

TRANSPORT FOR NSW (TfNSW)

QA SPECIFICATION 3222

NO FINES CONCRETE (FOR SUBSURFACE DRAINAGE)

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REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/Rev 0		First issued.	GM, IC	11.06.10
Ed 1/Rev 1		Spec title changed to include words “for Subsurface Drainage”.	GM, IC	16.05.11
	1	Scope limited to use in subsurface drainage.		
	3	Completion of Batching – previous item (d), defining time of completion of batching for continuous mixer discharging into tipper truck, deleted. Subsequent item renumbered.		
	5.1.1	Restrictions on source of aggregate and sampling locations of aggregate for testing removed. Requirement for identification and signposting of stockpiling deleted. Test method referenced in Table 3222.1 corrected.		
	5.1.3	Use of aggregates with potential for slow/mild or substantial AAR no longer allowed. Requirement related to use of blended cement for control of potential AAR deleted.		
	5.2	“Supplementary Cementitious Materials” deleted from clause title. Cement type specified to be Type GP.		
	5.3(b)	Requirement for total alkali contribution from admixtures not to exceed 0.20 kg/m ³ extended to all mixes.		
	6.1	Table 3222.3 - mix grade nomenclature changed and reduced to single grade. Item 6.1(ii), requiring Contractor to submit details of supplementary cementitious materials, deleted.		
	6.2	Permeability value requirement relocated to Clause 8.1.		

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/Rev 1 (cont'd)	7.1 7.2.1 7.2.3 8 Annex A Annex C & L Annex M	Table 3222.4 - binder content -ve tolerance increased to -3%. Total mass of cement and aggregate used in each day's production to be reported to Principal. New sub-headings inserted. Previous subclause 7.2.1. Restrictions on adding of water removed. New clause "Conformity" incorporating part of previous clause 6.2 and previous clause 7.5. Deleted. Clause references updated. Referenced documents updated.		
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



NO FINES CONCRETE (FOR SUBSURFACE DRAINAGE)

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VERSION FOR: DATE:

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FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW 3222 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 3222

NO FINES CONCRETE (FOR SUBSURFACE DRAINAGE)

1 SCOPE

This Specification sets out the requirements for the supply of no fines concrete for trench, edge and intra-pavement subsurface drainage systems.

2 STRUCTURE OF THE SPECIFICATION

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

2.1 (NOT USED)

2.2 SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

The schedules in Annexure 3222/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 3222/C are **Identified Records** for the purposes of TfNSW Q Annexure Q/E.

2.3 REQUIREMENTS FOR TECHNICAL PROCEDURES

Specific technical procedures for materials and preparation of samples for testing are detailed in Annexure 3222/E.

2.4 FREQUENCY OF TESTING

The minimum frequency of testing is shown in Annexure 3222/L.

2.5 REFERENCED DOCUMENTS

Unless specified otherwise, 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 3222/M.

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:

Batching	The process of combining the concrete ingredients in fixed proportions by mass or by volume, including charging and mixing.
Completion of batching	(a) For a stationary batch mixer discharging into a storage bin, this is the time at which discharge commences from the mixer. (b) For a stationary batch mixer discharging into a mobile mixer, this is the time at which mixing and slump adjustment ceases at the batching plant, or 10 minutes after the completion of charging of the stationary mixer, whichever occurs first. (c) For direct charging of a mobile mixer, this is the time at which mixing and slump adjustment ceases at the batching plant, or 10 minutes after the completion of charging, whichever occurs first. (d) For a continuous mixer discharging into a storage bin, this is the time of earliest discharge (from the mixer) of that concrete within the bin.
Mixing time	Applicable to batch mixers only. Comprises only that mixing time carried out at the specified mixing rate (i.e. excluding agitation), measured from the time all the ingredients (including all water) are in the mixing drum until mixing ceases, or after specified revolutions.
No fines concrete	No fines concrete is a material containing graded coarse aggregate, generally of a single AS sieve size, bonded together by a paste of cement and water sufficient to provide adequate strength while producing an open-textured cellular concrete with a high volume of voids and high permeability.
Subsurface drainage	A means of intercepting and removing subsurface moisture.

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.

5 MATERIALS

5.1 COARSE AGGREGATE

5.1.1 General

Aggregates for no fines concrete must consist of clean, durable materials. Do not use lag produced during the steel manufacturing process.

Coarse aggregate must conform to AS 2758.1. The properties of the coarse aggregate must also comply with Table 3222.1. If two or more coarse aggregates are to be blended, each coarse aggregate source must comply with the requirements in Table 3222.1.

Table 3222.1 – Coarse Aggregate Properties

Property	Requirement	Test Method
Bulk Density ⁽¹⁾	minimum 1,200 kg/m ³	AS 1141.4
Particle Density	minimum 2,100 kg/m ³	AS 1141.6
Water Absorption	maximum 2.5%	AS 1141.6
Particle Size Distribution	Table 3222.2	AS 1141.11
Particle shape: 2:1 ratio 3:1 ratio	maximum 35% maximum 10%	AS 1141.14
Wet Strength ⁽²⁾	minimum 150 kN	TfNSW T215
Fractured Faces: two or more ⁽³⁾	minimum 80%	TfNSW T239 ⁽⁴⁾
Wet/Dry variation	maximum 35%	TfNSW T215
Notes:		
(1) “Bulk density” in AS 2758.1 means the same as “unit mass” in AS 1141.4.		
(2) When tested in accordance with TfNSW T215, the wet strength must be a minimum of 150 kN and the wet/dry strength variation must not exceed 35%. The fraction to be tested is the particle size distribution interval in Table 1 of AS1141.22 which represents at least 50% of the aggregate by mass.		
(3) The area of each fractured face must be a significant proportion of the total surface area of the particle. Testing is required on aggregate derived from gravels and metasediments, including conglomerates. Testing is not required on aggregate derived from igneous rock.		
(4) TfNSW T239 Clauses 6.1, 6.2, 6.3, and 7(b) to 7(d) may be ignored.		

5.1.2 Particle Size Distribution

The aggregate particle size distribution in no fines concrete must comply with the requirements of Table 3222.2 when tested in accordance with TfNSW T201.

Table 3222.2 – No Fines Concrete Particle Size Distribution for Coarse Aggregate

Australian Standard Sieve Size (mm)	Percent Passing by Mass (%)
26.50	100
19.00	95 – 100
9.50	0 – 5

5.1.3 Alkali-Aggregate Reaction

Assess all aggregate for potential alkali-aggregate reaction (AAR) in accordance with Annexure 3222/E within 12 months from the date of closing of tenders.

Do not use aggregates that are classified as having potential for slow/mild or substantial ARR by Test Method TfNSW T363, or aggregates that are classified as reactive by Test Method TfNSW T364.

Use alternative aggregates and/or alternative concrete mix designs subject to compliance with the requirements of this Specification.

5.1.4 Soluble Salts

Assess the no fines concrete for soluble salt content in accordance with Annexure 3222/E within 12 months from the date of closing of tenders.

Determine chloride ion and sulphate ion contents by one of the methods in Annexure 3222/E.

The chloride ion and sulphate ion content of the no fines concrete must not be greater than 0.8 kg/m³ of concrete, and 5% of the cement content, respectively.

5.2 CEMENT

Cement must be Type GP cement complying with Specification TfNSW 3211, unless approved otherwise by the Principal.

5.3 ADMIXTURES

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

The following conditions also apply:

- (a) For combinations of two or more admixtures, their compatibility must be certified in writing by the manufacturers.
- (b) The total alkali contribution (measured as Na₂O equivalent) from all admixtures used in any mix must not exceed 0.20 kg/m³.
- (c) Detail in the PROJECT QUALITY PLAN the criteria for initiating changes in admixture type with season or ambient temperature. During the warm season, use a lignin or lignin-based ('ligpol') set-retarding admixture (Type Re or WRRe). If a retarder is used during the cool season, it must be a lignin Type WRRe containing not more than 6% reducing sugars.
- (d) Superplasticisers and high range water reducers Type HWRRe may be used.

5.4 WATER

Water used in the production of no fines concrete must be free from materials which are detrimental to the no fines concrete, and must neither be salty nor brackish. The water must conform to AS 1379, in particular Clause 2.4 and Table 2.2 – Limits for Impurities in Mixing Water, and the following:

- (a) chloride ion: maximum 500 parts per million of chloride ion, determined in accordance with Test Method TfNSW T1004;
- (b) sulphate ion: maximum 400 parts per million of sulphate ion, determined in accordance with Test Method TfNSW T1014.

6 DESIGN REQUIREMENTS

6.1 NOMINATED MIX

The aggregate to cement ratio must be in accordance with Table 3222.3.

Table 3222.3 – Aggregate to Cement and Water to Cement Ratios for NFC SD

Grade	Aggregate to Cement Ratio (by mass)	Water to Cement Ratio (by mass)
NFC SD	6:1	0.35 – 0.45

The water to cement ratio must provide for complete cementitious paste coverage of the aggregate. The water and paste content must not be such as to cause the paste to flow during mixing, handling or placing.

Before commencing production of the no fines concrete mix:

- (a) conduct trial mixes to demonstrate that the proposed mix designs comply with this Specification;
- (b) certify that each nominated mix and its constituents meet the requirements of this Specification;
- (c) submit NATA endorsed test results for all relevant tests;
- (d) submit a copy of a verification checklist covering the items listed below.

Submit the following details for each nominated mix:

- (i) Cement – in accordance with Specification TfNSW 3211;
- (ii) Nominated cement content expressed in kg/m³ and as a percentage of the dry mass being bound;
- (iii) Water – source;
- (iv) Admixture(s) – proprietary source, type, name, dosage recommended by manufacturer;
- (v) Aggregates – source, geological type, moisture condition on which the mix design is based (oven dry, saturated surface dry or nominated moisture content);
- (vi) Mix Design – constituent quantities per yielded cubic metre of no fines concrete, water to cement ratio, nominated particle size distribution of aggregates in accordance with AS 1141.11, and properties as listed in Table 3222.2;
- (vii) Permeability.

The date of testing of both the nominated mix and the aggregates must not be older than eighteen months from the time the nominated mix is proposed to be used. If sufficient production mix test results are available from within this period, the Principal may reduce the scope of the trial nominated mix.

Submit a new nominated mix if any changes occur to the source or proportions of materials or methods of production.

HOLD POINT

Process Held:	Delivery of no fines concrete.
Submission Details:	At least five working days before proposed date of delivery, submit the following: <ul style="list-style-type: none"> (i) All test results and certificates together with a statement that the Nominated Mix complies with all the requirements of this Specification. (ii) Details of the mixing plant and delivery vehicles in accordance with Clause 7.2.
Release of Hold Point:	The Principal will consider the submitted documents prior to authorising the release of the Hold Point.

6.2 PERMEABILITY

Mould and cure the specimens in accordance with Test Method TfNSW T376.

Test the permeability in accordance with Test Method TfNSW T377.

7 PROCESS CONTROL**7.1 PRODUCTION MIXES**

The production mix must always target the nominated mix.

Table 3222.4 shows the allowable tolerances on coarse aggregate and binder content for the production mix.

Table 3222.4 – Production Tolerances

Attribute	Tolerance (% by mass)
Particle Size Distribution (AS sieve):	
19.00 mm	± 2
9.50 mm	± 5
Binder content	+ 3.0 / - 0

Production of the mix must be such that the minimum proportion of cement incorporated is not less than that required to achieve the specified ratio of aggregate to cement.

At the end of each day's production, total up the individual masses of cement and aggregate used in the day's production of the no fines concrete, and provide these details to the Principal.

7.2 MIXING AND CONSISTENCE

7.2.1 General

Do not use aggregates which have become intermixed or contaminated with foreign matter.

Weigh the cement separately.

Use a measuring device calibrated in one litre increments for volumetric batching of water.

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

7.2.2 Handling, Storing and Batching

Detail in the PROJECT QUALITY PLAN the proposed methods of handling, storing and batching materials, and the method of charging the mixer, including the proposed sequence of addition of ingredients. The method of charging must be consistent with the recommendations of the suppliers of mix additives.

After the completion of batching in the case of batch mixers, discharge the entire batch of no fines concrete from the mixer before any further charging takes place, with the exception of conforming retempering.

The handling, storing and batching of materials and the mixing, transport and consistence of no fines concrete, including any retempering, must comply with AS 1379 (Section 4 and Appendix A) and the following conditions:

- (a) For stationary batch mixers, the mixing time must not be less than 54 seconds plus 6 seconds for each cubic metre (or part thereof).
For mobile batch mixers, provide the full period of mixing required for that mixer at either the testing station or the point of placement. Ignore all other mixing and agitation for the purpose of assessing the actual mixing time for a specific batch.
- (b) The maximum mixing time is five minutes for split drum mixers, or 10 minutes otherwise.
- (c) Admixtures must be separately and thoroughly prediluted in the mixing water before their introduction to other materials. They must then be mixed in accordance with the manufacturer's instructions, and by a method that ensures that no adverse reaction occurs. Detail in the PROJECT QUALITY PLAN how admixtures will be incorporated to comply with this requirement.
- (d) Each batch or load of no fines concrete must be accompanied by an identification certificate (delivery docket) which is pre-numbered and which must be issued sequentially in accordance with the order of batching. The certificate must record the time of completion of batching. Subsequent addition of water (retempering) in accordance with Clause 7.2.3 is deemed to have taken place after completion of batching.

Mixing time is measured from the time all ingredients, including all water, are in the mixing drum.

7.2.3 Retempering

Detail in the PROJECT QUALITY PLAN how the supply of no fines concrete will be monitored for compliance with the following retempering provisions.

No fines concrete which is delivered by mobile batch mixer may be retempered in accordance with the following conditions:

- (a) Immediately after retempering with water, the mixing mechanism must be operated at the designated mixing speed for not less than 30 revolutions or for such additional time as may be necessary to re-establish uniformity of the mix, except that if assurance is not available regarding the original mixing conditions, the retempered batch must be re-mixed for 55 revolutions.
- (b) The quantity of water added must be recorded on the identification certificate for that batch and must not exceed the mix design water to cement ratio. If water is added after the commencement of discharge, the estimated remaining quantity of no fines concrete at that time must also be recorded.
- (c) Retempering is permitted only within 40 minutes of the completion of batching.
- (d) Retempering must only take place in the presence of your representative previously nominated to the Principal for this purpose and only at either the batch plant, the testing station, or the point of placement.

7.3 TRANSPORT OF NO FINES CONCRETE

Transport the no fines concrete from the source of supply to the work in mobile batch mixer vehicles constructed so that loss of material does not occur. Delivery vehicles must be suitable for conditions at the delivery site.

At the time of delivery, the no fines concrete must be thoroughly mixed and must not be segregated or contaminated. Material delivered to the work site which is segregated or contaminated is nonconforming.

7.4 SAMPLING

Sample the no fines concrete in accordance with the requirements of this Specification.

Sample the no fines concrete at the point of delivery within 45 minutes of the completion of batching.

8 CONFORMITY

8.1 PERMEABILITY

All permeability results must exceed 20 mm/s.

8.2 AGGREGATE TO CEMENT RATIO

The aggregate to cement ratio must not exceed that specified in Table 3222.3 measured and reported daily.

8.3 NONCONFORMING MATERIAL

Nonconforming material must be removed from the Site and replaced by material that conforms to this Specification. Notify the Principal of any such nonconforming material and of the action taken to deal with the nonconformity.

ANNEXURES 3222/A AND 3222/B – (NOT USED)

ANNEXURE 3222/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

Refer to Clause 2.2.

C1 SCHEDULE OF HOLD POINTS

Clause	Description
6.1	Submission of nominated mix design 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
6.1	Nominated mix design.

ANNEXURE 3222/D – (NOT USED)

ANNEXURE 3222/E – REQUIREMENTS FOR TECHNICAL PROCEDURES

This Annexure details supplementary requirements for the supply of no fines concrete.

The clause numbers in this Annexure after the prefix “E” correspond with the relevant clause number in this Specification. There are gaps in the clause numbers.

E3 MATERIALS

E3.1 COARSE AGGREGATE

Alkali-Aggregate Reaction (AAR)

Use both of the following methods to carry out an assessment for AAR:

- (a) petrographic examination and;
- (b) assessment and classification for AAR using the accelerated mortar bar test TfNSW T363 or the concrete prism test TfNSW T364.

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

Petrographic examination must be in accordance with ASTM C295. Those aggregates containing obviously reactive components (such as the following) may be eliminated without further testing:

- (i) opaline material;
- (ii) unstable silica minerals such as moderate amounts of tridymite and cristobalite; or
- (iii) sheared rock containing moderate amounts of strained quartz and microcrystalline quartz.

Soluble Salts

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

(a) Test Method for Constituent Materials

- (i) Conduct chloride testing in accordance with:
 - AS 1012 Part 20 for aggregates;
 - AS 1478 Appendix D for water and admixtures dissolved in water;then calculate the total content and percentage.
- (ii) Conduct sulphate testing in accordance with:
 - AS 1012 Part 20 for aggregates;
 - AS 1289.4.1.2 for water and admixtures dissolved in water;
 - AS 2350.2 for cementitious materials;then calculate the total content and percentage.

(iii) Notes:

- (A) For admixtures, the soluble salt contents may be taken as the values certified in writing by the manufacturer.
- (B) For water, the source proposed for the Works must be tested.

(b) Test Method for Hardened Concrete

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

ANNEXURES 3222F TO 3222/K – (NOT USED)

ANNEXURE 3222/L – TESTING REQUIREMENTS**L1 MINIMUM FREQUENCY OF TESTING**

Clause	Characteristic Analysed	Test Method	Minimum Frequency of Testing
5.1.2	Particle size distribution	AS 1141.11	One per 400 tonnes
5.1.1	Bulk density	AS 1141.4	One per the trial mix
5.1.1	Water absorption	AS 1141.6	Once within previous 12 months ⁽²⁾
5.1.1	Particle shape, 2:1 and 3:1 ratios	AS1141.14	One per 2,000 tonnes
5.1.1	Fractured faces	T239	One per 1,000 tonnes
5.1.1	Wet strength	T215	One per 2,000 tonnes ⁽¹⁾
5.1.1	Wet/dry strength variation	T215	One per 2,000 tonnes ⁽¹⁾
6.2	Permeability	T377	One per trial mix and then one per 400 tonnes

Notes:

⁽¹⁾ Provided that all of the six previous tests have met the Specification requirements for both wet strength and wet/dry strength variation, the following reduced frequency may apply:

- (a) where all wet/dry variation results are less than 25 percent: 1 per 10,000 tonnes
- (b) where all wet/dry variation results are less than 30 percent: 1 per 4,000 tonnes

⁽²⁾ Within previous 12 months before the date of closing of tenders, or else in conjunction with the trial mix.

ANNEXURE 3222/M – REFERENCED DOCUMENTS

Refer to Clause 2.5.

TfNSW Specifications

TfNSW Q	Quality Management System
TfNSW 3211	Cements, Binders and Fillers

TfNSW Test Methods

TfNSW T201	Sieve Analysis of Aggregates
TfNSW T215	Ten percent fines
TfNSW T239	Aggregate fractured faces
TfNSW T363	Accelerated AAR assessment
TfNSW T364	Concrete Prism Test for AAR Assessment
TfNSW T376	Moulding of No Fines Concrete Specimens
TfNSW T377	Water Permeability of No Fines Concrete (Falling Head Laboratory Permeameter)
TfNSW T1004	Quantitative Determination of Chloride Ion in Water
TfNSW T1014	Quantitative Determination of Sulphate Ion in Water

Australian Standards

AS 1012.20	Methods of testing concrete – Determination of chloride and sulphate in hardened concrete and concrete aggregates
AS 1141	Methods for sampling and testing aggregates
AS 1141.4	Bulk density of aggregate
AS 1141.6	Particle density and water absorption of coarse aggregate
AS 1141.11	Particle size distribution – Sieving method
AS 1141.14	Particle shape, by proportional calliper
AS 1141.22	Wet/dry strength variation
AS 1289.4	Methods of testing soils for engineering purposes – Soil chemical tests – Determination of the sulphate content of a natural soil and the sulphate content of the groundwater – Normal method
AS 1379	Specification and supply of concrete
AS 1478	Chemical admixtures for concrete, mortar, and grout
AS 2350.2	Methods of testing portland, blended and masonry cements – Chemical composition
AS 2758.1	Aggregates and rock for engineering purposes – Concrete aggregates

AS 3550.4 Waters – Determination of solids – Gravimetric method

AS/NZS ISO 9001 Quality management systems – Requirements

ASTM Standards

C295 Standard Guide for Petrographic Examination of Aggregates for Concrete