specification TfNSW 3221 Edition 1 Revision 2.

TfNSW SPECIFICATION D&C 3221

ROLLER COMPACTED CONCRETE

1 SCOPE

This Specification sets out the requirements for the supply and delivery of roller compacted concrete for use in road pavements.

1.2 STRUCTURE OF THE SPECIFICATION

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

1.2.1 (Not Used)

1.2.2 Schedules of HOLD POINTS and Identified Records

The schedules in Annexure 3221/C list the **HOLD POINTS** that must be observed. Refer to Specification TfNSW D&C Q6 for the definition of **HOLD POINTS**.

The records listed in Annexure 3221/C are **Identified Records** for the purposes of Specification TfNSW D&C Q6 Annexure Q/E.

1.2.3 Planning Documents

The PROJECT QUALITY PLAN must, as a minimum, include each of the documents and requirements shown in Annexure 3221/D and must be implemented.

1.2.4 Testing Procedures

The Supplier is responsible for testing the product in accordance with the requirements of this Specification.

Testing must be completed by a laboratory accredited with the National Association of Testing Authorities Australia (NATA) for the relevant tests within seven working days after sampling. Where tests require curing, the maximum number of working days between sampling and completion of testing is seven plus the number of days specified for curing.

NATA endorsed documents certifying all sampling and test procedures for each test result must be issued by the laboratory.

The Inspection and Test Plan must nominate the proposed testing frequency to verify conformity of the item and it must not be less than that specified in Annexure 3221/L. Where a minimum frequency is not specified, nominate an appropriate frequency.

You may propose to the Principal a reduced minimum frequency of testing. The proposal must be supported by a statistical analysis verifying consistent process capability and product characteristics. The Principal may vary or restore the specified minimum frequency of testing, either selectively or permanently, at any time.

1.2.5 Referenced Documents

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 2350). For convenience, the full titles are given in Annexure 3221/M.

1.3 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:

Binder	A combination of cement and fly ash.
Coarse aggregate	That portion of a mineral aggregate retained on a 4.75 mm AS sieve.
Compactibility Index	A measure of the workability of roller compacted concrete.
Fine aggregate	That portion of a mineral aggregate passing a 4.75 mm AS sieve.
Nominated mix	A laboratory trial mix designated by a supplier to meet the specified requirements.
Production mix	A mix produced by a supplier using a stationary mixing plant to meet the specified requirements.
Roller compacted concrete	A relatively dry concrete mix with very low slump and compacted using smooth drum rollers.

1.4 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.

Provide evidence verifying compliance with this Clause.

2 MATERIALS

2.1 BINDER

Comply with Specification TfNSW D&C 3211, unless approved otherwise by the Principal.

2.2 AGGREGATES

Fine and coarse aggregates must comply with the requirements of Table 3221.1.

Table 3221.1 – Aggregate Properties

Property	Test Method	Requirement
Fine Aggregate		
Unit Mass (Bulk Density)	AS 1141.4	Min 1200 kg/m^3
Water Absorption	AS 1141.5	Max 5.0%
Soundness for Fine Aggregate	AS 1141.24	12% max weighted average loss
Material finer than 2 μm	AS 1141.13	Max 1%
Coarse Aggregate		
Unit Mass (Bulk Density)	AS 1141.4	Min 1200 kg/m^3
Water Absorption	AS 1141.5 AS 1141.6.1	Max 5.0% (slag aggregate - Max 6.0%)
Material finer than 75 μm	AS 1141.12	Max 10%
Wet Strength	TfNSW T215	Min 50 kN
Wet /Dry Strength Variation	TfNSW T215	Max 35%
Particle Shape: 2:1 ratio 3:1 ratio	AS 1141.14 AS 1141.14	Max 35% Max 10%

The combined particle size distribution must be in accordance with Table 3221.2.

Table 3221.2 – Combined Particle Size Distribution

AS Sieve Size (mm)	Percent Passing by Mass (AS 1141.11)
26.5	100
19.0	90 - 100
13.2	70 - 90
6.7	50 - 70
2.36	30 - 45

2.3 WATER

Water must be free from amounts of materials which are injurious to the roller compacted concrete such as oils, salts, acids, alkalis and vegetable substances. Water taken from other than a town water supply system must not contain more than:

(a) 600 parts per million of chloride ion in accordance with Test Method TfNSW T1004

(b) 400 parts per million of sulphate ion in accordance with Test Method TfNSW T1014

(c) 1% by mass of undissolved solids in accordance with AS 3550.4.

2.4 ADMIXTURES

Chemical admixtures and their use must comply with AS 1478, but they must not contain calcium chloride, calcium formate, triethanolamine or any other accelerator, unless approved in writing by the Project Verifier.

3 DESIGN REQUIREMENTS

3.1 DRYING SHRINKAGE

The drying shrinkage after 21 days air drying must not exceed 550 microstrain. Test in accordance with AS 1012.13 with compaction by external vibration.

3.2 COMPRESSIVE STRENGTH

Mould and cure test specimens in accordance with AS 1012.8.1. The compressive strength must be in accordance with Table 3221.3 for the nominated grade specified in Annexure 3221/A.

Table 3221.3 – Compressive Strength Grades

Grade	Compressive Strength at 28 days (AS 1012.9)	
	Nominated Mix	**Production Mix**
RCC5	≥ 6 MPa	≥ 5 MPa
RCC10	≥ 12 MPa	≥ 10 MPa
RCC20	≥ 22 MPa	≥ 20 MPa

3.3 COMPACTIBILITY INDEX

Nominate the required Compactibility Index at the point of discharge.

Determine the Compactibility Index of the roller compacted concrete in accordance with AS 1012.3.4, except for the timing of the test, which must be at the point of discharge.

3.4 ROLLER COMPACTED CONCRETE NOMINATED MIX DESIGN

The Supplier must:

(a) produce a trial batch of the nominated mix to demonstrate that the proposed mix design conforms with the design requirements of this Specification. Mould all specimens from the same homogenous batch;

(b) certify that the constituents of the nominated mix conform with the material requirements of this Specification;

(c) submit NATA endorsed test certificates for all relevant test results;

(d) submit the following details for each nominated mix:

(i) Cement - brand, source, type and age of test certificate

(ii) Fly ash - powerhouse source and grade

(iii) Nominated binder content expressed in kg/m^3 and as a percentage of the dry mass being bound

(iv) Water - source (for other than town water, provide the chloride ion and sulphate ion and undissolved solids content)

(v) Admixture(s) - proprietary source, type, name, dosage recommended by manufacturer(s), compatibility with other admixtures being used and changes to the type being used due to different seasons

(vi) Aggregates

- Source and geological type
- Particle size distribution in accordance with AS 1141.11
- Constituent quantities
- Properties as listed in Table 3221.2

(vii) Maximum dry density and optimum moisture content in accordance with Test Method TfNSW T130

(viii) Shrinkage in accordance with AS 1012.13 at 21 days

(ix) Compactibility Index in accordance with AS 1012.3.4

(x) Compressive strength at 7 and 28 days in accordance with AS 1012.9 with samples prepared to AS 1012.8.1 using a steel rammer for compaction.

The date of testing must be within three months prior to delivery to the work. If sufficient production mix results are available from within this period, the Principal may reduce the scope of the trial mix.

HOLD POINT

Process Held:	Delivery of concrete
Submission Details:	Submit, at least five working days before commencement of delivery, the following: - all test results and certificates together with a statement that the Nominated Mix Design complies with all the requirements of this Specification; - details of the mixing plant (refer Clause 4.1.1 and Annexure 3221/D); and - details of the vehicles (refer Clause 4.2.2 and Annexure 3221/D).
Release of Hold Point:	The Nominated Authority will consider the submitted documents prior to the release of the Hold Point.

4 PRODUCTION AND TRANSPORT

4.1 PRODUCTION

4.1.1 Plant

The stationary mixing plant must be capable of providing measurements of the binder incorporated in the mix, for each 200 tonnes produced, to within ± 0.3% of the dry mass of the material before the binder addition.

Provide daily calculations to verify conformity with the mix requirements.

Operate the plant in accordance with the manufacturer's recommendations. Mix the material, binder and water/admixture to produce a moist, homogeneous material conforming with the requirements of this Specification.

4.1.2 Production Mix

The Compactibility Index of the production mix must conform to the nominated Compactibility Index, within a tolerance of ± 10.

For the production mix, target the nominated design particle size distribution and binder content. The allowable tolerance on the aggregate particle size distribution is given in Table 3221.4. The allowable tolerance on the binder content is ± 3% by mass.

Table 3221.4 – Production Tolerances on Particle Size Distribution

AS sieve size (mm)	Production Tolerance (% by mass)
19.0	± 5
13.2	± 10
6.7	± 10
2.36	± 5

4.2 TRANSPORT

4.2.1 Discharge to Delivery Vehicles

Discharge materials from the mixer to a timed discharge hopper. Do not discharge directly from conveyor belts into delivery vehicles.

4.2.2 Delivery Vehicles

Deliver materials in vehicles fitted and operated with covers made of suitable material to prevent loss of moisture during transport.

Vehicles, where used for the delivery of materials to the hopper of a paving machine, must have bodies or discharge equipment that will enable the load to be discharged directly into the hopper without spillage on the road or segregation of material.

Provide sufficient number of delivery vehicles to ensure the delivery of roller compacted concrete at a uniform rate that is compatible with the spreading and compacting rate.

5 PROCESS CONTROL

5.1 APPLICATION OF BINDER AND ADMIXTURES

Determine the following at the end of each day's production:

(a) Percentage of Binder

Calculate the proportion of binder to one decimal place as a percentage of the dry mass of the material being bound, from:

(i) the total mass of binder used that day (determined from delivery dockets, silo dips, batch records etc), and

(ii) the total mass of material used in that day's production.

Where the calculated proportion of binder in the mix is less than the nominated proportion, the mix is nonconforming.

(b) Percentage of Admixture

The total quantity of admixture used that day.

5.2 COMPACTIBILITY INDEX

Test at the point of discharge, in accordance with AS 1012.3.4, with the exception that the test be carried out immediately prior to the roller compacted concrete being incorporated into the works.

When transit mixers are used for the delivery of roller compacted concrete, sample from the first 0.5 cubic metres of discharge.

5.3 CYLINDER STRENGTH TESTING

Sample at the point of discharge and mould in accordance with AS 1012.8.1 using a 100 mm diameter mould and steel rammer. Determine the compressive strength in accordance with AS 1012.9.

ANNEXURES 3221/A AND 3221/B – (NOT USED)

ANNEXURE 3221/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

Refer to clause 1.2.2.

C1 SCHEDULE OF HOLD POINTS

Clause	Description
3.4	Submission of Nominated Mix, plant and delivery vehicle details

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW D&C Q6 Annexure Q/E.

Clause	Description of Identified Record
2.1	Records of representative grab sample of the binder.
3.4	Nominate mix design with test certificates

ANNEXURE 3221/D – PLANNING DOCUMENTS

Refer to Clause 1.2.3.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. The requirements of this Specification and others included in the Deed must be reviewed to determine additional documentation requirements:

(a) details of how the cement and fly ash supplies will be monitored for compliance (refer to Clause 2.1);

(b) details of the type of mixing plant proposed and the operational and calibration procedures are to be supplied, including:

  (i) Stationary Mixing Plant

    - Type;
    - Proposed location;
    - Output capacity;
    - Control of binder content and moisture content (including methods to ensure uniformity).

  (ii) The method of measuring the binder incorporated in the mix.

  (iii) Method(s) and frequency of calibration.

  (iv) Materials Handling

    - Loading of mixer;
    - Control of segregation during loading and mixing.

(c) details relating to the transportation of the material (refer to Clause 4.2.2), including:

  (i) the number, type and capacity of transport vehicles;

  (ii) measures to prevent loss of moisture during transit;

  (iii) the time between completion of mixing and discharge into the paving machine.

ANNEXURES 3221/E TO 3221/K – (NOT USED)

ANNEXURE 3221/L – MINIMUM FREQUENCY OF TESTING

Clause	Characteristic Tested	Test Method / Standard	Minimum Frequency of Testing
Binder			
2.1	Quality of Cement	TfNSW 3211	Refer TfNSW 3211
2.1	Quality of Fly Ash	TfNSW 3211	Refer TfNSW 3211
Aggregates			
2.2	Unit Mass (Bulk Density)	AS 1141.4	One (Trial mix only)
2.2	Water Absorption	AS 1141.5 / AS 1141.6.1	Once within 12 months prior
2.2	Soundness for Fine Aggregate	AS 1141.24	1 per 4000 tonnes
2.2	Material finer than 2 μm	AS 1141.13	One per 4000 tonnes
2.2	Material finer than 75 μm	AS 1141.12	One per 4000 tonnes
2.2	Wet Strength	TfNSW T215	1 per 2000 tonnes or part thereof
2.2	Wet/Dry Strength Variation	TfNSW T215	1 per 2000 tonnes or part thereof
2.2	Particle shape	AS 1141.14	1 per 2000 tonnes or part thereof
Water and admixtures			
2.3	Quality of Water - Chloride ion concentration - Sulphate ion concentration - Undissolved solids	 TfNSW T1004 TfNSW T1014 AS 3550.4	 1 per deed per source 1 per deed per source 1 per deed per source
2.4	Admixtures	Compliance with AS 1478 (or other standard appropriate to the particular admixture)	1 per deed
Delivery of roller compacted concrete			
5.1	Percentage of binder Percentage of admixture		1 per day for the day's production 1 per day for the day's production
5.2	Compactibility Index	AS 1012.3.4 (except timing at point of discharge)	1 per 50 tonnes or part thereof
5.3	Compressive Strength	AS 1012.8.1 and AS 1012.9	1 per 50 tonnes or part thereof

ANNEXURE 3221/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.5.

TfNSW Specifications

TfNSW D&C Q6	Quality Management System (Type 6)
TfNSW D&C 3211	Cements, Binders and Fillers

TfNSW Test Methods

TfNSW T130	Dry Density – Moisture Relations for Mixtures of Road Materials Stabilised or Modified with Proportions of Cement, Lime or other Cementitious Materials
TfNSW T215	Wet/Dry Strength Variation
TfNSW T321	Drying Shrinkage of 100 x 100 x 280mm Concrete Prisms
TfNSW T1004	Quantitative Determination of Chloride Ion in Water where Chromate Content is more than 10 ppm.
TfNSW T1014	Sulphate Ion in Water

Australian Standards

AS 1012	Methods of testing concrete
AS 1012.3.4	Compactibility index
AS 1012.8.1	Method for making and curing concrete – Compression and indirect tensile test specimens
AS 1012.9	Determination of compressive strength of concrete specimens
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 1141.4	Bulk density of aggregate
AS 1141.5	Particle density and water absorption of fine aggregate
AS 1141.6.1	Particle density and water absorption of coarse aggregate – Weighing in-water method
AS 1141.11	Particle size distribution by dry sieving
AS 1141.12	Materials finer than 75μm in aggregates (by washing)
AS 1141.13	Material Finer than 2μm
AS 1141.14	Particle shape, by proportional calliper
AS 1141.24	Aggregate soundness - Evaluation by exposure to sodium sulfate solution
AS 1478	Chemical admixtures for use in concrete
AS 2349	Method of sampling portland and blended cements
AS 3550.4	Waters: determination of solids – Gravimetric methods
AS/NZS ISO 9001	Quality management systems - Requirements