Technical Specification

Transport and Main Roads Specifications
MRTS100 High Strength Geosynthetic Reinforcement in Road Embankments

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Queensland Government

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1 Introduction

This Technical Specification describes the requirements for the supply and installation of geosynthetic reinforcement to be used generally for the following applications:

1. as embankment basal reinforcement (e.g. embankment over soft ground, load transfer mats, piled embankments and platforms), and
2. within reinforced embankment (batter slope ≤ 70°).

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.

For other applications of geotextiles, refer to MRTS27 *Geotextiles (Separation and Filtration)* on the physical, material and construction requirements for geotextiles for use as separation and/or filtration elements in earthworks and pavement construction, and refer to MRTS57 *Geotextiles for Paving Applications* on the physical, material and construction requirements for geotextiles used in paving applications, and refer to MRTS58 *Subgrade Reinforcement using Pavement Geosynthetics* on the physical, material and construction requirements for pavement geosynthetics used in subgrade reinforcement applications.

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

2 Definition of terms

The terms used in Technical Specifications are as defined in Clause 2 of MRTS01 *Introduction to Technical Specifications.*

The following additional definitions in Table 2 below apply in respect of terms used to specify the physical and mechanical properties of geosynthetic reinforcement.

Table 2 – Definition of terms

Term	Definition
Tcs	Extrapolated tensile load based on creep strain at the end of the design life
Tcr	Extrapolated creep rupture strength at the end of the design life
Fm	Material factor for reinforcement

3 Reference documents

Table 3 lists documents referenced in this Technical Specification. The latest versions are to be used.

Table 3 – Referenced documents

Reference	Title
BS8006-1	*Code of practice for strengthened/reinforced soils and other fills*
ISO 10320	*Geotextiles and geotextile-related products - Identification on site*
ISO/TS 13434	*Geosynthetics - Guidelines for the assessment of durability*
MRTS01	*Introduction to Technical Specifications*
MRTS04	*General Earthworks*
MRTS06	*Reinforced Soil Structures*

Reference	Title
MRTS27	*Geotextile (Separation and Filtration)*
MRTS50	*Specific Quality System Requirements*
MRTS57	*Geotextiles for Paving Applications*
MRTS58	*Subgrade Reinforcement using Pavement Geosynthetics*

(Note: BS: British Standard, ISO: International Organization for Standardization, MRTS: Transport and Main Roads Specifications)

4 Standard test methods

The latest versions of the standard test methods given in Table 4 will be used in this Technical Specification.

Further details of test numbers and test descriptions are given in Clause 4 of *MRTS01 Introduction to Technical Specifications*

Table 4 – Standard test methods

Reference	Title
ASTM D 5262-07	*Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behaviour of Geosynthetics*
ASTM D 4355	*Standard Test Method for Determination of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus*
ASTM D 5818	*Standard Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage*
ASTM D 6637	*Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method*
ASTM D 6706-01	*Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil*
ASTM D 6992	*Standard Test Method for Accelerated Creep and Creep Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method*
ASTM D 7737	*Standard Test Method for Individual Geogrid Junction Strength*
ISO 10319	Geosynthetics - Wide-width tensile test
ISO 12957-1	Geosynthetic - Determination of Friction Characteristics, Part 1: Direct Shear Test
ISO 12957-2	Geosynthetic - Determination of Friction Characteristics, Part 2: Inclined Plane Test
ISO 13431	Geotextiles and geotextile-related products - Determination of tensile creep and creep rupture behaviour
ISO/TR 20432	Guidelines for the determination of the long-term strength of geosynthetics for soil reinforcement
T925	WSDOT Standard Practice T925 - Standard Practice for Determination of Long-Term Strength for Geosynthetic Reinforcement

(Note: ASTM: American Society for Testing and Materials, ISO: International Organization for Standardization, WSDOT: Washington State Department of Transportation).

5 Quality system requirements

5.1 Details of work

Project specific details of work are shown in Annexure MRTS100.1.

5.2 Measurement and payment

The method of measurement and payment must comply with MRS100.

5.3 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 applicable to this Technical Specification are summarised in Table 5.3. There are no Witness Points or Milestones defined.

Table 5.3 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
6.4	1. Submission of Supplier's Certificate of Compliance and design/manufacture information		
8.1	2. Submission of Method Statement		
8.3	3. Informing the Administrator 24 hours prior to the completion of the installation of a layer of geosynthetic reinforcement		

5.4 Quality records

The records listed in Table 5.4 below are Quality Records for the purposes of MRTS50 *Specific Quality System Requirements*.

Table 5.4 – Schedule of Quality Records

Clause	Quality Records
6.3	Design/manufacture information for geosynthetic reinforcement
6.4	Certificate of Compliance and signed statement certifying material conformity
9	Short term tensile strength test certificates

5.5 Construction procedures

The Contractor shall prepare documented procedures for all construction processes as defined in Clause 5 of MRTS50 *Specific Quality System Requirements.*

The Project Quality Plan must include each of the documents and requirements listed in Annexure MRTS100.2 and must be implemented.

If the Contract does not require the Contractor to implement a Project Quality Plan, the documents listed in Annexure MRTS100.2 must be submitted to the Administrator for consideration at least five working days prior to work commencing and must be implemented.

In all cases where this Technical Specification refers to the Manufacturer's recommendations, these must be included in the Project Quality Plan.

6 Material requirements

6.1 Geosynthetic reinforcement

6.1.1 Reinforcement types and properties

Geosynthetic reinforcement may be either of non-woven (e.g. grid, strap, geocomposite) or woven type structure.

Geosynthetic reinforcement must be directionally stable in both directions and have no tendency to unravel, loosen or tear during construction. High strength geosynthetic reinforcement shall consist of high tenacity materials as appropriate for some products. The manufacturer shall certify compliance with this requirement.

In addition, geosynthetic reinforcement must be UV stable and must not deteriorate, experience a reduction in strength or degrade when exposed to sunlight. ISO/TS 13434 provides guidelines for the assessment of durability for the geosynthetics. Exposure of geosynthetic reinforcement shall be strictly controlled with reference to the recommendations in ISO/TS 13434. ISO/TR 20432 guidelines specifically explain how to assess durability and how to use reduction factors. All geogrid supplied shall comply with a minimum UV resistance at 500 hours of at least 90% retained strength when tested to ASTM D4355.

6.1.2 Chemical composition

Geosynthetic reinforcement must be manufactured from either of the following polymers:

a) polyester, and

b) high-density polyethylene.

6.1.3 Design strength requirements

The short term and long term longitudinal design strength of geosynthetic reinforcement for the typical design section of the road embankments must be as specified in Annexure MRTS100.1. "Short term" and "long term" is defined in Annexure MRTS100.1.

In order to meet the design strength requirements, up to a maximum of four layers of geosynthetic reinforcement (each layer sandwiched between Selected Material fill) may be used. Refer to BS 8006 1 for the assessment of the tensile resistance for multiple reinforcement layers.

Whilst no strength requirements are specified for the transverse direction, geosynthetic reinforcements must be robust enough to resist any tendency to tear, unravel or debond in both directions.

Derive the design strength of geosynthetic reinforcement in accordance with Section 5.3.3, Annexure A and Annexure D of BS 8006 1.

The following requirements in BS 8006 1 are to be taken into account in determining strength reduction factors and in calculating design strengths of geosynthetics:

a) Long term creep. Creep and creep rupture tests must be carried out in accordance with ISO 13431. For creep and creep rupture tests based on the Stepped Isothermal Method (SIM) to be acceptable, the supplier has to submit test data and track records of the product to substantiate the accuracy and validity of the SIM test results for the product.

b) Tensile strength characteristics that is tensile strength-strain behaviour of the product.

c) Chemical effects due to ground water and the fill, and durability (for example, hydrolysis).

d) Temperature.

e) Construction site installation damage.

f) Deviations from the manufacturer's quality control strength.

g) Pull out strength interaction values, and

h) Connection strengths.

The following conditions will apply in accordance with Section 5.3.3 and Annexure A of BS 8006-1:

i. maximum operating temperature shall be 20°C, and

ii. maximum creep strain must not exceed 1% over a design life of 100 years at the maximum operation temperature in the derivation of Tcs.

Furthermore, the long term design strength of the connections (if required) in the longitudinal direction must be higher than that of the reinforcement. Otherwise sufficient lap lengths shall be proposed, and substantiated by relevant calculations and test data, to allow the transmission of the reinforcement load.

The junction efficiency of the non-woven product (i.e. the ratio of the shear strength of a pair of junctions on either side of a rib to the strength of an individual rib determined from acceptable test methods, namely ASTM D 7737, ASTM D 6637, etc.) must be at least 90%.

6.2 Selected Material above and below geosynthetic reinforcement

The Selected Material above and below geosynthetic reinforcement must be frictional fill material and shall satisfy the requirements specified by the Designer in order to minimise any damage to the geosynthetic reinforcement during placing of the fill. The Selected Material shall comply with the properties of Class A1 or B, or better as defined in MRTS04 *General Earthworks*.

However, the Selected Material shall meet the electrochemical requirements specified in Table 7.2(c) in MRTS06 *Reinforced Soil Structures*.

The compacted thickness of Selected Material above and below the geosynthetic reinforcement must be between 300 mm and 350 mm.

Where multilayered reinforcement layers are used, the compacted fill thickness between reinforcement layers must not be less than 150 mm.

6.3 Information to be supplied by the Contractor

At least four weeks prior to the supply of geosynthetic reinforcement, the Contractor is to submit to the Administrator the following design/manufacture information for the geosynthetic reinforcement:

a) complete documentation (including raw data test details) for the derivation of Tcs, Tcr and Fm as defined in BS 8006-1

b) tensile strength characteristics, that is tensile strength-strain behaviour of the product

c) if available, the results of any laboratory pull-out tests and frictional resistance tests on the product with different types of backfill

d) roll length and width

e) overlap details (both longitudinal and transverse) and connection details, including supporting calculations and test data

f) method of packing and identification

g) samples of the product

h) manufacturer's specifications and instructions on storage and installation

i) nomination of a suitable installation damage factor relevant to the particular application. The installation damage factor used in long term design strength calculation for the supplier's proposed material should be supported by current testing (within five years). The procedure must conform to T925 and ASTM D 5818, and

j) name and address of the supplier/manufacturer, country of origin, product literature and relevant documentation supporting the technical evaluation of the products.

The above information must also be supplied four weeks prior to changing the materials originally proposed.

6.4 Product conformity

Each consignment of geosynthetic reinforcement to be delivered to the site must be accompanied with a manufacturer's Certificate of Compliance certifying that the geosynthetic reinforcements comply with the strength requirements in Clause 6.1.3 of this Technical Specification. **Hold Point 1**

At least seven days prior to the proposed use of geosynthetic reinforcement, the Contractor is to submit a signed statement certifying that the geosynthetic reinforcement complies with the requirements of this Technical Specification. This statement must be supported by a copy of the relevant test reports from a laboratory accredited by NATA. Where NATA accredited laboratory is not available for a particular test, a laboratory accredited by ISO, or with reciprocal recognition by NATA, and approved by the Administrator shall be used. The laboratory must demonstrate test competency in the test method with at least three years' experience of proficiency in testing high strength geosynthetic reinforcements.

Hold Point 1 Process Held:	Delivery to site of geosynthetic reinforcement
Release of Hold Point:	The Administrator will consider the submitted documents and may request further information or direct further action, such as directing site sampling and testing, prior to authorising the release of the Hold Point.
Submission Details:	Certificate of Compliance from the Supplier, and design/manufacture information specified under Clause 6.3. Four weeks before placement of order to allow sufficient time for product evaluations. The data published in the data sheet shall be based on test properties from the laboratory. Technical values shall meet 95% confidence level requirements of the specification as evaluated under the Supplier/Manufacturer's quality control program.

7 Packaging, delivery and storage

Geosynthetic reinforcement shall be supplied to site in rolls with each roll securely attached with a durable, marked and waterproof label identifying the manufacturer, specific roll number, product type, grade and its manufacturing code. The labelling shall be at 5 m spacing along the length of the roll of geosynthetic material. If the geosynthetic products have difficulties with labelling/printing, the supplier is to propose a method of identification to be considered by the Administrator for complying to the requirement. Refer to ISO 10320 for guidance.

Geosynthetic reinforcement shall be delivered to the site at least 14 days prior to commencement of installation.

Geosynthetic reinforcement shall be stored under protective cover or wrapped with a waterproof, opaque UV protective sheeting 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.

8 Construction requirements

8.1 Method statement

At least five working days prior to installation of geosynthetic reinforcement, the Method Statement shall be submitted to the Administrator and it must include the following:

a) a plan showing the proposed layout of the geosynthetic reinforcement, including locations of overlaps and connections (where permitted)

b) the construction plant to be used for laying and covering the reinforcement and any restrictions on construction plant, which may affect the installation or performance of the reinforcement, and

c) method of filling and compaction over installed reinforcement.

Submission of the Method Statement constitutes a Hold Point. **Hold Point 2**

Hold Point 2 Process Held:	Placing of geosynthetic reinforcement
Release of Hold Point:	The Administrator will consider the submitted documents and may require changes prior to authorising the release of the Hold Point
Submission Details:	At least five working days before the commencement of installation of geosynthetic reinforcement, submit to the Administrator the Method Statement including the details stated in Clause 8.1

Overlapping of the geosynthetic soil reinforcement in the primary (that is, load carrying) direction is not permitted, unless otherwise approved by the Administrator.

8.2 Traceability

Provide traceability in the use of geosynthetic reinforcement at all stages from delivery to installation.

8.3 Filling over installed reinforcement

Hold Point 3 Process Held:	Acceptance of laid geosynthetic reinforcement.
Release of Hold Point:	The Administrator will inspect the laid geosynthetic reinforcement prior to authorising the release of the Hold Point.
Submission Details:	Inform the Administrator 24 hours prior to the completion of the installation of a layer of geosynthetic reinforcement.

No construction equipment must stand or travel directly on the laid reinforcement.

Do not commence placing selected material on the laid reinforcement prior to the acceptance of the laid reinforcement by the Administrator. **Hold Point 3**

A minimum cover of 150 mm (uncompacted) of cover material must be placed over the reinforcement layer prior to construction equipment travelling over the area.

Unless otherwise approved in writing by the Administrator, vibratory and heavy compaction plant must not be used on the initial lifts of filling materials to avoid damage to reinforcement.

9 Acceptance criteria

Conformance testing on geosynthetic reinforcement delivered to the project shall be carried out as specified in Clause 9.

The Administrator may accept test certificates for tests carried out for other projects in accordance with this clause that verify compliance with Clause 9, provided that the Contractor's quality system ensures the specified minimum frequency of testing is maintained and ensures traceability of material to the same manufacturing batch. The currency of the test certificates shall be no older than 12 months from the date of the supply to the site.

9.1 Short term tensile test

For every 10,000 m² of each geosynthetic grade supplied, provide to the Administrator a test certificate, related to the batch produced, verifying that its short term tensile strength (refer to Annexure MRTS100.1) complies with this Technical Specification. The tensile strength tests must be carried out in accordance with test method ISO10319.

9.2 Testing requirement - site audit

The Administrator may select samples from the Site and make arrangements for audit testing to be carried out, regardless of the quantity of geosynthetic reinforcement supplied. The Administrator shall advise the Contractor who may be present and who may select additional samples when samples for audit testing are taken.

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