Department of Transport and Main Roads

Technical Specification

Transport and Main Roads Specifications MRTS270 Supply of Geopolymer Concrete

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Queensland Government

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About this document

The document adopts and modifies Austroads Technical Specification ATS 5330 *Supply of Geopolymer Concrete* as part of national harmonisation. It sets out the requirements for supply, delivery and use of geopolymer concrete.

How to use this document

This document includes the national guidance and Queensland-specific advice while following the structure established in Austroads Technical Specifications.

Queensland-specific advice includes practices which vary from national practice because of local environmental conditions (such as geography, soil types, climate); different funding practices; local research; local legislation requirements; and to expand instruction on particular issues.

This document:

- sets out how the Austroads Technical Specification ATS 5330 *Supply of Geopolymer Concrete* applies in Queensland
- has precedence over the Austroads Technical Specification ATS 5330 *Supply of Geopolymer Concrete* when applied in Queensland
- has the same clause numbering and headings as the Austroads Technical Specification ATS 5330 *Supply of Geopolymer Concrete*.

Transport and Mains Roads provides an ancillary document which outlines adopted national and modified Queensland-specific content with tracked changes. To access a copy click on the below link: Ancillary documents for harmonised Technical Specifications.

Terminology

The following general amended definitions apply when reading this document.

Reference to…	Means
Shall	Denotes mandatory requirements.
Must	Denotes mandatory requirements.
Principal	The State of Queensland acting through the Department of Transport and Main Roads.
Administrator	The Administrator will be responsible for the overall administration of this Contract.

Contents

1 Scope

1.1 This Technical Specification covers the requirements for the construction of road and marine structures in Geopolymer Concrete in strength grades up to 50 MPa for use in the following applications:

a) insitu surface drainage, light duty pavement (e.g. footpaths) and minor footings (e.g. lighting pole footings), and

b) precast elements with a design life not exceeding 50 years, such as noise panels and boating infrastructure, and

c) where permitted in the relevant design criteria or project documentation.

Under this Technical Specification, geopolymers are intended for use in elements with a 50-year or below design life.

1.2 This Technical Specification shall be read in conjunction with MRTS70 *Concrete*, and where MRTS70 is referenced the special-class provisions are applicable.

This means that MRTS270 essentially modifies Clauses 6 to 10 and 15 to 16 of MRTS70 *Concrete*.

1.3 This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

1.4 This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

2 Definitions

2.1 The following definitions apply to this Technical Specification.

Table 2.1 – Definitions of terms

Term	Definition
Geopolymer Binder	Polymeric binder formed by reacting alumina-silicate pre-cursors with alkaline activator(s).
Geopolymer Concrete	Geopolymer Binder with aggregates, water and additives. Geopolymer concrete contains no General Purpose Cement.

3 Referenced documents

3.1 The following documents are referenced in this Technical Specification or are relevant to this Technical Specification.

Table 3.1 – Referenced documents

Reference	Title
Australian / New Zealand Standards	
AS 1012.3.1	*Methods of testing concrete, Method 3.1: Determination of properties related to the consistency of concrete—Slump test*
AS/NZS 1379	*The Specification and Supply of Concrete*
AS 3582.1	*Supplementary cementitious materials for use with portland and blended cement – Part 1: Fly ash*
AS 3582.2	*Supplementary cementitious materials for use with portland and blended cement – Part 2: Slag Ground granulated iron blast furnace*
AS/NZS 3582.3	*Supplementary cementitious materials for use with portland and blended cement – Part 3: Amorphous silica*
ISO/AS/NZS 9001	*Quality management systems – Requirements*
SP43	*ATIC SPEC SP43*
Transport and Main Roads Technical Documents	
MRTS01	*Introduction to Technical Specifications*
MRTS50	*Specific Quality Systems – Requirements*
MRTS70	*Concrete*
MRTS271	*Glass Fibre Reinforced Polymer (GFRP) Reinforcement*
MRTS272	*Shotcrete for Aboveground Applications*
-	*Supplier Registration Scheme: Bridges and Other Structures*

4 Quality System Requirements

4.1 The Geopolymer Concrete must be manufactured under a quality management system which has been independently certified by a JASANZ accredited organisation as fully complying with AS/NZS ISO 9001.

5 Manufacturer competency

5.1 Geopolymer Concrete must be supplied by a manufacturer with at least 12 months experience in the commercial supply of Geopolymer Concrete.

5.2 The manufacturer must have submitted the following to E&T Structures, and had it approved within the 12 months preceding the supply of Geopolymer Concrete under this Technical Specification:

a) details of the mix design, including all details and test results as listed in MRTS70 *Concrete*, except that only a generic description of each chemical component of the activator is required, and

b) test results from a NATA accredited laboratory demonstrating that the proposed Geopolymer Concrete complies with the properties listed in this Technical Specification (Table 8.2). **Hold Point 1** **Milestone** **Record**

HOLD POINT 1	
Process Held	Supply of Geopolymer Concrete.
Submission Details	Mix design approval certificate from E&T Structures must be provided at least 14 days prior to the supply of the Geopolymer Concrete.

5.3 Mix design variations within approval are permitted as per MRTS70 *Concrete*.

6 Batching of Geopolymer Concrete

Materials

6.1 Alumino-silicate precursors (for example, fly ash, slag) must:

a) comply with the requirements of the relevant part of AS 3582 and ATIC SPEC SP43

b) be registered under the Cementitious Material Registration Scheme (CMRS) in accordance with ATIC SPEC SP43

c) be registered by Transport and Main Roads under the *Supplier Registration Scheme: Bridges and Other Structures*, and

d) not be used in the manufacture of Geopolymer Concrete if it is more than 3 months old, unless it is re-tested to demonstrate compliance with this Technical Specification.

6.2 The quality of water to be used in the mix of Geopolymer Concrete must comply with the requirements of Clause 2.4 of AS 1379.

Manufactured pozzolans under AS 3582.4 are not yet covered by SP43 or the *Registration Scheme*. Geopolymer materials containing these precursors should be discussed with E&T Structures for individual assessment.

Batching

6.3 The manufacturing plant and equipment, production, and delivery of Geopolymer Concrete must comply with the requirements specified in MRTS70 *Concrete*, except as modified by this Technical Specification.

6.4 The mix design for each Geopolymer Concrete strength grade must have a unique identification number.

6.5 Super-workable and highly-workable Geopolymer Concrete shall comply with the requirements of MRTS70 *Concrete*.

Addition of water at the slump stand

6.6 Slump stand water meters must be initially zeroed and actual amounts of water added into the agitator drum must be accurately recorded. The following records must be included on the delivery docket:

a) actual amount of water added into the agitator drum at the slump stand

b) time that the water is added, and

c) calculated maximum permissible amount of water that can be added.

7 Delivery of geopolymer concrete

General

7.1 Transport and delivery of Geopolymer Concrete must be in accordance with MRTS70 Concrete, except as modified by this Technical Specification.

7.2 Prior to the discharge of Geopolymer Concrete at the site, the mixer or agitator must be operated at the mixing speed, listed on the compliance plate, for not less than 3 minutes.

Water additions

7.3 Water may be added to the freshly mixed Geopolymer Concrete prior to commencement of discharge, subject to:

a) obtaining the manufacturer's prior approval

b) no more than 10 L/m³ is added

c) no more than 45 minutes has elapsed since batching

d) the maximum water / Geopolymer Binder ratio is not exceeded

e) a means of accurately measuring the volume of water is utilised

f) the load is remixed in accordance with AS 1379

g) no more than a single slump sample has been taken previously, and

h) the maximum water available to be added has been listed on the delivery docket.

This clause replaces the list of conditions in MRTS70 Concrete Clause 11.3.1 but is essentially the same other than (a).

7.4 Water must not be added after commencement of discharge of Geopolymer Concrete (ignoring any testing sample taken). **Record**

Delivery docket

7.5 In addition to the information required by Clause 1.7.3 of AS 1379, the following information must also be recorded on each delivery docket:

a) the total water in the batch, including:

i. the moisture content (in litres), beyond SSD, of aggregates

ii. batch water

iii. water added at the slump stand

iv. total amount of water permitted to be added on site

v. water added on site before commencement of discharge, including water used to wash down the mixing blades of the mixer or agitator.

b) total specified mass of Geopolymer Binder

c) nominated slumps

d) any other additions to a batch, and

e) the unique identification number allocated to the mix design.

7.6 Further to the above requirements, the following information must be traceable to the supplier's batching plant(s) for each batch (truck load) of Geopolymer Concrete used in the works and must be made available for review upon request by the Principal.

a) Geopolymer Binder brand and type, including:

i. proportions of components (by mass), and

ii. total actual mass of Geopolymer Binder.

b) chemical admixtures, including:

i. types, and

ii. amounts.

Acceptance of plastic Geopolymer Concrete

7.7 Geopolymer Concrete must be placed and compacted within 60 minutes of the commencement of mixing.

7.8 The consistency of each load of the Geopolymer Concrete must be determined in accordance with AS 1012.3. No reduced testing is permitted.

7.9 Assessment and acceptance of plastic Geopolymer Concrete shall be as per MRTS70 *Concrete*.

Water left in the mixer or agitator

7.10 Water left in the mixer or agitator from the previous load must be discharged prior to reloading new Geopolymer Concrete in accordance with the requirements of Clause 4.1.3(c)(ii) water in mixing chamber of AS 1379.

8 Hardened Geopolymer concrete properties

8.1 If the Geopolymer Concrete is cast in place with a strength grade not exceeding 25 MPa: **Record**

a) concrete must be sampled, tested and assessed for compressive strength as per MRTS70 *Concrete* (N-class clauses), and

b) for mix design approval, the hardened Geopolymer Concrete must be tested to demonstrated conformance with the properties as listed in Table 8.2.

8.2 For all other Geopolymer Concrete: **Record**

a) concrete must be sampled, tested and assessed for compressive strength as per MRTS70 Concrete (S-class clause), and

b) for mix design approval, the hardened Geopolymer Concrete must be tested to demonstrated conformance with the properties as listed in Table 8.2.

Table 8.2 – Hardened geopolymer concrete properties

Property	Test Method	Criteria	Age
Compressive Strength	AS 1012.9	As per design	28 days
Flexural Strength[1]	AS 1012.11	≥ 2.5 MPa	28 days
Abrasion Resistance[1]	AS/NZS 4456.9	Report only	28 days
Shrinkage[1]	AS 1012.13	≤ 750 με	91 days
Modulus of Elasticity[1]	AS 1012.17	30 GPa ± 20%	28 days
Density	AS 1012.12	2.1 – 2.8 t/m³	28 days
Chloride Permeability[1]	ASTM C1202	< 1000 C	56 days
ASR resistance[1]	AS 1141.60.1	< 0.1 %	to 21 days
Carbonation resistance[1]	ISO 1920-12	Report only	to 91 days
Chloride ion content[2]	AS 1012.20.1	< 0.4 kg/m³ (Exposure classifications C1/C2) < 0.8 kg/m³ (Exposure classifications B1/B2)	28 days

Notes:

[1] Testing required on representative mixes only (see commentary).

[2] May be calculated by component as per MRTS70 Concrete.

While mix design approval is granted on a per-mix basis, the representative tests noted above should be conducted on a per-grade or per-(binder) system basis. Consult with E&T Structures.

9 Additional requirements for geopolymer concrete

9.1 Formwork, placement, finishing of Geopolymer Concrete must comply with MRTS70 Concrete, including Hold Points.

9.2 Curing of the Geopolymer Concrete must comply with the following:

a) curing must be in accordance with MRTS70 Concrete (S-class provisions) by either: steam, membrane, polyethylene sheet or maintaining the formwork in place

b) water curing is not permitted

c) where steam curing is used, care must be taken to prevent condensation pooling on the surface of Geopolymer Concrete, and

d) if temperature-matched curing tanks are used, the manufacturer must protect the sample cylinders from water infiltration.

9.3 Surface finish and dimensional tolerances must comply with MRTS70 Concrete and the underlying element specification.

9.4 Fibrecrete (to MRTS271 *Glass Fibre Reinforced Polymer (GFRP) Reinforcement*) and shotcrete (to MRTS272 *Shotcrete for Aboveground Applications*) versions of geopolymer are permitted, subject to approval of E&T Structures on a case-by-case basis. Switching to geopolymers will have implications for design and material compatibility.

The underlying element specification is usually where the Work Item Number resides and MRTS70 Concrete and/or MRTS270 are referenced from.

Appendix A: Summary of Hold Points, Witness Points, Milestones and Records

General requirements for Hold Points, Witness Points, Milestones and Records, are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points, Witness Points, Milestones and Records that the Contractor must submit to the Administrator to demonstrate compliance with this Technical Specification are summarised in Table A. There are no Witness Points defined.

Table A – Hold Points, Witness Points, Milestones and Records

Clause	Hold Point	Witness Point	Milestone	Record
5.2	1. Supply of the Geopolymer Concrete		Submission of mix design details	Mix design approval certificate
7.4				Delivery docket with additional information
8.1				Production assessment reports
8.2				Test reports