



Austroads

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1. Scope

- 1.1 Austroads Technical Specification ATS 2160 sets out the requirements for the supply and installation of geotextiles used as separation and / or filtration elements in the construction of earthworks, pavement and soil structures. It does not cover:
- paving fabrics used in bituminous spray sealing applications; or
 - high strength geotextile reinforcement used to improve global stability.

2. Referenced Documents

2.1 The following documents are referenced in this Specification:

Australian / New Zealand Standards

AS 1289	Methods of testing soils for engineering purposes
Method 3.6.1	Soil classification tests – Determination of the Particle Size Distribution of a Soil – Standard Method of analysis by sieving.
Method 6.1.1	Soil strength and consolidation tests—Determination of the California Bearing Ratio of a soil—Standard laboratory method for a remoulded specimen
AS 1726	Geotechnical site investigations
AS 3706.1	Geotextiles – Methods of test – General requirements, sampling, conditioning, basic physical properties and statistical analysis
AS 3706.2	Geotextiles – Methods of test – Determination of tensile properties - Wide strip and grab method
AS 3706.3	Geotextiles – Methods of test – Determination of tearing strength – Trapezoidal method
AS 3706.7	Geotextiles – Methods of test – Determination of pore-size distribution – Dry-sieving method
AS 3706.9	Geotextiles – Methods of test – Determination of permittivity, permeability and flow rate
AS 3706.11	Geotextiles – Methods of test – Determination of durability – Resistance to degradation by light, heat and moisture
AS 3706.12	Geotextiles – Methods of test – Determination of durability – Resistance to degradation by hydrocarbons or chemical reagents
AS 3706.13	Geotextiles – Methods of test – Determination of durability – Resistance to certain microbiological agents
AS/NZS ISO 9001	Quality management systems – Requirements

Austrorads

AP-C87-15	Austrorads Glossary of Terms
AGPT-04G	Guide to Pavement Technology Part 4G: Geotextiles and Geogrids

International Standards

ISO 12956	Geotextiles and geotextile-related products – Determination of the characteristic opening sizes
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3. Definitions

3.1 In addition to the definitions in AP-C87-15 and AGPT-04G, the following definitions and abbreviations apply to this Specification.

C_u	Coefficient of Uniformity = D_{60}/D_{10} in accordance with AS 1726.
D_n	Nominal particle size of material defined as the sieve through which n % by mass of the particles will pass when tested in accordance with AS 1289.3.6.1.
EOS	Equivalent opening size of the geotextile material defined as O_{95} taken to be the mean value of the test results obtained in accordance with AS 3706.1, AS 3706.7 or ISO 12956.
G Rating	Geotextile Strength Rating, determined in accordance with Annexure B.
Q_{100}	Flow rate through the geotextile material, in L/m ² /s, under 100 mm constant head conditions in accordance with AS 3706.9.
Ψ	Permittivity of the geotextile material, in s ⁻¹ , determined in accordance with AS 3706.9 under 100 mm constant head conditions.

4. Quality System Requirements

4.1 The Contractor must prepare and implement a Quality Plan that includes the documentation in Table 4.1.

Table 4.1: Quality Plan

Clause	Description of Document
4.2	Evidence of AS/NZS ISO 9001 certification.
6	Details (including strength and filtration properties) of the geotextile to be used in the Works
8	Site sampling and testing procedure (where Site Conformance Testing is used).
9	Details / procedures to ensure that the construction process and compaction method does not result in damage to the placed geotextile.

HOLD POINT 1.

Process Held	Placement of order for the geotextile.
Submission Details	The Quality Plan must be provided to the Principal at least 10 working days prior to ordering of the nominated geotextile product.

4.2 The geotextile must be manufactured under a quality management system independently certified as fully complying with AS/NZS ISO 9001, by an organisation accredited by JAS-ANZ or an affiliated international certification organisation.

5. Materials

General

- 5.1 The fibres of the geotextile and thread used in joining lengths must consist of long chain synthetic polymers composed of at least 95% by mass of polyolefins or polyesters.
- 5.2 The geotextile filaments must be rot-proof, chemically stable and must have low water absorbency. Filaments must resist delamination and maintain their relative dimensional stability in the geotextile.
- 5.3 Non-woven geotextiles must have filaments bonded by needle punching, heat or chemical bonding processes.
- 5.4 Woven geotextiles must have filaments interlaced in two sets, mutually at right angles. One set must be parallel to the longitudinal direction of the geotextile.
- 5.5 Geotextiles must be free of any flaws which may have an adverse effect on the physical and mechanical properties of the geotextile.
- 5.6 The geotextiles must be stabilised against ultraviolet radiation such that when tested in accordance with AS 3706.11 it has a retained strength of at least 50% after 500 hours of test exposure. The Certificate of Compliance (refer Clause 8.14) must include evidence of compliance with this requirement.
- 5.7 Geotextiles manufactured from recycled materials must conform to the requirements of this Specification, be identified as such on the Certificate of Compliance (refer Clause 8.14), and must be homogeneous with respect to the content of recycled material.

Geotextile Strength Class

- 5.8 The geotextile, when sampled and tested in accordance with Clause 8, must comply with the relevant requirements of Table 5.8 for the Strength Class specified.

Table 5.8: Geotextile Survivability Strength Class Requirements

Geotextile Strength Class	Elongation ⁽¹⁾	Minimum Characteristic Grab Strength (N)	Minimum Characteristic Tearing Strength (N)	Minimum G Rating
Test Method:	AS 3706.4	AS 3706.2 Method B	AS 3706.3	ATM-810
A	≥ 30%	500	180	900
	<30%	800	300	1,350
B	≥ 30%	700	250	1,350
	<30%	1,100	400	2,000
C	≥ 30%	900	350	2,000
	<30%	1,400	500	3,000
D	≥ 30%	1,200	450	3,000
	<30%	1,900	700	4,500
E	≥ 30%	1,600	650	4,500

Notes:

- (1) *Elongation, to differentiate between woven geotextiles and nonwoven geotextiles, is the % CBR puncture elongation corresponding to maximum puncture strength determined in accordance with AS 3706.4. In general, woven geotextiles will break at elongations less than 30% while nonwoven geotextiles will break at elongations equal to or greater than 30%.*

Geotextile Filtration Classes

- 5.9 The geotextile, when sampled and tested in accordance with Clause 8, must comply with the relevant requirements of Table 5.9 for the Filtration Class specified.

Table 5.9: Geotextile Filtration Class Requirements

Filtration Class ⁽¹⁾	Minimum Characteristic Flow Rate Q100 (l/m ² /s)	Minimum Characteristic Permittivity Ψ (s-1)	Maximum Mean EOS (μm) ⁽¹⁾
Test Method:	AS 3706.9	AS 3706.9	AS 3706.7
Class I	50	0.5	120
Class IIa	50	0.5	250
Class IIb	50	0.5	430
Class III	30	0.3	120
Class IVa	20	0.2	250
Class IVb	20	0.2	600
Class V	10	0.1	120
Class VI	10	0.1	300
Class VII	5	0.05	300
Class VIII	5	0.05	600

Notes:

- (1) Slit film woven type geotextile is not permitted for Filtration Classes I, II, III, IV, V and VI.

6. Selection of Geotextile

General

- 6.1 If the requirements for Strength Class and Filtration Class are not specified on the Drawings, the Contractor must determine the requirements for the Strength Class and Filtration Class in accordance with this Clause 6.
- 6.2 The Contractor must determine the type, Strength Class and Filtration Class of the geotextile, the method of placement and any special requirements for the fill material.
- 6.3 Where the geotextile is used as filter / separation layers under or within embankments, it may be a woven or a non- woven type. However, where the geotextile is used under rockfill embankments or placed over rockfill or other uneven surfaces (such as broken mangrove stumps and roots), it must have an elongation greater than 30%. For the purposes of this clause, any material with maximum nominal stone size $D_{85} > 400$ mm is deemed to be rockfill.
- 6.4 The Strength Class and Filtration Class must comply with Table 6.4. The CBR of the existing soil or rock is determined in accordance with AS 1289.6.1.1.

Table 6.4: Geotextile Application Categories

Application	Strength Class ^(1, 2)	Filtration Class		
		D ₁₅ ≤ 0.075 mm (Cohesive soils)		D ₁₅ > 0.075 mm (Granular soils)
<ul style="list-style-type: none"> Separation under / within embankments (unsaturated conditions) To prevent mixing of dissimilar soil types during construction for unsaturated soils where CBR > 3 	Refer Table 6.5	VII		VIII
<ul style="list-style-type: none"> Separation under/within embankments (saturated ground) Working platform / bridging layer applications To prevent mixing of dissimilar soil types in saturated conditions in working platform / bridging layer applications for soils where CBR ≤ 3 and where filtration is not a critical function 	Refer Table 6.5	VI		IVb
<ul style="list-style-type: none"> Drainage and separation behind retaining structures including rock filled mattresses and joints of pipes and arches To provide the combined functions of separation and filtration 	Refer Table 6.7	III		IIa
<ul style="list-style-type: none"> Under rock armour revetment layer in embankments ⁽³⁾ For cushioning layer requirements to minimise damage to geotextile due to excessive drop height 	Class D for D ₈₅ < 200 mm and Class E for D ₈₅ between 200 and 400mm	III		IIa
		D ₅₀ ≤ 0.075 mm (Predominantly silt and clay soils)	D ₅₀ > 0.075 mm and D ₁₅ ≤ 0.075 mm (Predominantly granular soils with low permeability)	D ₁₅ ≥ 0.075 mm (Predominantly pervious granular soils)
<ul style="list-style-type: none"> Drainage blankets 	Refer Table 6.5	V	IVa	IIb
<ul style="list-style-type: none"> Drains, including trench drains, edge drains, counterfort and cut-off drains 	Refer Table 6.6	V	IVa	IIb

Notes:

- (1) Requirements for strength class for installation damage protection are based on a 1.5 m drop height of material for the corresponding maximum nominal stone size.
- (2) Geotextile Strength Class to ensure survivability for the given application. Geotextile survivability refers to the ability of the geotextile to withstand the installation stresses during construction. It is related to construction method, subgrade condition, backfill material including stone size and other factors.
- (3) Where the maximum drop height of the rock armour exceeds 1.5 m, an aggregate layer with a nominal maximum stone size of less than 75 mm must be placed as an initial layer prior to the placement of larger revetment rock armour, to protect the geotextile.
- (4) Separation under saturated ground may encounter circumstances where filtration could become a critical function; for example, shallow height embankments where foundation pumping can occur during the life of the roadway. In these circumstances, the selection of geotextile must also satisfy the filtration requirements of drains.

6.5 The Strength Class for mechanical separation of soil layers, including drainage blanket, must comply with Table 6.5.

Table 6.5: Minimum Strength Class for Mechanical Separation of Soil Layers and Drainage Blankets

D ₈₅ of Material (mm) ⁽¹⁾	Strength Class (Mechanical Separation of Soil Layers)		Strength Class (Drainage Blanket)	
	CBR ≤ 3 ⁽²⁾	CBR > 3 ⁽²⁾	CBR ≤ 3 ⁽²⁾	CBR > 3 ⁽²⁾
≤ 37.5	C	A	C	B
≤ 75	C	B	D	C
≤ 200	D	C	E	D
≤ 400 ⁽³⁾	E ⁽⁴⁾	D	E ⁽⁴⁾	E
≤ 600 ⁽³⁾	Not applicable ⁽⁵⁾	E	Not applicable ⁽⁵⁾	Not applicable ⁽⁵⁾

Notes:

- (1) Applies to the layer to be placed over geotextile.
- (2) Applies to the material on which the geotextile is placed.
- (3) For cushioning purposes, a minimum thickness of 150 mm of material with a D₈₅ < 75 mm must be used for the initial lift to protect the geotextile.
- (4) Not applicable for geotextiles with elongation < 30%.
- (5) Specialist design advice must be sought. As an alternative, a layer of fill material with a nominal maximum stone size of less than 75 mm may be used for the initial and final layer of the drainage layer, to prevent damage to the geotextile.

6.6 The Strength Class for trench drain applications must comply with Table 6.6.

Table 6.6: Minimum Strength Class for Trench Drain Applications

D ₈₅ of Material (mm) ⁽¹⁾	Strength Class	
	Trench Depth < 2 metres	Trench Depth < 3 metres
≤ 37.5	A	B
≤ 75	B	C
≤ 200	C	D

Notes:

- (1) Applies to layer to be placed over geotextile.

6.7 The Strength Class for drainage and separation behind retaining structures must comply with Table 6.7.

Table 6.7: Minimum Strength Class for Drainage and Separation Behind Retaining Structures

Type of Structure	Strength Class
Concrete retaining walls Segmental block walls Reinforced soil concrete panel walls	B
Gabion walls Crib walls Rock filled mattresses Joints of pipes and arches	C

Limitations

- 6.8 Table 6.4 does not apply to any of the following circumstances:
- a) The water flow may undergo reversal.
 - b) Highly dispersive clay soils, gap graded soils, fine silt soils and artificially derived soils such as flyash are used.
- 6.9 If Clause 6.8 applies, the Contractor must determine the necessary properties of the geotextile and the need for additional granular filters or any special construction techniques. This may require additional soil/geotextile testing. Special consideration is required if the C_u of the insitu material is less than 3.

Certification

- 6.10 Prior to delivery of each consignment of geotextile to the Site, the Contractor must submit a certificate to the Principal which verifies that the design and selection of the geotextile complies with this Clause 6.

HOLD POINT 2.	
Process Held	Delivery of each consignment of geotextile to the Site.
Submission Details	Certification that the selection of geotextile complies with this Clause 6 must be submitted to the Principal at least 3 working days prior to the delivery of each consignment of the geotextile to the Site.

7. Storage and Delivery

- 7.1 Geotextiles must be stored under a protective cover or wrapped with a waterproof, opaque UV protective sheeting to avoid any damage prior to installation.
- 7.2 Geotextiles must not be stored directly on the ground or in any manner in which they may be affected by heat. The method of storage must be in accordance with any other recommendations set by the manufacturer.
- 7.3 The protected geotextile rolls must be clearly labelled showing manufacturer, type of geotextile and batch number identification number.
- 7.4 If Factory Conformance Testing is used, with each batch of geotextile delivered to the Site, quality records must include a certificate of compliance that the geotextile complies with all the requirements of this standard for its specified usage, together with test results reported on NATA endorsed test documents. The certificate must not be more than 12 months old. (Refer Hold Point 3, Clause 8.14)
- 7.5 If Site Conformance Testing is used, the geotextile must be delivered to the Site at least 10 working days prior to commencement of installation.

8. Sampling, Testing and Acceptance

General

- 8.1 The Contractor must ensure that the geotextile is sampled and tested in accordance with this Specification.
- 8.2 This Specification covers two methods of sampling and testing as follows:
- a) Factory Conformance Testing, where the tests are carried out prior to delivery to Site and the following applies:
 - i the test samples are manufactured under identical conditions to the geotextile delivered to the Site, using identical constitute materials and the same production machinery;
 - ii the samples are manufactured within the 12 month period preceding delivery to the Site;
 - iii a quality system is in place which demonstrates that the statistical control is in place; and
 - iv traceability of material to each manufacturing batch is in place.
 - b) Site Conformance Testing, where the tests are carried out after delivery to Site and before installation.
- 8.3 Unless specified otherwise in the Contract documents or directed by the Principal, the method of sampling and testing specified in Table 8.3 must be used.

Table 8.3: Method of Sampling and Testing

Quantity of Geotextile used on the Site for the Specified Application	Application	
	Geotextile used for earthworks, separation or filtration	Geotextile used for applications other than earthworks (such as behind retaining walls and sub-soil drains)
< 5,000 m ²	Refer Clause 8.4	Factory Conformance Testing
≥ 5,000 m ²	Site Conformance Testing	Factory Conformance Testing

- 8.4 Where the total area of geotextile supplied under this Contract is less than 5,000 m², Factory Conformance Testing may be used, provided that the nominal strength of the geotextile supplied is 20% higher than the design Strength Class and the nominal filtration properties are 20% lower than the design Filtration Class requirements. Otherwise, Site Conformance Testing will apply.
- 8.5 All testing must be performed by a laboratory which is accredited by a body that is a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC MRA). The National Association of Testing Authorities (NATA) and International Accreditation New Zealand (IANZ) are signatories to ILAC MRA.

Sampling

- 8.6 Sampling must be carried out at the frequency specified in Table 8.6.

Table 8.6: Sampling Frequency

Batch or Order Size Defined as the Lot Size (m ²)	Number of Rolls to be Sampled Representing the Lot
Initial 10,000 or part thereof	1
Each subsequent 20,000 or part thereof	1

- 8.7 A representative sample covering approximately 15 m² of geotextile must be cut from each sampled roll, but not within two metres of the start or end of the roll. Where directed by the Principal, samples must also be cut and supplied to the Principal.

WITNESS POINT 1.

Process	Sampling of geotextile (where Site Conformance Testing applies).
Notification Period	At least 1 working day before the sampling.

- 8.8 Each sample must be clearly marked with a large arrow showing the longitudinal direction of the geotextile. This is termed the warp direction for woven geotextiles. The directional marking is required to identify strength tests in both longitudinal and transverse directions. This applies to both woven and non-woven geotextiles.
- 8.9 At least 10 test specimens must be cut from the longitudinal direction and at least 10 specimens must be cut from the transverse direction of the sampled roll of geotextile.
- 8.10 Where Factory Conformance Testing is used, the period between the testing must not exceed 12 months.

Testing and Acceptance

- 8.11 A minimum of 10 specimens from each sample must be tested for each property listed in Table 5.8 and Table 5.9.
- 8.12 The results of all tests undertaken must be included in the test report for each Lot.
- 8.13 Where a characteristic value is specified, it is the 20th percentile value for the Lot tested.
- 8.14 A Lot is deemed to conform if the properties determined from the testing meet or exceed the values specified in Table 5.8 and Table 5.9 for the specified Strength Class and Filtration Class. If a Lot is non-conforming, the Lot may be re-sampled as specified in Clause 8.6 and retested. If on retesting, the Lot fails to achieve conformance, the Lot is rejected and must not be used in the Works.
- 8.15 Geotextile must not be placed prior to the release of Hold Point 3.

HOLD POINT 3.

Process Held	Placement of Geotextile.
Submission Details	For each consignment, a Certificate of Compliance and the test report must be provided to the Principal at least 3 working days prior to: <ul style="list-style-type: none"> ▪ Delivery to Site (where Factory Conformance Testing is used); or ▪ Commencement of the placement of geotextile (where Site Conformance Testing is used).

Audit Testing

- 8.16 The Principal may select samples from the Site for audit testing.

9. Construction Requirements

- 9.1 This Clause 9 specifies the general requirements for the installation of geotextiles. For additional installation requirements which are specific to a particular application (such as earthworks, behind a reinforced soil wall or sub-soil drainage), refer to the applicable ATS.
- 9.2 Geotextiles must be installed as specified in the Drawings and the manufacturer's instructions.
- 9.3 Geotextiles must not be damaged during installation or subsequent construction work. Any manufacturing defects, tears or punctures must be repaired so that the performance of the geotextile is not adversely affected or the geotextile must be replaced with conforming geotextile.
- 9.4 Joints in geotextiles must be made by overlapping, sewing, or other methods recommended by the manufacturer. Sewing, where carried out must have seam strengths, as measured in accordance with AS 3706.2, equal or greater than 100% of the specified grab strength. Flat or "prayer" seams, J or Double J type or "butterfly" seams are permitted with a minimum number of two parallel rows of stitching required. If the amount of overlap is not specified, it must be a minimum of 500 mm. Sewing must be carried out using a suitable portable industrial sewing machine and a suitable durable polyester or polyester/cotton blend sewing thread, the thread to have minimum breaking load of 20 kg.
- 9.5 Where overlapping is used, subsequent construction work must not reduce the overlap to less than the minimum specified amount.
- 9.6 Construction equipment must not stand or travel directly on the laid geotextile. The initial layer of cover material must be placed over the geotextile prior to any construction equipment travelling over the area concerned. The initial layer must not be less than 150 mm thick.
- 9.7 Once placed, geotextiles must be covered by the specified construction materials or suitable protective sheeting within 48 hours.

Annexure A: Summary of Hold Points, Witness Points and Records

The following is a summary of the Witness Points / Hold Points that apply to this Specification and the Records that the Contractor must submit to the Principal to demonstrate compliance with this Specification.

CLAUSE	HOLD POINT	WITNESS POINT	RECORD
4.1	1. Ordering the geotextile product.		Quality Plan
6.10	2. Delivery of each consignment of geotextile product to the Site		Certification that the selected geotextile is compliant with Clause 6.
8.7		1. Sampling of geotextile (where Site Conformance Testing applies).	
8.14	3. Placement of Geotextile		Certificate of Compliance and the test report.

Annexure B: Determination of the Geotextile Strength Rating (G Rating) of a Geotextile

The G Rating must be determined by the following process:

- a) For each property to be tested, obtain a minimum of 10 test specimens cut from the longitudinal direction and a minimum of 10 specimens cut from the transverse direction of the sampled roll in accordance with AS 3706.1.
- b) Determine the CBR burst strength (L) of at least 10 specimens in accordance with AS 3706.4. However, if the strain at failure exceeds 80%, the burst strength at 80% strain must be used.
- c) Determine the Drop Cone Puncture Resistance (h_{50}) of at least 10 specimens in accordance with Equation A7 of Appendix A of AS 3706.5.
- d) If the geotextile is anisotropic, values from the weakest direction must be used.
- e) Calculate the following:
 - i the characteristic values of CBR burst strength (L_c) of the Lot tested (i.e. mean CBR Burst Strength – 0.83 x standard deviation).
 - ii the characteristic value of Drop Cone Puncture Resistance (h_{50c}) of the Lot tested (i.e. mean Drop Cone Puncture Resistance – 0.83 x standard deviation).
 - iii the Geotextile Strength Rating (G Rating) for each Lot, as follows:

$$\text{G Rating} = \sqrt{L_c \times h_{50c}}$$

Note: the calculation of characteristic value is based on the 20th percentile value for the Lot tested, for a sample number of 10.

The following must be reported:

- a) Manufacturer's name.
- b) Product identification and geotextile type.
- c) The order represented by the sample.
- d) The identifying roll / batch number and any roll directional markings.
- e) Sampling date and date of test.
- f) For each specimen tested, the CBR burst strength and Drop Cone Puncture Resistance.
- g) Other parameters as required by relevant parts of AS 3706.
- h) Mean, standard deviation and characteristic value of CBR burst strength (L_c) and Drop Cone Puncture Resistance (h_{50c}).
- i) G Rating, to the nearest 10 units.

Amendment Record

Amendment no.	Clauses amended	Action	Date
-	New specification	New	October 2023

Key

Format	Change in format
Substitution	Old clause removed and replaced with new clause
New	Insertion of new clause
Removed	Old clauses removed