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## GRI-GC14 Standard Specification \*

Standard Specification for

### “Test Methods, Required Properties and Testing Frequency for High Performance Turf Reinforcement Mats”

This specification was developed by the Geosynthetic Research Institute (GRI) with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

#### 1. Scope

- 1.1 This generic specification covers high performance turf reinforcement mats (TRMs) for the purpose of enhancing the soil holding properties of vegetation so as to mitigate or eliminate soil erosion.

Note 1: As will be noted several places herein soil slope erosion resulting from sheet-flow runoff is often distinguished from erosion in channels and ditches resulting from concentrated-flow runoff.

- 1.2 The specification is intended to cover all types of TRM products *provided they are polymer related* recognizing that the configuration, stiffness, thickness and conformity to the soil will vary greatly.
- 1.3 The specification does not cover erosion control products which are made partially or completely from natural fibers.

\*This GRI standard specification is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version and it is kept current on the Institute’s Website <<[geosynthetic.institute.org](http://geosynthetic.institute.org)>>.

Note 2: If natural fibers are confined in a polymer matrix, such fibers can be removed and the polymer matrix evaluated as described herein.

- 1.4 This generic specification sets forth a number of physical, mechanical and endurance properties that must be met, or exceeded, by the TRM product being manufactured.
- 1.5 In the context of quality systems and management, this specification represents a manufacturing quality control (MQC) document; see definitions section.
- 1.6 This standard specification is intended to assure good quality and performance of the TRM materials involved, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive values for the tests indicated, may be necessary under conditions of a particular application.
- 1.7 This standard specification does not address installation practices or design guidance. Both of these items are addressed in the literature dealing with this particular type of geosynthetic material. Consult Koerner R. M. (2012) Designing with Geosynthetics - 6<sup>th</sup> Edition Vol. 1 and Vol. 2 Xlibris USA pp. 914 and ASTM D4873 for further information.

## 2. Referenced Documents

### 2.1 ASTM Standards

- D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D 4439 Terminology for Geosynthetics
- D 4354 Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing
- D4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus.
- D4759 Standard Practice for Determining the Specification Conformance of Geosynthetics
- D 4873 Guide for Identification, Storage and Handling of Geosynthetic Rolls and Samples
- D 6459 Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from rainfall-Induced Erosion
- D 6460 Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion
- D 6525 Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products
- D 6524 Test Method for Measuring the Resiliency of Turf Reinforcement Mats (TRMs)
- D 6566 Test Method for Measuring Mass per Unit Area of Turf Reinforcement Mats
- D 6567 Test Method for Measuring the Light Penetration of a Turf Reinforcement Mat (TRM)

- D 6575 Test Method for Determining Stiffness of Geosynthetics Used as Turf Reinforcement Mats (TRMs)
- D 6818 Test Method for Ultimate Tensile Properties of Turf Reinforcement Mats
- D 7238 Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus

## 2.2 References

EPA/600/R-93/182 (1993), "Quality Assurance and Quality Control for Waste Containment Facilities," U.S. EPA, Cincinnati, Ohio.

Koerner, R. M. (2012), *Designing with Geosynthetics*, 6<sup>th</sup> Edition, Xlibris Publ. Co., 914 pgs.

## 3. Definitions

- 3.1 Formulation - The mixture of a unique combination of ingredients identified by type, properties and quantity. For TRMs, a formulation is defined as the exact percentages and types of resin, additives and/or carbon black. [Koerner, 2012]
- 3.2 Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications [EPA/600/R-93/182].
- 3.3 Manufacturing Quality Assurance (MQA) - A planned system of activities that provide assurance that the materials were manufactured as specified in the certification documents and contract plans and specifications. MQA includes manufacturing and fabrication facility inspections, verifications, audits, and evaluation of the raw materials and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer or fabricator is in compliance with the product certification and contract plans and specifications for the project. [EPA/600/R-93/182]

## 4. Material Classification and Formulations

- 4.1 This specification covers all polymeric TRMs regardless of their shape, thickness and configurations. As shown in Figure 1, there is a tremendous variety of products available and likely more to come in the future.



Figure 1 - Array of various turf reinforcement mats (TRMs).

4.2 The precise resin formulations of all types of TRMs are proprietary to the manufacturers. That said, the formulation shall be virgin material with no more than 25% rework. If rework is used, it must be the same formulation as the parent material.

4.3 No post-consumer resin (PCR) of any type shall be added to the formulation.

Note 3: With sustainability and resource conservation being major societal concerns, TRMs with PCRs might be made in the future provided that the parties involved enter into such an arrangement.

## 5. Specification Requirements

5.1 The TRMs shall conform to the tests and properties of Table 1.

5.2 The table is subdivided into two different categories (Classes 1, 2, 3 or 4 and Classes A, B, C or D) of TRMs depending on their application.

5.2.1 For *soil slope erosion control* the classifications listed are Class 1 greater than 1:1 slope (rugged), Class 2 1:1 to 3:1 slope (standard), Class 3 3:1 to 5:1 slope (moderate) and Class 4 less than 5:1 (non-critical). It should be clearly stated that this specification deals with erosion control and “not” slope instability.

Note 4: A 1(H)-to-1(V) slope is 45° to the horizontal. A 3(H)-to 1(V) slope is 18.4° to the horizontal.

5.2.2 *For channel and ditch erosion control* the classifications are based on vegetated maximum allowable shear stress in the following four categories:

- Class “A” Rugged
- Class “B” Standard
- Class “C” Moderate
- Class “D” Non-Critical

The number of test specimens required to arrive at an average test value per roll is contained in each of the specific test method designations.

- 5.3 All values in Table 1 are typical values, in the minimum principal direction, unless otherwise stipulated in the footnotes.
- 5.4 The table also lists minimum test frequencies for quality control purposes. If the manufacturer’s internal quality control requirements are more restrictive than those listed they (the manufacturer’s) will control.

## 6. Workmanship and Appearance

- 6.1 The finished TRM product shall have good appearance qualities. It shall be free from defects that would affect the specific properties of the product, or its proper functioning.
- 6.2 General manufacturing procedures shall be performed in accordance with the manufacturer’s internal quality control guide and/or documents.

## 7. MQC Sampling, Testing, and Acceptance

- 7.1 TRM products shall be subject to manufacturing quality control (MQC) sampling and testing to demonstrate conformance with this specification as set forth in the specific test methods within Table 1. In the absence of purchaser’s testing, verification may be based on the manufacturer’s certifications.
- 7.2 Testing shall be performed in accordance with the method referenced in this specification for the indicated application, i.e., soil slope erosion or channel/ditch erosion.
- 7.3 In addition to the required tests and limiting values, Table 1 also provides minimum testing frequency for the various TRM properties. If the manufacturer’s quality control documents are more restrictive, they shall apply.

8. MQC Retest and Rejection

8.1 If the results of any MQC test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality control documents. In general, if any roll fails only the roll bracketed by passing rolls needs to be rejected.

9. Shipment and Storage

9.1 TRM labeling, shipment, and storage shall follow ASTM D 4873 for Rolled Erosion Control Products. Product labels shall clearly show the manufacturer or supplier name, style, roll number and date of production. Each shipping document should include a notation certifying that the material is in accordance with this specification.

9.2 TRM rolls shall be adequately covered to protect them from the following: construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 160°F (70°C), root intrusion, and any other environmental condition that may damage the property values of the product involved.

10. Certification

10.1 The manufacturer shall provide to the engineer a certificate stating the name of the manufacturer, product name, style number, and the composition of the TRM.

10.2 The manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request.

10.3 The manufacturer's certificate shall state that the finished TRM meets requirements of the specification as evaluated under the manufacturer's quality control program. A person having legal authority to bind the manufacturer shall attest to the certificate.

10.4 Either mislabeling or misrepresentation of materials shall be reason to reject the products involved in this specification.

**Table 1 Turf Reinforcement Mat Specification; S.I. (Metric) Units**

Property (1) (2) (3)	Units	Test Method	Rugged Class “1” or “A”	Standard Class “2” or “B”	Moderate Class “3” or “C”	Non-Critical Class “4” or “D”	Frequency
Mass per unit area	g/m <sup>2</sup>	D6566	1000	700	460	270	per D4354
Thickness	mm	D6525	12	10	6	3.3	per D4354
Stiffness	g-cm	D6575	1000	600	450	300	per D4354
Density	g/cc	D792	0.9	0.9	0.9	0.9	1/year
Resiliency	%	D6524	70	70	70	70	1/year
Tensile strength	kN/m	D6818	50	40	20	10	per D4354
Tensile elongation	%	D6818	15	15	15	15	per D4354
Light penetration (Range) (4)	%	D6567	10-50	10-50	10-50	10-50	per D4354
C (Cover Management Factor)							
• (50mm/h)	-		≤ 0.003	≤ 0.004	≤ 0.010	≤ 0.020	Per Formulation
• (100mm/h)	-	D6459	≤ 0.015	≤ 0.020	≤ 0.030	≤ 0.035	
• (150mm/h)	-		≤ 0.035	≤ 0.040	≤ 0.045	≤ 0.050	
Shear Stress in vegetated conditions	Pa	D6460	1000	750	500	250	Per Formulation
UV resistance strength (5)	% ret @ 3000 hr	D7238	60	60	60	60	1/year

- (1) Classes 1, 2, 3 and 4 (most severe to least severe) are for soil slope erosion control TRM’s.
- (2) Classes A, B, C and D (most severe to least severe) are for channel and ditch erosion control TRM’s.
- (3) Values are Minimum Average Roll Values (MARV) except for specific gravity, resiliency and UV resistance. In these cases they are minimum average values. Stiffness is a maximum average value and is listed as gram-centimeters
- (4) Light penetration values must fall within the range given
- (5) UV Resistance is based on the percent retained strength before versus after testing via ASTM D6818

## Adoption and Revision Schedule

Adopted: December 11, 2015

Revision 1: March 11, 2016 - Changed stiffness value from 300 to 450 g-cm.

Revision 2: November 23, 2020

Addition of reference documents

Delete reference to AASHTO M288

Delete 3.4 MARV reference

Note in 5.2.1 stating that this specification does not address slope instability

5.2.2 change shear strength to shear “stress” and added allowable unvegetated shear stress in addition to allowable vegetated shear stress

5.3 changed from MARV to typical

Table 1a and 1b-

- Eliminated Mass per unit area from table
- Increased thickness to 250 mils (6.35mm) for all classes
- Changed specific gravity to density
- Increased tensile strength across classes
- Changed numbers in table to reflect light penetration instead of ground cover
- Changed UV resistance test method from ASTM D7238 to ASTM D4355 which has shown to have less uncertainty with colored geosynthetics
- Incorporated footnotes into table

Revision 3: December 6, 2024

• Eliminated English Imperial Unit Table 1

• Added Mass Per Unit Area back to table

• Added ASTM D6459 C Factor to table

• Added ASTM D6460 Shear Stress to table

• Added an additional category and changed category names from:  
Most Severe, Moderate, Least Severe

to:

Rugged, Standard, Moderate, Non-Critical

• Changed UV Resistance Test Method from ASTM D4355 Xenon to ASTM D7238 QUVA