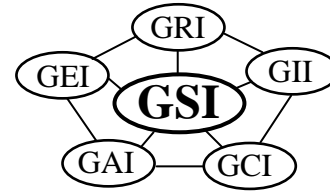


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## **GRI Test Method GT10\***

Standard Specification for

### **“Test Methods, Properties and Frequencies for High Strength Geotextile Tubes used as Coastal and Riverine Structures”**

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 It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part.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 specification covers high strength geotextile index test properties for subsequent use to form coastal and riverine structures in the form of soil filled geotextile tubes.
- 1.2 This specification sets forth a set of minimum physical, mechanical and chemical properties that must be met, or exceeded by the geotextile being manufactured. In a few cases, a maximum value is specified.
- 1.3 This specification covers not only the main geotextile tube, but also the scour apron(s), if so required in the design.
- 1.4 In the context of quality systems and management, this specification represents a manufacturing quality control (MQC) document.

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that a product represents the stated objective and properties set forth in the specification.

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\*This GRI standard 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.

- 1.5 This standard specification is intended to ensure good quality and performance of high strength fabrics used as geotextile tubes and scour aprons 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.
- 1.6 This standard specification does not address installation practices or design guidance. Both of these items are addressed in companion documents focusing on this application area.

## 2. Referenced Documents

### 2.1 ASTM Standards

- D 4355 Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
- D 4491 Test Methods for Water Permeability of Geotextiles by Permittivity
- D 4533 Test Method for Trapezoidal Tearing Strength of Geotextiles
- D 4595 Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
- D 4751 Test Method for Determining Apparent Opening Size of a Geotextile
- D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
- D 4873 Guide for Identification, Storage and Handling of Geotextiles
- D 4884 Test Method for Seam Strength of Sewn Geotextiles

### 2.2 GRI Standards

- GTXX Standard Practice for the Installation of Geotextile Tubes used as Coastal and Riverine Erosion Control Structures
- GTXX Standard Guide for the Design of Geotextile Tubes used as Coastal and Riverine Erosion Control Structures (in preparation)
- GT9/GG6 Standard Guide for Grip Types for Use in the Wide Width Testing of Geotextiles and Geogrids

## 3. Definitions

- 3.1 Geotextile Tube - A large tube [greater than 7.5 ft (2.3 m) in circumference] fabricated from high strength woven geotextile in lengths greater than 20 ft (6.1 m). Geotextile tubes used in coastal and riverine applications are most often filled hydraulically with a slurry of sand and water, although many other fill materials have been used. The tubes can also be filled by a combination mechanical and hydraulic method.
- 3.2 Scour Apron - An apron of geotextile designed to protect the foundation of the main geotextile tube from the undermining effects of scour. In coastal and riverine applications, scour can be present at the base of the tube due to wave and current action. Scour aprons may be on both sides of the main tube, or on only one side.

Scour aprons also reduce local erosion and scour caused during the hydraulic filling process of the main tube. Scour aprons are typically anchored by a small tube at the water's edge or by sandbags attached to the apron.

- 3.3 Fill Port - Also called a fill spout or fill nozzle, fill ports are sleeves sewn into the top of the geotextile tube into which the pump discharge pipe is inserted. Ports are typically 12 to 18 inches (300 to 450 mm) in diameter and 3 to 5 feet (0.9 to 1.5 m) in length. Ports are spaced along the top of the tube to provide access to the contractor. Spacing is usually no closer than 25 feet (7.6 m) to accommodate sand slurry but can be as far apart as 100 feet (30 m) for some viscous fill materials. After pumping, ports are to be closed by tying, sewing or gluing shut. After filling the tube the port sleeves shall be closed and attached to the main tube in a manner sufficient to prevent movement of the sleeve by wave action. Fill ports are fabricated from the same geotextile as the main tube.
- 3.4 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 [ref. EPA/600/R-93/182]. This definition is expanded herein for geotextile tubes and scour aprons to include fabrication, including sewing and packaging by the fabricator.

Note 2: This particular specification for high strength fabrics used as geotextile tubes and scour aprons falls under the concept of MQC.

- 3.5 Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and finished geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project [ref. EPA/600/R-93/182].

#### 4. Material Classification and Formulation

- 4.1 This specification covers high strength geotextiles for tubes and scour aprons which are placed into two categories: Class 1 is for aggressive conditions, and Class 2 is for typical conditions.

Note 3: It is recognized that "aggressive" and "typical" are arbitrary terms, however, based on current practice and field performance these two categories appear to be suitable for most projects.

- 4.2 The type of fabric style is not identified as such, but based on current manufacturing practice the properties lend themselves to woven, high tenacity, monofilament, multifilament or fibrillated geotextiles.
- 4.3 The type of polymer used for the production yarns is not identified as such, but based on current manufacturing practice both the "aggressive" conditions and the "typical" conditions can be attained using polyester or polypropylene yarns.
- 4.4 Due to the critical nature of fabrication and the involvement of the manufacture, the main tube and scour apron must be sourced from the same manufacturer.

## 5. Specification Requirements

- 5.1 The fabric for use as geotextile tubes and associated scour aprons shall conform to Tables 1(a) and 1(b) for "aggressive" conditions, and to Tables 2(a) and 2(b) for "typical" conditions. These are referred to Class 1 and Class 2, respectively. Each table is further subdivided according to the tube in part "a" and the scour apron in part "b", of the respective tables. Each of the tables are given in English and SI (metric) units. The conversion from English to SI is soft.
- 5.2 The tables are subdivided into mechanical, hydraulic and endurance test categories. Each item is accompanied by the appropriate ASTM test method designation and the minimum frequency of performing the test.

Note 4: The wide width testing of high strength fabrics is not trivial. Past problems have arisen from noncalibrated testing machines, poorly prepared specimens, inadequate elongation measuring devices, and (perhaps most of all) improper gripping devices. This last item of grips is addressed in GRI GT9/GG6.

Note 5: The targeted value of apparent opening size (AOS) is the largest opening size of the fabric's voids. Thus, the sieve size number is intended to specify the minimum sieve opening size. When specified in units of mm, AOS is the maximum dimension allowed.

Note 6: A minimum water flow rate is specified in both tables via ASTM D4491. This is a constant head permeability test usually resulting in the permittivity of the fabric. En route to permittivity one measures the water flow rate (i.e., the "flux") which is requested in the specification. The two terms are interrelated by the thickness of the fabric.

- 5.3 The various properties shall be tested at the minimum frequency shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and the product is certified accordingly, it must be followed in like manner.

Note 7: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance organization.

6. Workmanship and Appearance

- 6.1 The finished fabric shall have good appearance qualities. It shall be free from such defects that would affect the specific properties of the geotextile, tube or apron.
- 6.2 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

- 7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire width of the geotextile. No sampling of the fabricated tube is recommended.
- 7.2 The number of replicate tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.
- 7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values.

Note 8: The exceptions to this item are the physical properties and the AOS, as described in Note 5.

8. MQC Retest and Rejection

- 8.1 If the results of any 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 manual.

9. Packaging and Labeling

- 9.1 The finished geotextile tube and its associated scour apron shall be rolled on a stable core or accordion folded into a bundle for handling, storage and shipment. The geotextile tube and/or scour apron is to be protected by an outer wrapping or plastic bag. The manufacturer's identification label shall be clearly visible on the outer wrapping and in a manner consistent with the established policy of the manufacturer.
- 9.2 Handling of the rolls or bundles shall be by forklift stinger or carpet pole, or by dedicated slings and spreader bars consistent with the weight of the unit. No hooks,

tongs or other sharp instruments shall be used for handling. The geotextile tube or scour apron shall not be dragged along the ground.

9.3 Geotextile tubes shall be stored elevated off the ground in areas where water cannot accumulate and where they are protected from conditions that will affect the properties or performance of the geotextile.

9.4 Geotextile tubes and scour aprons shall be labeled, shipped, stored, and handled in accordance with ASTM D4873 and as specified herein. Each segment of geotextile tube and scour apron shall be wrapped in an opaque layer of plastic during shipment and storage. The plastic wrapping shall be placed around the unit in the manufacturing facility and shall not be removed until deployment. Each packaged segment of geotextile tube and/or scour apron shall be labeled with the manufacturers name, geotextile type, lot numbers, roll numbers, and dimensions (length, width, gross weight).

## 10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

**Table 1(a): Class 1 Tubes - Aggressive Conditions**  
(all are minimum average values unless noted otherwise)

Property	Test Method ASTM	English Units		Metric Units	
		Property	Frequency	Property	Frequency
<u>Physical</u>					
Tube Circumference	Measured	7.5/15/22.5/30/45/60-ft.	n/a	2.3/4.6/6.8/9.1/14/18 m	n/a
Fill Port (diameter)	Measured	12 or 18 in.	n/a	30 or 45 cm	n/a
<u>Mechanical</u>					
Wide Width Tensile Strength	D4595	1000 x 1000 lb/in.	10,000 yd <sup>2</sup>	175 x 175 kN/m	7500 m <sup>2</sup>
Wide Width Elongation (max.)	D4595	15 x 15%	10,000 yd <sup>2</sup>	15 x 15%	7500 m <sup>2</sup>
Trapezoidal Tear Strength	D4533	600 x 600 lb	10,000 yd <sup>2</sup>	2.7 x 2.7 kN	7500 m <sup>2</sup>
Puncture Strength	D4833	400 lb	10,000 yd <sup>2</sup>	1.8 kN	7500 m <sup>2</sup>
Seam Strength (factory)	D4884	600 lb./in.	50,000 yd <sup>2</sup>	105 kN/m	40,000 m <sup>2</sup>
<u>Hydraulic</u>					
Apparent Opening Size (AOS)	D4751	No. 40 Sieve (min.)	50,000 yd <sup>2</sup>	0.425 mm (max)	40,000 m <sup>2</sup>
Water Flow Rate	D4491	6 gpm/ft <sup>2</sup>	50,000 yd <sup>2</sup>	240 l/min/m <sup>2</sup>	40,000 m <sup>2</sup>
<u>Endurance</u>					
Accelerated UV Resistance (% retained after 150 hr)	D4355	65%	year	65%	year

**Table 1(b): Class 1 Scour Aprons - Aggressive Conditions**  
(all are minimum average values unless noted otherwise)

Property	Test Method ASTM	English Units		Metric Units	
		Property	Frequency	Property	Frequency
<u>Physical</u>					
Anchor Tube Circumference	Measured	3-6 ft.	n/a	0.9 - 1.8 m	n/a
<u>Mechanical</u>					
Wide Width Tensile Strength	D4595	400 x 550 lb/in.	10,000 yd <sup>2</sup>	70 x 95 kN/m	7500 m <sup>2</sup>
Wide Width Elongation (max.)	D4595	20 x 20%	10,000 yd <sup>2</sup>	20 x 20%	7500 m <sup>2</sup>
Trapezoidal Tear Strength	D4533	180 x 270 lb	10,000 yd <sup>2</sup>	0.8 x 1.2 kN	7500 m <sup>2</sup>
Puncture Strength	D4833	260 lb	10,000 yd <sup>2</sup>	1.2 kN	7500 m <sup>2</sup>
Seam Strength (factory)	D4884	350 lb/in.	50,000 yd <sup>2</sup>	60 kN/m	40,000 m <sup>2</sup>
<u>Hydraulic</u>					
Apparent Opening Size (AOS)	D4751	No. 40 Sieve (min.)	50,000 yd <sup>2</sup>	0.425 mm (max)	40,000 m <sup>2</sup>
Water Flow Rate	D4491	6 gpm/ft <sup>2</sup>	50,000 yd <sup>2</sup>	240 l/min/m <sup>2</sup>	40,000 m <sup>2</sup>
<u>Endurance</u>					
Accelerated UV Resistance (% retained after 150 hr)	D4355	65%	year	65%	year

**Table 2(a): Class 2 Tubes - Typical Conditions**  
(all are minimum average values unless noted otherwise)

Property	Test Method ASTM	English Units		Metric Units	
		Property	Frequency	Property	Frequency
<u>Physical</u>					
Tube Circumference	Measured	7.5/15/22.5/30/45-ft	n/a	2.3/4.6/6.8/9.1/14 m	n/a
Fill Port (diameter)	Measured	12 or 18 in.	n/a	30 or 45 cm	n/a
<u>Mechanical</u>					
Wide Width Tensile Strength	D4595	400 x 550 lb/in.	10,000 yd <sup>2</sup>	70 x 95 kN/m	7500 m <sup>2</sup>
Wide Width Elongation (max.)	D4595	20 x 20%	10,000 yd <sup>2</sup>	20 x 20%	7500 m <sup>2</sup>
Trapezoidal Tear Strength	D4533	180 x 270 lb	10,000 yd <sup>2</sup>	0.80 x 1.2 kN	7500 m <sup>2</sup>
Puncture Strength	D4833	260 lb	10,000 yd <sup>2</sup>	1.2 kN	7500 m <sup>2</sup>
Seam Strength (factory)	D4884	350 lb./in.	50,000 yd <sup>2</sup>	60 kN/m	40,000 m <sup>2</sup>
<u>Hydraulic</u>					
Apparent Opening Size (AOS)	D4751	No. 40 Sieve (min.)	50,000 yd <sup>2</sup>	0.425 mm (max)	40,000 m <sup>2</sup>
Water Flow Rate	D4491	6 gpm/ft <sup>2</sup>	50,000 yd <sup>2</sup>	240 l/min/m <sup>2</sup>	40,000 m <sup>2</sup>
<u>Endurance</u>					
Accelerated UV Resistance (% retained after 150 hr)	D4355	65%	year	65%	year

**Table 2(b): Class 2 Scour Aprons - Typical Conditions**  
(all are minimum average values unless noted otherwise)

Property	Test Method ASTM	English Units		Metric Units	
		Property	Frequency	Property	Frequency
<u>Physical</u>					
Anchor Tube Circumference	Measured	3-6 ft	n/a	0.9-1.8 m	n/a
<u>Mechanical</u>					
Wide Width Tensile Strength	D4595	400 x 400 lb/in.	10,000 yd <sup>2</sup>	70 x 70 kN/m	7500 m <sup>2</sup>
Wide Width Elongation (max.)	D4595	20 x 20%	10,000 yd <sup>2</sup>	20 x 20%	7500 m <sup>2</sup>
Trapezoidal Tear Strength	D4533	180 x 270 lb	10,000 yd <sup>2</sup>	0.80 x 1.2 kN	7500 m <sup>2</sup>
Puncture Strength	D4833	160 lb	10,000 yd <sup>2</sup>	0.70 kN	7500 m <sup>2</sup>
Seam Strength (factory)	D4884	200 lb./in.	50,000 yd <sup>2</sup>	35 kN/m	40,000 m <sup>2</sup>
<u>Hydraulic</u>					
Apparent Opening Size (AOS)	D4751	No. 30 Sieve (min.)	50,000 yd <sup>2</sup>	0.60 mm (max)	40,000 m <sup>2</sup>
Water Flow Rate	D4491	6 gpm/ft <sup>2</sup>	50,000 yd <sup>2</sup>	240 l/min/m <sup>2</sup>	40,000 m <sup>2</sup>
<u>Endurance</u>					
Accelerated UV Resistance (% retained after 150 hr)	D4355	65%	year	65%	year