Technical Specification

Transport and Main Roads Specifications MRTS58 Subgrade Reinforcement using Pavement Geosynthetics

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1 Introduction

This technical specification applies to the physical, material and construction requirements for pavement geosynthetics used in subgrade reinforcement applications.

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.

This technical specification forms part of the Transport and Main Roads Specifications Manual.

2 Definition of terms

The terms used in this technical specification shall be as defined in Clause 2 of MRTS01 *Introduction to Technical Specifications*. Further definitions are defined in Table 2. Where indicated in Table 2 a more complete definition is contained in the referenced clause.

Table 2 – Definition of terms

Term	Definition	Clause Reference
Geogrid Aperture Size	Dimension of the geogrid opening through direct measure.	Table 6.2
Geosynthetics	A polymeric material used in contact with soil/rock and/or any other geotechnical material in civil engineering applications.	Table 3
Pavement Geosynthetics	Geosynthetic products used in roads such as geogrid, woven geotextile and geocomposite products for reinforcement.	Clause 6 and 7
Geogrid	A polymeric geogrid formed by a regular network of connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth to function primarily as reinforcement. The geogrid may be formed by either stretching and drawing a punched sheet of polymer, by welding together highly oriented discrete bars of polymer or by weaving together discrete polymer bars into a network that may then be coated if necessary to protect the polymer strips. Geogrids shall be manufactured using High density Polyethylene (HDPE), polypropylene (PP) and/or polyester (PET).	Table 4
Woven Geotextile	A geotextile produced by interlacing two or more sets of yarns, filaments, tapes or other elements. The elements pass each other essentially at right angles and one set of elements is parallel to the fabric. Woven geotextiles shall be manufactured using polypropylene (PP) and/or polyester (PET).	Clause 6.3 and 8.2
Non-Woven Geotextile	A geotextile in the form of a manufactured sheet, web or batt of directionally or randomly orientated fibres, filaments or other elements, mechanically and/or thermally and/or chemically bonded.	Clause 6

Term	Definition	Clause Reference
Characteristic Value	Where a characteristic value is specified, a statistical procedure in accordance with Clause 12 of MRTS01 shall be used to determine the value which represents the properties of a lot. The statistical procedure makes allowances for variations in the construction and measurement processes. The Works shall be constructed so that the characteristic value complies with the relevant requirements.	Clause 9.3
Tensile Strength	For pavement geosynthetics the maximum resistance to deformation developed for a specific material when subject to tension by an external force. Tensile strength of pavement geosynthetics is the characteristic of a sample as distinct from a specimen and is expressed in force per unit width.	Table 6.2
Junction Strength	Junction strength is often reported in terms of force per width of the material, which is obtained by dividing the force applied to the junction by the nominal aperture opening, or efficiency, which is the ultimate junction strength divided by the strength of the rib.	Table 6.2
Reinforcement	The improvement of the pavement system by introducing a geosynthetic to enhance lateral restraint, bearing capacity and/or membrane support. Lateral restraint is achieved through a combination of friction and interlock. A woven geotextile primarily uses friction to engage the tensile strength and a geogrid/geocomposite primarily uses interlock.	Clause 6 & 7
Geocomposite	A manufactured or assembled material using at least one geosynthetic product among the components, used in contact with soil/rock and/or any other geotechnical material in civil engineering applications.	Clause 6.3 and 8.1.2
Separation	A geotextile function that prevents the intermixing between two dissimilar materials, so that the integrity of the materials on both sides of the geotextile remain intact.	Clause 6.3
Reduction Factor For Creep (R_c)	The reduction factor for creep of the product is concerned with the time-related change in tensile properties of the reinforcement	Table 6.2 Note 1
Reduction Factor For Manufacture (R_m)	The reduction factor which is concerned with the consistency of manufacture of the pavement geosynthetic and how any variations affect the stated tensile properties.	Table 6.2 Note 1

3 Referenced documents

Table 3 lists documents referenced in this technical specification.

Table 3 – Referenced documents

Reference	Title
BS8006-1:2010	Code of practice for strengthened/reinforced soils and other fills
MRTS01	Introduction to Technical Specifications
MRTS04	General Earthworks
MRTS05	Unbound Pavements
MRTS06	Reinforced Soil Structures
MRTS27	Geotextile (Separation and Filtration)
MRTS50	Specific Quality System Requirements
MRTS57	Geotextile (Paving Application)
ISO/TS 13434	Geosynthetics – Guideline for the assessment of durability
AS3705	Geotextiles- Identification, marking and general data

4 Standard Test Methods

The Standard Test Methods listed in Table 4 shall be used in this technical specification. Further testing details and requirements are given in Clauses 6 to 10.

Table 4 – Standard Test Methods

Geogrid property to be tested	Test Method*	Test Name
Ultimate Tensile Strength/Tensile Strength at 2% Strain	ASTM D6637-11 or EN ISO 10319	Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
Wide Width Tensile Tests (@ 2% and 5% strain)	ASTM D4595 or EN ISO 10319	Standard Test Method for Tensile Properties of Geotextile by the Wide-Width Strip Method
Installation Damage	ASTM D5818-11	Standard Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics
Junction Strength	ASTM D7737-11 (Method B – Confined)	Individual Geogrid Junction Strength
Resistance to UV	ASTM D4355-07	Standard Test Method for Determination of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
Coefficient of Direct Shear Note 1	ASTM D5321/D5321M-14	Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear

Note 1

Direct shear test shall apply vertical stress of 50kPa, 100kPa and 150kPa. Base layer shall consist of granular material with friction angle of 30 degree.

*Refer to Clause 5.1

5 Quality system requirements

5.1 General

Testing under ASTM test methods shall be conducted by a laboratory accredited under the following:

a) NATA
b) NATA's partners by MRA (Mutual Recognition Arrangements) or
c) GAI-LAP (USA)

5.2 Hold Points, Witness Points and Milestones

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

The Hold Points, Witness Points and Milestones applicable to this technical specification are summarised in Table 5.2

Table 5.2 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
5.3	1) Approval of construction procedures		Supply of the construction procedures (14 days)
6.1	2) Supply of certificate of compliance		
7	3) Delivery of geosynthetic material (14 days)		
9.2		Site sampling of geosynthetic material	
9.4	4) Acceptance of delivery of geosynthetic material		

5.3 Construction procedures

The Contractor shall prepare documented procedures for all construction processes in accordance with the quality system requirements of the Contract. The construction procedure described in this clause shall be submitted to the Administrator.

A construction procedure detailing all work described in this technical specification shall be prepared.

The proposed construction procedure shall be submitted to the Administrator at least 14 days prior to the commencement of any works related to the placement of the pavement geosynthetic material(s). **Milestone**

No works related to the placement of pavement geosynthetic material(s) shall commence until the construction procedures have been approved by the Administrator and the Administrator has given the Contractor permission to proceed. **Hold Point 1**

5.4 Conformance requirements

The conformance requirements that apply to materials covered by this technical specification are given in Clauses 6 to 9.

5.5 Testing frequencies and lot sizes

The minimum testing frequencies for work covered by this technical specification shall be as defined in Clause 9.

6 Material

6.1 General

The pavement geosynthetics shall have high tensile modulus in relation to the material being reinforced and shall also have high continuity of tensile strength through all ribs and junctions of the grid structure. The pavement geosynthetics shall maintain its reinforcement and interlock capabilities under repeated dynamic loads while in service and shall also be resistant to ultraviolet degradation, to damage under construction practices, and to all forms of biological or chemical degradation normally encountered in the material being reinforced.

The pavement geosynthetics shall conform in all respects to the property requirements listed in Table 6.2.The values listed in this table are minimum certified values.

A certificate demonstrating compliance with this technical specification shall be provided by the Contractor to the Administrator for each pavement geosynthetic material used, and proposed to be used in the Contract. In addition all test results on which the certificates are based shall not be more than one year old, measured from the date of supply to the site. **Hold Point 2**

Junction efficiency

Junction efficiency is required to maintain the aperture size and to provide a state of confinement with the aggregate materials. The junctions should have the ability to transfer stress at low strains and should be strong enough for installation survivability. During roadway construction operations, the geogrid experiences relatively high levels of localized load as aggregate material is placed, spread, and compacted on top of the reinforcement. Junction efficiency @ 2% strain is measured as a percentage and is calculated on the average maximum junction tensile strength @ 2% strain divided by the maximum rib tensile strength @ 2% strain.

6.2 Subgrade reinforcement geosynthetic material classes

The pavement geosynthetic material shall meet the requirements of the specified class defined in Table 6.2. All values listed in this table are minimum certified values.

Table 6.2 – Pavement geosynthetic property requirement

Subgrade Reinforcement Type				
			Type 1	**Type 2**
Property	**Test Method***	**Unit**	**Subgrade Application (CBR > 3%)**	**Subgrade Application (CBR ≤ 3%)**
Application	-	-	Reinforced subgrade with CBR > 3%	Reinforced subgrade with CBR ≤ 3%
Geogrid aperture size	-	mm	Min ≥ D50 ≈ 9.5 mm Max ≤ 2 x D85 ≈ 38 mm	Min ≥ D50 ≈ 9.5 mm Max ≤ 2 x D85 ≈ 38 mm

Subgrade Reinforcement Type				
			Type 1	**Type 2**
Property	**Test Method***	**Unit**	**Subgrade Application (CBR > 3%)**	**Subgrade Application (CBR ≤ 3%)**
Geogrid junction strength at 2% strain	ASTM D7737-11	kN/m	≥ 9.5	≥ 12.5
Tensile strength (T_s) at 2% strain in any direction of the MD and CMD Note 1	ASTM D6637-11 / ASTM D4595 or EN ISO 10319	kN/m	≥ 10.5	≥ 14
Resistance to installation damage (**R_d**) Note 1 & 2	ASTM D5818-11	%	≥ 85	≥ 85
Resistance to UV (**R_{uv}**) Note 1	ASTM D4355-07	%	≥ 90	≥ 90
Coefficient of direct shear	ASTM D5321/D5321M-14	%	≥ 75	≥ 75

Note 1

For Tensile Strength (T_s) shall be at 2% strain taken from load vs strain curves obtained from a NATA approved laboratory to demonstrate the Ultimate Tensile Strength (UTS). T_s @ 2% ≤ UTS x R_d x R_{uv} x R_c x R_m. Other recognised laboratories can be considered provided they are recognised by NATA or NATA MRA (Mutual Recognition Arrangements) or GAI-LAP (USA). Refer to Clause 5.1.

For biaxial product, minimum strength from both directions should satisfy the requirement of Table 6.2.

For uniaxial product, minimum strength from the principal direction should satisfy the requirement of Table 6.2

Note 2

The particle grading used for the installation damage test result determined in accordance with ASTM D5818 shall use a particle grading consistent with grading C of Table 7.2.4-A as defined in MRTS05 *Unbound Pavements*.

Note 3

D50: The particle size represented by the “50 percent passing” point when conducting a sieve analysis of a soil sample.

D85: The particle size represented by the “85 percent passing” point when conducting a sieve analysis of a soil sample.

Note 4

Pavement geosynthetic reinforcement to be used in natural subgrades with pH value between 4 and 9.

*Refer to Clause 5.1.

pH Value

The pH value of the underlying subgrade can affect the performance of geosynthetic products. It is recommended for polyester woven geotextiles, nonwoven geotextiles and geogrids to be installed in soils ranging between 4 < pH < 9. Polypropylene woven geotextile, nonwoven geotextiles and geogrids can be installed in soils exhibiting pH ranges beyond the 4 to 9 limits. Suppliers must provide additional tests to confirm their use and the designer may make adjustments to the reduction factor where required

Installation damage

The placement and compaction of the subbase on top of a pavement geosynthetics in the field can result in installation damage to the geosynthetic materials. This is typically reflected by a reduction of the tensile strength properties of the geosynthetic. The amount of installation damage is determined by subjecting the geosynthetic to a backfill and compaction cycle, exhuming the material, and determining the tensile strength retained within the geosynthetic. The ultimate tensile strength of the uninstalled product is compared to the ultimate tensile strength of the installed product to derive at the installation damage reduction factor

6.3 Geotextile separation/filtration requirements

Where the geogrid reinforcement is to be placed directly onto the subgrade, then a non-woven geotextile separation and filtration layer will be required in combination with the geogrid.

The Contractor shall place a non-woven geotextile compliant with Strength Class C and Filtration Class I or II in accordance with MRTS27 *Geotextiles (Separation and Filtration)*. This geotextile shall be placed beneath the geogrid. Alternatively the Contractor may substitute the placement of the Type 1 or Type 2 geogrid with a woven geotextile or geocomposite that meets the properties of Table 6.2 of this technical specification and the requirements of Strength Class C and Filtration Class I or II properties of MRTS27.

7 Packaging, delivery, storage and protection

Supply pavement geosynthetic rolls with each roll having adhesive tape fixing bands or printing directly on the material identifying the product name, and its manufacturing style code. The labelling/printing is preferably at 5 m spacing along the length of the roll of pavement geosynthetic material. If the pavement geosynthetic product proposed has difficulties with labelling/printing, the supplier is to propose a method of identification to be considered by the Administrator. Refer to AS 3705 for guidance.

Deliver pavement geosynthetic reinforcement to the site at least 14 days prior to commencement of installation. **Hold Point 3**

Store pavement geosynthetic reinforcement to avoid any damage prior to installation. Do not store the reinforcement directly on the ground or in any manner in which it may be affected by heat. The method of storage must be in accordance with any other recommendations set by the manufacturer.

Follow the manufacturer's recommendations regarding protection from exposure to sunlight. Geogrid materials should not be left directly exposed to sunlight for a period longer than the period recommended by the manufacturer.

All geogrid supplied under this technical specification shall comply:

a) with a minimum UV resistance at 500 hours of at least 90% retained strength when tested to ASTM D4355.
b) to a non-contaminated geogrid with no mud, wet concrete, epoxy, or other deleterious materials from coming in contact with and affixing to the geogrid materials.
c) to a storage at temperature not less than – (minus) 15°C.

In addition, rolled materials may be laid flat or stood on end.

8 Construction requirements

8.1 Construction methods

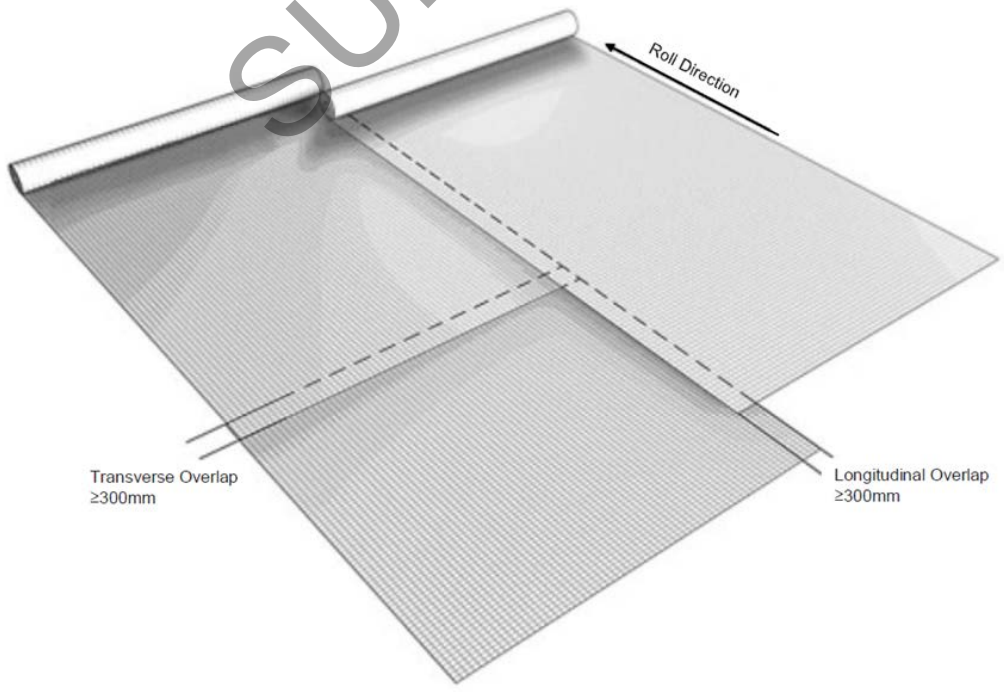
8.1.1 Subgrade preparation

Subgrade shall be prepared prior to placement, providing a level and uniform ground surface, with appropriate clearing and grubbing performed to accomplish this. Additional preparation as outlined in the project documents may be required.

8.1.2 Installation of geogrid/woven/geotextile/geocomposite

The pavement geosynthetics shall be installed in accordance with the lines and grades shown on the plans and specifications. The pavement geosynthetics shall be oriented such that the roll length runs parallel to the road direction. Geogrid shall be laid flat and smooth directly on the prepared subgrade. All wrinkles and folds shall be removed. When required, the pavement geosynthetics may be pretensioned to eliminate slack (refer Figure 8.1-A). This requirement is applicable particularly to uniaxial geosynthetic product.

Figure 8.1-A – Minimum overlap



The pavement geosynthetics shall be overlapped a minimum of 300 mm in longitudinal directions, or joined as specified in the project plans or as directed by the Administrator. Soft subgrade installations may require a greater overlap and in some cases, geogrids may be joined using cable ties or other suitable methods to maintain the geogrids location and orientation during fill placement. Consult project plans and specifications for more instructions in this regard (refer Table 8.2).

8.1.3 Placement of fill material and compaction control

Prior to placement of the fill material, the pavement geosynthetics shall be inspected by the Administrator, to make sure it is placed in the proper location, and has not been damaged during delivery and placement. Damaged geogrid shall be replaced immediately (refer Clause 8.3 and Figure 8.3-A).

Care shall be taken to ensure that pavement geosynthetics sections do not separate at the overlaps during construction. Road base material shall be placed in lift thickness as shown on the plans. Typically, tracked construction equipment shall not operate directly upon the pavement geosynthetics. A minimum compacted fill thickness of 200 mm is required prior to operation of tracked vehicles over the pavement geosynthetics (refer Figure 8.1-B). On firm subgrades rubber tyred vehicles may be allowed to traverse directly on the geogrid, providing no turning or sudden stops are allowed, and slow speeds are maintained. The contractor shall obtain permission from the Administrator before this may occur. Any ruts occurring during fill placement shall be immediately filled in with a suitable capping material.

Typically granular fill is used for (conforming to the requirements of the technical specification MRS05/MRTS05 *Unbound Pavements*). In all cases, the granular fill used shall be as required in the specifications, and shall be placed and compacted accordingly.

Figure 8.1-B – Minimum fill thickness

8.2 Overlap

The recommended minimum overlap for woven geotextile is 1000 mm in all directions for all subgrade CBR values. The recommended minimum geogrid/geocomposite overlaps are shown below:

(Also refer Figure 8.1-A)

Table 8.2 – Minimum overlap

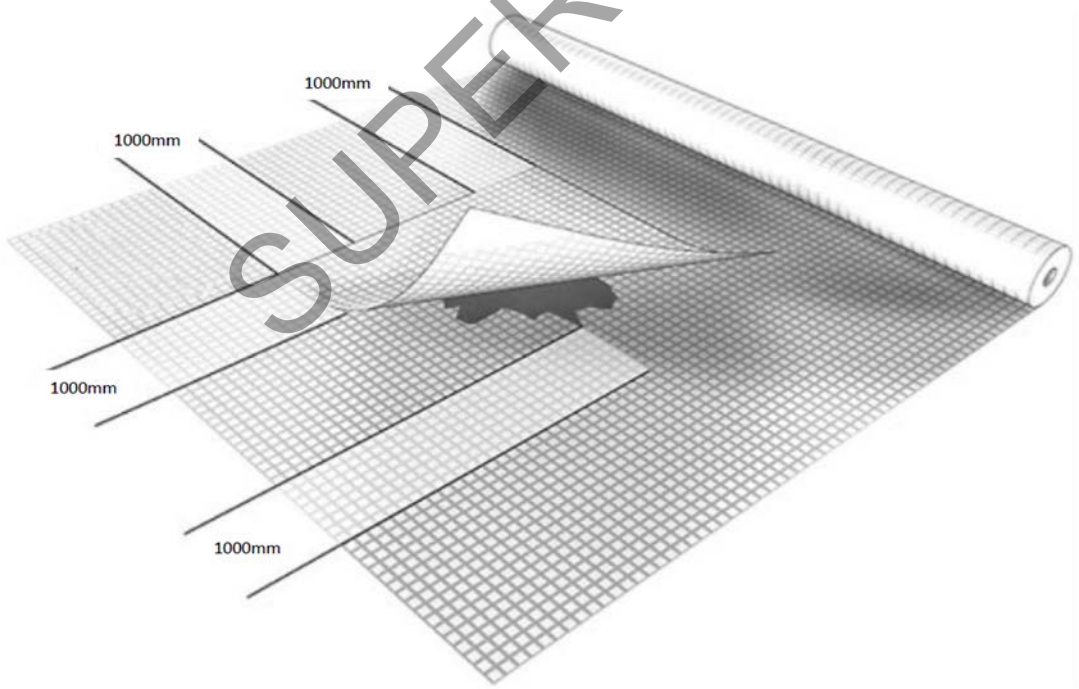
Subgrade CBR	Minimum Overlap (mm)
> 2	300 – 450
1 – 2	600 – 900
0.5 – 1	900
< 0.5	Advice from Engineering and Technology Branch to be obtained
All roll ends	900
All woven geotextiles	1000

8.3 Replacement

Any roll of pavement geosynthetics damaged before or during installation shall be replaced by the Contractor at no additional cost to the Principal.

Proper replacement shall consist of replacing the affected area and adding at least one metre additional geogrids to all sides of the affected area (refer Figure 8.3-A).

Figure 8.3-A - Repair of damage areas



9 Acceptance criteria

9.1 General

Conformance testing on the pavement geosynthetics delivered to the site shall be undertaken by the Contractor in accordance with the requirements of Clause 9.

The Administrator may accept test certificates, verifying compliance with Clause 6, for tests carried out, in accordance with this technical specification, on the materials to be used for the specific project. In addition, Contractor's quality system shall demonstrate that the specified minimum frequency of testing has been maintained and ensuring traceability of the material.

The currency of the test certificates shall be no older than 12 months from the date of the supply to the site.

9.2 Site sampling

Where the total required batch size for the Contract is less than 5000 m², sampling and testing need not be undertaken, provided that the tested mean value for tensile strength at 2% strain of the material supplied is higher than the requirements stated in Table 6.2 for the appropriate application. In addition, the pavement geosynthetics manufacturer shall demonstrate compliance with the remainder of this technical specification.

On-site sampling shall be carried out in accordance with ASTM D4354 at the frequency stated in Table 9.2.

Table 9.2 – On Site sampling frequency

Batch or order size defined as the lot size	Number of rolls to be sampled representing the lot
The initial 10,000 m² or part thereof	1
Each subsequent 20,000 m² or part thereof	1

A representative sample shall be taken from the roll(s) to be tested in accordance with ASTM D4354. The representative sample shall be no less than four linear metres along the roll for the full production width but not within two metres of the start or end of the roll. **Witness Point**

Each sample shall be clearly marked with a large arrow showing the "Machine Direction" (longitudinal) and "Cross Machine Direction" (transverse) of the pavement geosynthetic. The directional marking shall be used to identify the direction of samples for strength tests in the 'Machine' and 'Cross' directions.

The Administrator may select additional samples to be taken at the site for audit testing.

9.3 Testing of site samples

The tensile strength at 2% strain of the sampled pavement geosynthetics shall be tested by the Contractor:

Identification information including the pavement geosynthetic supplier, type, batch identification, and details of the order represented by sample, sample date and roll directional markings shall be shown on or attached to the test reports.

The tensile strength at 2% strain test results shall be calculated from the results of tests carried on a minimum number of five test specimens. For the appropriate test method refer Table 4.

The characteristic value of the strength properties listed in Table 9.3 shall be calculated in accordance with the requirements of Clause 12 of MRTS01 *Introduction to Technical Specifications*. Refer to the Table 9.3 for the characteristic value requirement for compliance.

Table 9.3 – Characteristic value requirement for compliance test

Property	Characteristic value requirement for compliance	
	Type 1	**Type 2**
Application	Subgrade Application (CBR > 3%)	Subgrade Application (CBR ≤ 3%)
Tensile strength (Ts) at 2% strain in any MD and CMD*(kN/m)	10.5	14

* Refer to Note 1, Table 6.2.

9.4 Acceptance

A lot shall be deemed to achieve conformance, if all samples tested comply with the technical specification. If a lot fails to achieve conformance, the lot may be re-sampled in accordance with Clause 9.2 and retested in accordance with Clause 9.3 to verify whether the lot conforms or not. If on retesting the lot fails to achieve conformance then the lot shall be rejected.

The pavement geosynthetics shall not be placed prior to the Administrator accepting the lot conforms to this technical specification. **Hold Point 4**

9.5 Audit testing

The Administrator may select samples from the site and make arrangements for audit testing to be carried out, regardless of the quantity of pavement geosynthetics supplied.

Tensile strength @ 2% strain

The ultimate tensile strength of a geosynthetics is measured using the wide width tensile strength test. Roller or capstan grips are used to clamp the geosynthetic and to prevent damage to the test samples. The geosynthetics is tested at a constant speed and the increase in length of a specimen is measured during the test, this is referred to as strain. During the test, the load is measured and strain is recorded. The results are plotted on a load/strain curve and from the curve the tensile strength at 2% strain can be determined.