

Technical Specification

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

March 2023

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1 Introduction

This Technical Specification prescribes the requirements for the supply and installation of geosynthetic reinforcement in the following geosynthetic applications:

1. basal reinforcement beneath embankments (with or without vertical drains)
2. piled embankments with basal reinforcement, and
3. reinforced embankment slopes (batter slope $\leq 70^\circ$).

For applications of geosynthetic materials used as separation and/or filtration elements in earthworks and pavement construction, refer to MRTS27 *Geotextiles (Separation and Filtration)*.

For paving applications, refer to MRTS57 *Geotextiles for Geotextile Reinforced Seals*.

For subgrade reinforcement applications, refer to MRTS58 *Geosynthetics for Subgrade and Pavement Reinforcement*.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual and shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

2 Definitions of terms

The terms defined in MRTS01 *Introduction to Technical Specifications* apply to this Technical Specification. Additional terminology relevant to this Technical Specification is defined in Table 2 below.

Table 2 – Definitions of terms

Term	Definition
Geosynthetic Reinforcement	Soil reinforcement made of polymeric materials used in reinforced soil structure for example, geotextiles and geogrids.
Primary Reinforcing Direction	The direction in the plane of the geosynthetic parallel to the direction of manufacture (or machine direction), which is the direction with the higher tensile strength, parallel to the principal stress direction.
Secondary Reinforcing Direction	The direction in the plane of the geosynthetic perpendicular to the direction of manufacture (or cross-machine direction), which is the direction with a lower tensile strength, perpendicular to the principal stress direction.
Select Fill Material	Backfill material selected by Designer to be placed over the geosynthetic reinforcement that can develop sufficient mechanical interlock and/or frictional resistance with the reinforcement to prevent sliding and pull-out failures.

3 Referenced documents

The requirements of the referenced documents listed in Table 3 below apply to this Technical Specification. Where there are inconsistencies between this Technical Specification and the referenced documents, the requirements specified in this Technical Specification shall take precedence. The latest versions are to be used.

Table 3 – Referenced documents

Reference	Title
BS8006-1	<i>Code of practice for strengthened/reinforced soils and other fills</i>
ISO 10320	<i>Geotextiles and geotextile-related products - Identification on site</i>
ISO/TS 13434	<i>Geosynthetics - Guidelines for the assessment of durability</i>
MRTS01	<i>Introduction to Technical Specifications</i>
MRTS04	<i>General Earthworks</i>
MRTS06	<i>Reinforced Soil Walls</i>
MRTS27	<i>Geotextile (Separation and Filtration)</i>
MRTS50	<i>Specific Quality System Requirements</i>
MRTS57	<i>Geotextiles for Geotextile Reinforced Seals</i>
MRTS58	<i>Geosynthetics for Subgrade and Pavement Reinforcement</i>

4 Standard test methods

The latest versions of the standard test methods given in Table 4 shall 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 4355	<i>Standard Test Method for Determination of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus</i>
ASTM D 6637	<i>Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method</i>
ASTM D 6992	<i>Standard Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method</i>
ASTM D 7737	<i>Standard Test Method for Individual Geogrid Junction Strength</i>
ASTM D 5818	<i>Standard Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage</i>
ISO 9864	<i>Geosynthetics - Test method for determination of mass per unit area of geotextiles and geotextile products</i>
ISO 10319	<i>Geosynthetics - Wide-width tensile test</i>
ISO 13431	<i>Geotextiles and geotextile-related products - Determination of tensile creep and creep rupture behaviour</i>
ISO/TR 20432	<i>Guidelines for the determination of the long-term strength of geosynthetics for soil reinforcement</i>
T925	<i>WSDOT Standard Practice T925 - Standard Practice for Determination of Long-Term Strength for Geosynthetic Reinforcement</i>

5 Quality system requirements

Quality system requirements for the supply and installation of geosynthetic reinforcements shall include verification of the properties and placement of the geosynthetic reinforcements.

5.1 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 and Witness Points applicable to this Technical Specification are summarised in Table 5.1. There are no Milestones defined in this Technical Specification.

Table 5.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
6.4	1. Submission of Supplier / Manufacturer's Certificate of Compliance and designer/manufacture information.		
7	2. Submission of Contractor's method for storage and handling of geosynthetic reinforcement.		
8.1	3. Submission of Method Statement.		
8.3	4. Acceptance of the laid geosynthetic reinforcement, prior to placement of Select Fill Material.		
8.4		1. Inspection of covered reinforcement after placement of Select Fill Material.	

5.2 Quality records

The records listed in Table 5.2 below are Quality Records for the purposes of MRTS50 *Specific Quality System Requirements*.

Table 5.2 – 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	Characteristic Initial tensile strength test certificates

5.3 Construction procedures

Supply and installation of geosynthetic reinforcement shall be included in the construction procedures 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 Clause 1 of Annexure MRTS100.2 and it must be implemented.

If the Contract does not require the Contractor to implement a Project Quality Plan, the documents listed in Clause 1 of 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 woven geotextiles or geogrids.

Geosynthetic reinforcement must be directionally stable in both directions and have no tendency to unravel, loosen or tear during construction. The Manufacturer shall certify compliance with this requirement. The minimum strength in the secondary reinforcing direction shall be 50 kN unless otherwise specified.

All geosynthetic reinforcements supplied shall comply with a minimum UV resistance at 500 hours of at least 50% 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, or
- b) high-density polyethylene.

6.1.3 Design strength requirements

The design requirements of the geosynthetic reinforcements for each design sections of the embankment shall be specified in Annexure MRTS100.1 by the Designer.

All proposed geosynthetic products for the Works must comply with the design strength requirements for Ultimate Limit State (ULS) and Serviceability Limit State (SLS) and the maximum allowable strains specified in Annexure MRTS100.1. The design strength shall be multiplied by the reduction factors (for creep-strain (SLS) / Creep-rupture (ULS), weathering effects, installation damage, environmental effects, and extrapolation) in accordance with BS8006-1 to get the characteristic initial strength for the selection of geosynthetic reinforcement for the Work.

The design strengths of the geosynthetic reinforcements for ULS and SLS shall be determined in accordance with BS8006-1.

For basal reinforcement and piled embankment applications, multiple layers of geosynthetic reinforcement (each layer sandwiched between Select Fill Material) may be used to meet the design strength and strain limit requirements (refer to BS8006-1 for the assessment of the tensile resistance for multiple reinforcement layers).

For applications that require reinforcement in both the primary and secondary directions (for example, piled embankments), the Designer should consider using two layers of uniaxial geosynthetic reinforcement, separated by a minimum of 150 mm Select Fill Material, as an alternative to one layer of biaxial geosynthetic reinforcement.

The following requirements in BS8006-1 are to be considered in determining the strength reduction factors and in calculating the required characteristic initial strengths of geosynthetic reinforcements:

- a) Creep and creep rupture tests in accordance with ISO 13431 or ASTM D 6992.
- b) Tensile strength characteristics, that is, the tensile strength-strain behaviour of the product.
- c) Chemical effects due to ground water and fill, and durability (for example, hydrolysis).
- d) Temperature.
- e) Construction site installation damage.

Joints using either overlap or stitched are only allowed in secondary reinforcing direction (or cross-machine direction). The overlap length of geotextile in the secondary reinforcing direction shall not be less than 0.5 m. Alternatively, the adjacent geosynthetic reinforcement can be sewn using a double chain stitch sewing machine in the form of a double J seam with a minimum of 3 stitches per 25 mm with a minimum overlapped of 50 mm. The sewing thread used shall be of high tenancy polyester with a breaking load of not less than 200N.

No joint in the primary reinforcing direction (or machine direction) is allowed. However, in situations where joints are unavoidable in the primary reinforcing direction, for placing geosynthetic reinforcement in the longitudinal direction to embankment, the Designer may propose overlap joints (designed in accordance with an acceptable design standard) to the acceptance of Transport and Main Roads Geotechnical Section. If the proposed overlap joint is acceptable to Transport and Main Roads Geotechnical Section, then the details of the joint shall be shown on drawings.

6.2 Select Fill Material above and below geosynthetic reinforcement

The Select Fill Material above and below geosynthetic reinforcement shall:

- a) be frictional fill material
- b) not cause damage to the geosynthetic reinforcement during placing of the fill, and
- c) comply with the requirements in Table 6.2 below, unless otherwise specified by the Designer.

Table 6.2 – Select Fill Material properties

Application	Piled embankments with basal reinforcement	Basal reinforcement beneath embankments, and Reinforced embankment slopes (Batter slope $\leq 70^\circ$)
Material properties	<ul style="list-style-type: none"> • MRTS06 <i>Reinforced Soil Walls</i>, Clause 7.2 	<ul style="list-style-type: none"> • MRTS06 <i>Reinforced Soil Walls</i>, Clause 7.2, or • MRTS04 <i>General Earthworks</i>, Clause 14.2.2, Class A1 or Class B Earth Fill

The Select Fill Material shall be placed and compacted in accordance with MRTS04 *General Earthworks*.

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

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

For reinforced embankment slopes, intermediate reinforcement may be required to improve compaction and stabilise the slope between primary reinforcement layers.

6.3 Information to be supplied by the Contractor

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

- a) A complete documentation showing the calculation method used to convert the specified design strength and maximum allowable strain requirements of reinforcements to the required characteristic initial strengths (refer Annexure MRTS100.1). This documentation shall be reviewed and accepted by the Designer and the Transport and Main Roads Geotechnical Section before submitting the Certificate of Compliance (see Clause 6.4 of this Technical Specification).
- b) Datasheets, reinforcement material reduction factors used, technical notes, Isochronous curves and/or test reports shall be included in the above calculations.
- c) Tensile strength characteristics—that is, the tensile strength-strain behaviour of the product.
- d) If available, the results of any laboratory pull-out tests and frictional resistance tests on the product with different types of backfill.
- e) Roll length and width.
- f) Overlap details (both longitudinal and transverse) and connection details, including supporting calculations and test data. No joint in the primary reinforcing direction (or machine direction) is allowed, see Clause 6.1.3 for details.
- g) Method of packing and identification.
- h) Samples of the product.

- i) Manufacturer's specifications and instructions on storage and installation.
- j) Nomination of a suitable installation damage factor relevant to the particular application and type of Select Fill Material. 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 for the determination of the installation damage factor must conform to T925 and ASTM D 5818, and
- k) 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 (if any).

6.4 Product conformity

Each consignment of geosynthetic reinforcement to be delivered to the site must be accompanied with a Certificate of Compliance from the Supplier / Manufacturer certifying that the geosynthetic reinforcements comply with the strength requirements in Clause 6.1.3 of this Technical Specification.

Hold Point 1

The certification documents shall include:

- a) Statement of product grades that satisfy the design strengths and maximum allowable strain requirements specified in Annexure MRTS100.1.
- b) Calculation method used to convert reinforcement design tensile strength and maximum allowable strain requirements to the required characteristic initial strengths (this should be the final version of the calculations requested in Clause 6.3 (a) and (b) of this Technical Specification).
- c) The certification document must be signed by a senior representative of the Supplier / Manufacturer on Supplier / Manufacturer's letterhead.

At least seven days prior to delivery of each consignment of the proposed geosynthetic product, the Contractor shall submit a signed statement to the Administrator, 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.

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

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

The laboratory must demonstrate test competency in the test method with at least three years' experience and proficiency in testing high strength geosynthetic reinforcements.

Hold Point 1 Process Held:	Submission of Supplier / Manufacturer's Certificate of Compliance and designer / manufacture information
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.

Where label attachment or printing onto the product is difficult to achieve, the Supplier may propose an alternative method of identification for approval by the Administrator to comply with this requirement. Refer to ISO 10320 for guidance.

All geosynthetic reinforcement delivered to site shall be stored under protective cover or wrapped with a waterproof, opaque UV protective sheeting to avoid any damage prior to installation.

The reinforcement shall be stored on site such that it is supported off the ground surface and protected from exposure to excessive heat.

The storage requirements must also be in accordance with any other recommendations set out in the Manufacturer's certificate.

The Contractor shall submit a proposed method for the storage and handling of geosynthetic reinforcement at least seven days prior to delivery to site. **Hold Point 2**

Hold Point 2 Process Held:	Submission of Contractor's method for storage and handling 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 for storage and handling of reinforcement on site.

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

8 Construction requirements

8.1 Method statement

At least five working days prior to installation of geosynthetic reinforcement, the Contractor shall submit the Method Statement to the Administrator. The Method Statement must include:

- 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 3**

Hold Point 3 Process Held:	Submission of Method Statement.
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.

8.2 Traceability

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

8.3 Placement of installed reinforcement

Geosynthetic reinforcement shall be laid horizontally in continuous longitudinal strips in the direction of primary reinforcement at the location and levels specified in the Project Drawings. The geosynthetic reinforcement shall be pulled taut before placing the overlaying fill material. The method of fill placement and compaction shall ensure that slack is not introduced into the soil reinforcement as fill is placed.

Construction plant and equipment shall be prohibited from being placed on or traversing over the uncovered reinforcement during and after the laying process.

Geosynthetic reinforcement that has been exposed to sunlight and weathering longer than the permissible exposure time allowed in the Manufacturer's certificate, or more than seven calendar days (whichever is shorter), shall be rejected and thereafter shall be removed and replaced at the Contractor's own cost. This UV exposure requirement shall also be shown on drawings as a Hold Point.

Placing of Select Fill Material on the laid geosynthetic reinforcement shall not commence prior to acceptance by the Administrator. **Hold Point 4**

Hold Point 4 Process Held:	Acceptance of laid geosynthetic reinforcement, prior to placement of Select Fill Material.
Release of Hold Point:	The Administrator will inspect the laid geosynthetic reinforcement and confirm that the elapsed UV exposure time since its placement is within the maximum permitted exposure time in accordance with the Manufacturer's certificate, or no more than seven days (whichever is the shorter), 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.

8.4 Placing of Select Fill Material over geosynthetic reinforcement

The Contractor shall commence placing the Select Fill Material to cover the accepted reinforcement layer after Hold Point 4 is released.

A minimum fill thickness of 150 mm must be placed over the reinforcement layer prior to operation of construction equipment over the reinforcement.

The geosynthetic reinforcing shall not be damaged or displaced during placement and compaction of the fill.

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 the reinforcement.

Within 24 hours of the completion of the placement of the first layer of Select Fill Material on the reinforcement layer, the Contractor shall arrange for an inspection by the Administrator to verify that the minimum fill thickness has been placed over the reinforcement layer and the geosynthetic reinforcement has been covered within the maximum permitted UV exposure time (refer Clause 8.3).

Witness Point 1

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 Characteristic Initial tensile strength 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 characteristic initial tensile strength complies with this Technical Specification. The tensile strength tests must be carried out in accordance with test method ISO 10319.

9.2 Testing requirement – Site audit

The Administrator may select samples from the site and make arrangement 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.

