TRANSIT NEW ZEALAND
ARARAU AOTEAROA

TNZ F/7 NOTES: 2003

NOTES TO THE SPECIFICATION FOR GEOTEXTILES

These notes are for the guidance of Transit New Zealand's staff and consultants, and must not be included in the contract documents.

1. SCOPE

These notes accompany the TNZ F/7 Specification: Geotextiles. They apply to geotextiles for use in filtration and/or separation functions on state highways.

2. APPLICATION CATEGORIES

Where selection of the geotextile has not been by site specific design, the strength and filtration classes shall comply with Table 1 below.

Table 1: Geotextile Application Categories

Application	Material Requirements	Filtration Class in Table 5
G1: Separation under/within Embankments (Unsaturated Ground) Primarily to prevent mixing of dissimilar soil types where the soils will not become saturated and any filtration is not critical. (Not to be associated with seepage areas or areas requiring drainage blankets). Applicable for subgrade soils CBR ≥ 3.	A type conforming to the geotextile class strength requirements in Table 2 of these Notes for the specific site, subgrade and nominal maximum stone particle size (D_{85}) of the fill.	Class 4
G2: Combined Filtration and Separation under/within Embankments including Drainage Blanket Applications To provide coincident functions of separation and filtration, or for drainage blanket applications. Applicable for subgrade soils CBR > 1.	A type, other than a slit film woven type, conforming to geotextile strength requirements in Table 2 of these Notes applying site subgrade conditions with CBR ≤ 3 and nominal maximum stone particle size (D_{85}) of the fill.	Class 2
G3: Trench Drains and Highway Edge Drains	A type, other than a slit film woven type, conforming to the geotextile strength class requirements of Table 3 of these Notes for the nominal maximum stone size of fill (D_{85}) and specific trench depth.	Class 1

Application	Material Requirements	Filtration Class in Table 5
G4: Drainage and Separation behind Retaining Structures including Rock Filled Mattresses To provide the combined functions of separation and filtration.	A type, other than a slit film woven type, conforming to the geotextile strength class requirements of Table 4 of these Notes for the particular wall type.	Class 1
G5: Under Rock Armour Revetment Layer in Embankments Note: An aggregate layer with a nominal maximum stone size of less than 75mm shall be used where the maximum drop height of the rock armour exceeds 1.5 metres and should be considered as the initial layer prior to the placement of larger revetment rock armour to protect the geotextile.	A type, other than a slit film woven type, which shall meet the geotextile strength requirements for Class D or E requirements in Table 6 of these Notes for a nominal revetment stone size (D_{85}) of 200mm and 400mm respectively.	Class 3

Table 2: Selection of Geotextile Class for Mechanical Separation of Soil Layers including Drainage Blankets

Nominal Max Stone Particle Size D_{85} (mm) (note a)	Geotextile Strength Class (Table 6)	
	Subgrade 1 ≤ CBR ≤ 3 (notes d, e)	**Subgrade CBR > 3**
≤ 37.5	C	A
≤ 75	C	B
≤ 200	D	C
≤ 400	E (note b)	D
≤ 600	Not Applicable (note c)	E

Table 3: Selection of Geotextile Strength Class for Trench Drain Applications

Nominal Max Stone Particle Size D_{85} (mm) (note a)	Geotextile Strength Class (Table 6)	
	Trench Depth < 2m	**Trench Depth < 3m**
≤ 37.5	A	B
≤ 75	B	C
≤ 200	C	D

Table 4: Selection of Geotextile Strength Class for Drainage and Separation behind Retaining Structures including Rock Filled Mattresses

Type of Structure	Geotextile Strength Class (Table 6)
Conventional concrete retaining walls Segmental block walls Reinforced soil concrete panel walls	B
Gabion walls Crib walls Rock filled mattresses	C

Notes Accompanying Tables 2 to 4:

(a) Nominal maximum stone size of fill.

(b) Not applicable for geotextiles with elongation < 30% (refer to Note a) of Table 6).

(c) Not applicable for this case. Specific design is required. As an alternative a fill with a maximum nominal stone size less than 75mm should be considered for the initial lift to protect the geotextile.

(d) Specific design is required for separation over subgrades with CBR < 1.

(e) Specific design may support the specification of strength classes other than those given by Tables 2-4. Specific design should consider factors in addition to those included in Tables 2-4; a number of the references appended to these Notes provide guidance. However, the strength classes listed for each item in Tables 2-4 shall be considered the minimum allowed.

3. GEOTEXTILE FILTRATION CLASS REQUIREMENTS

From Table 1 of these Notes, or from specific design, the required geotextile filtration class is obtained. The geotextile is then required to meet the filtration requirements for that class of geotextile. The filtration requirements are defined in Table 1 of the specification and repeated below:

Table 5: Geotextile Filtration Class Requirements

Filtration Class	**Flow Rate and Permittivity** Q_{100} (l/m²/s) ψ (s^{-1}) (note a)		**EOS Requirements for Cohesive Soils** (notes b, c, d)	**EOS Requirements for Granular Soils** (notes b, c, d)
Class 1	$Q \geq 50$	$\psi \geq 0.5$	≤ 180µm	≤ 250µm
Class 2	$Q \geq 30$	$\psi \geq 0.3$	≤ 180µm	≤ 250µm
Class 3	$Q \geq 50$	$\psi \geq 0.5$	≤ 180µm	≤ 200µm
Class 4	$Q \geq 10$	$\psi \geq 0.1$	≤ 300µm	≤ 600µm

Notes Accompanying Table 5:

(a) Flow rate (Q_{100}) under a 100mm constant head and permittivity (ψ) determined in accordance with AS 3706.9.

(b) Equivalent opening size (EOS) defined as O_{95} taken to be the **mean** value of the test results in accordance with AS 3706.7.

(c) AS 3706.7 measures the size distribution of the geotextile by dry sieving of a calculated quantity of sand through the dry geotextile. The EOS requirements in Table 5 are based on these measurements by dry sieving.

(d) In general, all soils with a PI greater than 15 can be considered cohesive. Also, soils with a PI >7 and more than 10% by mass of the soil smaller than 5 µm (i.e. more than 10% of the soil is clay sized) can be considered cohesive. Other soils can be considered cohesionless.

Testing of the soil for the percentage less than 5 μm should be carried out to NZS 4402:1986 Test 2.8.4. This test is a hydrometer method to determine particle size distribution with a dispersing agent.

(e) The EOS, permittivity and flow rate requirements apply for soil types where water flow is predominantly unidirectional or non-critical. Specific design is required where water flow may undergo reverse flow characteristics. For geotextiles used as a separator and filter under the subbase on a weak, wet and poorly drained subgrade, the dynamic loadings from heavy traffic may cause reversing flow directions across the geotextile which may result in some migration of the subgrade fines into the subbase. This should be recognised in the pavement design.

4. GEOTEXTILE STRENGTH CLASS REQUIREMENTS

From Tables 1, 2, 3 and 4 of these Notes, or from specific design, the required geotextile strength class is obtained. The geotextile is then required to meet or exceed the strength requirements for that class of geotextile. The strength requirements are defined in Table 2 of the specification and repeated below.

Table 6: Geotextile Strength Class Requirements

Geotextile Strength Class	**Elongation** (Note d)	**Grab Strength** (N) (Note a)	**Tear** (N) (Note b)	**G Rating** (Notes c, e)
A	≥ 30% < 30%	500 800	180 300	900 1350
B	≥ 30% < 30%	700 1100	250 400	1350 2000
C	≥ 30% < 30%	900 1400	350 500	2000 3000
D	≥ 30% < 30%	1200 1900	450 700	3000 4500
E	≥ 30%	1600	650	4500

Notes accompanying Table 6

(a) Grab strength shall be the characteristic value of grab strength for the Lot tested (i.e. mean grab strength – 0.83 x standard deviation) in accordance with Clause 9.1 of specification. Mean grab strength and the corresponding standard deviation shall be determined in accordance with AS 2001.2.3 Method B. For anisotropic geotextiles, the characteristic grab strength in the weaker direction shall be used. Ten test specimens from each direction are required to be tested to determine the characteristic grab strength. (Refer to Part 9 of the specification.)

(b) Characteristic value of tearing strength for the Lot tested (i.e. mean tear strength – 0.83 x standard deviation) determined in accordance with AS 3706.3 and Clause 9.1 of this specification. For anisotropic geotextiles, the characteristic tearing strength in the weaker direction shall be used. Ten test specimens from

each direction are required to be tested to determine the characteristic tear strength. (Refer to Part 9 of the specification.)

(c) G = Geotextile Strength Rating determined to be $(L \times h_{50c})^{1/2}$ based on the characteristic values of the Lot. A minimum of ten test specimens is required to determine the characteristic CBR and h_{50c} values. (Refer to Clause 9.1 of the specification). L is the characteristic value of CBR plunger failure load N for the Lot tested determined in accordance with AS 3706.4. (i.e. mean CBR plunger failure load N – 0.83 x standard deviation.) If the strain at failure exceeds 80% then the characteristic CBR load L_{80} at 80% strain shall be used in the calculation of G. h_{50c} is the characteristic value of h_{50c} for the Lot (i.e. mean h_{50c} – 0.83 x standard deviation). h_{50c} shall be determined in accordance with AS 3706.5 (revised 1994).

(d) Elongation to differentiate wovens from non-woven geotextiles shall be the % CBR puncture elongation corresponding to maximum puncture strength determined in accordance with AS 3706.4. In general woven geotextiles would break at elongations less than 30% while non-wovens would break at elongations equal to or greater than 30%.

(e) Requirements for survivability class based on a 1.5m drop height of material for the corresponding maximum nominal stone size.

5. SITE SPECIFIC DESIGN

Specific design may be undertaken for the use of geotextiles at any highway site. Indeed the undertaking of site specific design is encouraged and recommended, particularly for highway works that will include significant quantities of geotextile. Where site specific design has been undertaken, the Engineer may specify additional test methods to be undertaken and/or increase the frequency of testing.

It is important to protect the Principals' interest to ensure the pavement lasts its design life and any risk of instability or extended construction related to the use of geotextile(s) is minimised.

Site Specific Design should be by a Registered Engineer or an experienced Geotechnical Engineer. Such design should accord with or exceed those established by recognised procedures.

A knowledge of the sites' soils is required including particle size distributions and plasticity characteristics. If the soils are dispersive, then this needs to be known. The expected flow condition (eg unidirectional or reversing, hydraulic head) need to be known. For embankments constructed on soft ground information on calculated settlements with time, proposed drainage blankets and the total drainage system is required.

To perform their intended function(s) it is important that geotextiles retain their integrity during installation and service. There are few recognised design procedures to relate the required integrity of geotextile separators and/or filters to specific site conditions. Hence the strength requirements for site specific design should equal or exceed those of Table 6 for the appropriate strength class.

Slit film woven geotextiles may not be considered for G3-G5 applications.

While specific design is recommended for all sites, it is mandatory for the following conditions:

- Use of geotextile for filtration in association with these soil types:
  - Dispersive soils, or loessial soils
  - Gap graded soils and single sized soils, e.g. where the coefficient of uniformity of the soil $\frac{D_{60}}{D_{10}}$ is less than 5.
  - Non-cohesive fine sands and/or silts, e.g. filtration of a water bearing soil comprising a sand with $D_{85} < 250\mu m$, when tested to NZS 4402:1986 Test 2.8.1 by wet sieving.
  - Artificially derived soils such as flyash.
- Use of geotextiles under rock armour revetment layers or behind retaining structures with these hydraulic conditions:
  - Subject to wave action, tidal conditions, or reversing flow conditions across the geotextile.
  - Subject to unidirectional flow conditions across the geotextile with a hydraulic gradient more than 5.
- Use of geotextile in association with trench drains or highway edge drains with these conditions:
  - Surface water or stormwater is discharged into the subsurface drainage pipe.
  - The outlet of the subsurface drainage pipe can become submerged.
  - The hydraulic gradient of the subsurface water near the geotextile is greater than 5.
- Use of geotextiles in embankments:
  - Where stress conditions may cause global stability or foundation failure.
  - Where wick drains are used to speed consolidation.

The use of a geotextile filter is to alleviate siltation such that the drain or structure can function over a long period of time without a failure of the filter or drain by blocking and without significant erosion of the upstream soil. Geotextile filters are not highly permeable systems and are not suitable to carry the flow of water from high flow acquifers, e.g. springs.

6. TEST METHODS

The test methods specified are all Australian Standards.

There are a number of ASTM Standards that are similar to an Australian Standard and may be used in lieu of the specified Australian Standard as the basis for the Certificate of Compliance and the Control Testing. The tests for which the ASTM Standard may be used in lieu of the Australian Standard are:

Property	Australian Standard	ASTM Standard
Mass per Unit Area	AS 3706.1 – 1990	D 5261 – 92 (Reapproved 1996)
Trapezoidal Tear	AS 3706.3 – 2000	D 4533 – 91 (Reapproved 1996)
Thickness	AS 3706.1 – 1990	ASTM D1777-96
Grab tensile	AS 2001.2.3 (B)	ASTM D4632-91
Permittivity	AS 3706.9 – 2001	D 4491 – 96 (Constant Head Test)

In the event of a dispute arising, the Australian Standard shall take precedence.

7. QUALITY PLAN

Contractors working on state highways are required to operate a quality assurance system which meets or exceeds the requirements of TNZ TQS1 or TQS2, as appropriate for the specific contract. Suppliers of geotextile for use on state highways will be required to operate a quality assurance system which meets or exceed the requirements of TNZ TQS1.

The Contractor is required to provide a Quality Plan for the contract. The Quality Plan would be expected to include:

- Rigorous monitoring and control of the production of the geotextile. To fulfil this requirement, it is likely that the geotextile manufacturer will operate a formal Quality System, e.g. ISO 9002.

  The testing to support the Certificate of Compliance would be expected to include:

AS3706.1 – 1990	Basic physical properties
AS3706.3 – 2000	Trapezoidal tear
AS3706.4 – 1990	CBR burst
AS3706.5 – 2000	Drop-cone puncture
AS3706.7 – 1990	Pore-size distribution
AS3706.9 – 2001	Permittivity
AS3706.11 – 1990	Resistance to light and heat

- Control testing for each batch of geotextiles. This is to include determination of the mean weight of the geotextile and the grab strength.
- Identification of each roll of geotextile for at least manufacturer, type of geotextile and batch identification number.
- Traceability of each roll of geotextile from manufacture to installation.
- Construction requirements. As a minimum, site preparation, control of exposure to UV, jointing, initial layer thicknesses and construction machinery.

8. DELIVERY

Where in-warehouse testing has not occurred, deliver of the geotextile to site is required at least 14 days prior to commencement of installation.

For sites where security is a problem, delivery must be at least 14 days prior but may be to a secure location in the general vicinity of the site. In such cases, the Quality Plan must ensure identification and traceability of those particular individual rolls of geotextile to site then installation.

9. COVERING

The specification requires geotextiles to be covered within 48 hours of laying. For some situations this may be impractical; in these cases a longer period may be specified.

Caution should be used in extending this, as during the period between laying and covering the geotextile is vulnerable to damage from machinery or from wind gusts.

10. JOINTING

Sewing of seams is permitted. As the geotextiles are for use in filtration and/or separation applications, the seam types specified are medium strength but have the advantage of not using the selvage as a stitching surface.

Polyester thread of at least to 300 tex should be used for sewing of seams. Standard polyester thread of 300 tex and of 350 tex, and field machines for two – line lock stitching are available in New Zealand.

Where joints are not sewn, they can be overlapped. The minimum overlap is usually 300mm, but in poor ground conditions the required width of overlap increases.

The Table below provides a guideline for minimum overlap required.

CBR	Minimum Overlap
> 3	300 - 450 mm
1 - 3	0.6 - 1 m
0.5 - 1	1 m or sewn
< 0.5	sewn
all roll ends	1 m or sewn

Where high settlements are expected (eg embankments over peat), the overlap should be increased, eg up to 1.5m.

11. ACKNOWLEDGMENT

Specification TNZ F/7 Geotextiles and TNZ F/7 Geotextile Notes are based on the Roads and Traffic Authority of New South Wales Specification R63 (RTA 1998).

12. BASIS OF PAYMENT

The specification will need to define the basis of payment.

The most straightforward basis is linear metres or square metres of geotextile in terms of plan area. Ignoring the extra length or area attributable to the slope or gradient of the site makes little difference until the slope of the site becomes quite step, e.g. ≥ 2 horizontal to 1 vertical.

Costs for laboratory testing of the geotextile samples can cause concern with the Contractor or Supplier. It is suggested that “testing” be identified as a separate item in the schedule of prices, and a Provisional Sum be allocated to it.

For the majority of sites, the suggested wording for the basis of payment is:

- **Basis of Payment**

  All miscellaneous items, board, supervision, contingencies, sampling, quality assurance, conveyance of plant and incidental work, plus general overheads and administration are incorporated in the unit rates listed in the schedule. The unit rates shall be full compensation for the supply of all materials, labour and plant necessary to complete construction as specified.

- **Payment for Trench Drains or Edge Drains**

  Payment will be made on the total number of lineal metres in plan of drains installed in accordance with the specification and at the various depths as detailed in the schedule of prices. No additional payment will be made for laps, joints, kinks, or wastage. No additional payment will be made to compensate for the slope or gradient of the site.

- **Payment for Geotextiles Other Than Drains**

  Payment will be made on the total number of square metres in plan of geotextile installed in accordance with the specification. No additional payment will be made for laps, joints, kinks, sags or wastage. No additional payment will be made to compensate for the slope or gradient of the site.

- **Payment for Testing of Geotextiles**

  A lump sum payment will be made for each set of geotextile conformance tests.

For steep sites, e.g. ≥ 2 horizontal to 1 vertical, the slope can significantly increase the amount of geotextile needed in comparison to the plan area. For these situations, the number of lineal or square metres for payment could be increased in recognition of the increased amount. For these sites, the suggested wording for the basis of payment is:

- **Basis of Payment**

  All miscellaneous items, board, supervision, contingencies, sampling, quality assurance, conveyance of plant and incidental work, plus general overheads and administration are incorporated in the unit rates listed in the schedule. The unit rates shall be full compensation for the supply of all materials, labour and plant necessary to complete construction as specified.

- **Payment for Trench Drains or Edge Drain**

  Payment will be made on the total number of lineal metres in plan of drains installed in accordance with the specification and at the various depths as detailed in the schedule of prices. If the site is sloping, the plan length of the drains shall be factored up to allow for the additional length due to the gradient of the drain. No additional payment will be made for laps, joints, kinks or wastage.

- **Payment for Geotextiles Other Than Drains**

  Payment will be made on the total number of square metres in plan of geotextile installed in accordance with the specification. If the site is sloping, the plan area of the geotextile shall be factored up to allow for the additional area due to the gradient. No additional payment will be made for laps, joints, kinks or wastage.

- **Payment for Testing of Geotextiles**

  A lump sum payment will be made for each set of geotextile conformance tests.

13. REFERENCES

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