

TRANSPORT FOR NSW (TfNSW)
QA SPECIFICATION 3221
ROLLER COMPACTED CONCRETE

NOTICE

This document is a Transport for NSW QA Specification. It has been developed for use with roadworks and bridgeworks contracts let by Transport for NSW or by local councils in NSW. It is not suitable for any other purpose and must not be used for any other purpose or in any other context.

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REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1		New issue	GM, IC	26.06.07
Ed 1/Rev 1	“Notice” 1 1.3 2.1 Annex L	RTA PO Box and Fax numbers updated Heading “General” added, and numbering error corrected Definition of “you” and “your” added Existing clause replaced by reference to RTA 3211. “Minimum Frequency of Testing” for cement and flyash replaced by reference to RTA 3211	GM, IC	03.02.09
Ed 1/Rev 2	Global	References to “Roads and Maritime Services” or “RMS” changed to “Transport for NSW” or “TfNSW” respectively.	DCS	22.06.20

GUIDE NOTES (Not Part of Contract Document)

Using TfNSW 3221

TfNSW 3221 is a QA specification and the use of QA specifications requires the implementation of a quality management system by the Contractor that meets the quality management system requirements specified in TfNSW Q. To comply with the intention of government policy as well as TfNSW 3221, Roller Compacted Concrete works constructed using TfNSW 3221 require adequate surveillance and audit by the Principal.

Technical Reference Notes

The following notes are intended to provide guidance on the application of this Specification. They do not form part of the Contract.

Clause 1: General

This Specification requires the Principal to nominate the grade of roller compacted concrete. There is no default grade for a project and further advice is found below.

Clause 3.2: Compressive Strength

This Specification provides for three standard grades of roller compacted concrete to be specified, based on a minimum 28-day compressive strength. It is envisaged that one of these three grades would be selected for the subbase layer. Selection of the mix grade will take into consideration the time constraints for trafficking of the base layer after construction, as detailed in Clause 4.12.3 of Specification TfNSW R90.

Clause 3.3: Compactibility Index

The Supplier must nominate the Compactibility Index for the mix, which should be in the range of 60 to 90.

Clause 3.4: Roller Compacted Concrete Nominated Mix Design

If the Supplier can establish the properties from another trial mix independent of this work and can demonstrate that the roller compacted concrete has been produced in a homogenous manner and meets the requirements of this Specification, a trial mix for the work under this Contract may not be required.

Annexure 3221/A: Details of Work

The Principal nominates in this Annexure the grade required for the mix.

The Supplier nominates the Compactibility Index.

Annexure 3221/L: Minimum Frequency of Testing

Where the Supplier can demonstrate good and consistent process control, the Principal may consider reducing the frequency of testing.

Appendix A

For a contract where the order to the Supplier is placed directly by the Transport for NSW, the requirements of Appendix A apply. The Principal has to nominate appropriate amounts for deductions by way of liquidated damages for late delivery.

In determining the deductions for late delivery, the Principal should take into consideration the costs related to the size of the crew, plant used for the job and the inconvenience for waiting. The maximum amount per day should be based on the length of a normal working day.



Transport
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QA SPECIFICATION 3221

ROLLER COMPACTED CONCRETE

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VERSION FOR: DATE:

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FOREWORD

TfNSW COPYRIGHT AND USE OF THIS DOCUMENT

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When this document forms part of a contract

This document should be read with all the documents forming the Contract.

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW 3221 Edition 1 Revision 1.

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 3221

ROLLER COMPACTED CONCRETE

1 GENERAL

1.1 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 Details of Work

Details of the particular work required are shown in Annexure 3221/A.

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 Q for the definition of **HOLD POINTS**.

The records listed in Annexure 3221/C are **Identified Records** for the purposes of TfNSW Q 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

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

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 2350). For convenience, the full titles are given in Annexure 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 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	AS 1141.14	Max 35%
3:1 ratio	AS 1141.14	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 TfNSW T1004
- (b) 400 parts per million of sulphate ion in accordance with 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 Principal.

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/m³ 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 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 Principal will consider the submitted documents prior to authorising 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 $\pm 0.3\%$ 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 to 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 $\pm 3\%$ 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.

ANNEXURE 3221/A – DETAILS OF WORK**Location Details**

Site Number	Location		RCC Grade [#]	Compactibility Index [†]
	From:	To:		

Value to be nominated by the Principal (Clause 3.2)

† Value to be nominated by the Supplier (Clause 3.3)

ANNEXURE 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 Q 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 Contract 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 Contract per source 1 per Contract per source 1 per Contract per source
2.4	Admixtures	Compliance with AS 1478 (or other standard appropriate to the particular admixture)	1 per Contract
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 Q	Quality Management System
TfNSW 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 sulphate 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

APPENDIX A

The requirements of this Appendix apply where the order to the Supplier is placed directly by the Transport for NSW.

A1 Measurement

The unit of measurement is the tonne. The delivery vehicle must be weighed empty and again after loading.

A2 Payment

Payment is for the activities associated with completing the work detailed under this Specification, including supply, delivery, testing and disposal of excess material.

Where the roller compacted concrete is rejected because of its failure to meet the requirements of this Specification, all costs associated with rectification including removal and replacement and any extra costs incurred by the Principal in respect of delays caused by such removals, replacements and corrections must be borne by the Supplier.

A3 Supply of Binder

Where the calculated proportion of binder in the mix in Clause 5.1 for the specified grade is less than the nominated proportion in Clause 3.4, consideration will be given to acceptance of the material subject to applying deductions in accordance with Table 3221/A.1.

Table 3221/A.1 - Deductions for Binder Content

Percentile range of binder content below nominated binder content	Deductions per cent of Payment
0.1% to less than 0.6%	2%
0.6% to less than 1.0%	5%
1.0% to less than 2.0%	15%
2% or greater	Mix to be rejected

A4 Compressive Strength

Where the compressive strength of the specified grade is less than the specified compressive strength in Table 3221.3 for the production mix, consideration will be given to acceptance of the material subject to applying deductions in accordance with Table 3221/A.2.

Table 3221/A.2 - Deductions for Compressive Strength

Percentile range of compressive strength below production mix strength	Deductions per cent of Payment
1% to less than 10%	10%
10% to less than 20%	30%
20% or greater	Material to be rejected

A5 Deductions Where Both The Binder Content And Compressive Strength Are Nonconforming

Where both the binder content and the compressive strength are nonconforming, only the deduction for compressive strength is applied.

A6 Compactibility Index

Where the Compactibility Index is outside the nominated value ± 10 , the load is to be rejected.

A7 Deductions For Late Delivery

In the event that the concrete is not available for use at the time ordered, the Purchaser may apply the following deductions by way of liquidated damages and not as a penalty:

An hourly rate of \$____ per hour^{##} or part thereof for each hour delay to the concrete paving operation until the concrete is available, up to a maximum of \$____ per day^{##}.

^{##} Values to be nominated by the Principal