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GRI-GM30*

Standard Specification for

“Test Methods, Test Properties and Testing Frequency for Reinforced Composite Polyethylene (RCPE) Geomembranes”

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 It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part.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 (GSI), 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 reinforced composite polyethylene (RCPE) geomembranes in two thickness categories. These thicknesses reflect both varying hydrostatic resistance and mechanical property strength values.

Note 1: The base reinforcement fabric for this type of geomembrane is a woven tape product (also called slit film or split film) polyethylene textile which is then polyethylene coated on both sides. Some products may also incorporate an additional laminated polyethylene film on one or both sides. In either scenario, the final products are composite materials.

Note 2: The two thickness categories of this type of geomembrane can also be categorized on the basis of their mass per unit area.

1.2 This specification sets forth a set of minimum, maximum, or range of physical, mechanical and endurance properties that must be met, or exceeded by the geomembrane being manufactured.

*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.

- 1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 3: This specification is intended to set forth physical, mechanical and vapor properties focused on appropriate manufacturing quality control (MQC) practices for general applications. Manufacturing quality assurance (MQA) can utilize any or all of the stated test methods so as to verify product conformance and/or acceptance.

- 1.4 This standard specification is intended to ensure good uniform quality RCPE geomembranes for use in general applications.

Note 4: Additional tests, or more restrictive values for the tests indicated, may be necessary under conditions of a particular application. In this situation, interactions between the purchaser/specifier and the manufacturer are required.

Note 5: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject. Manufacturer's literature may also indicate product-specific considerations.

2. Referenced Documents

2.1 ASTM Standards

- D 751 Standard Test Methods for Coated Fabrics
- D 1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
- D 4833 Test Method for Index Puncture Resistance of Geomembranes and Related Products
- D 5884 Test Method for Determining Tearing Strength of Internally Reinforced Geomembranes
- D 5885 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
- D 6241 Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
- D 7003 Test Method for Strip Tensile Properties of Reinforced Geomembranes
- D 7238 Test Method for Effect on Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
- E96 Test Methods for Water Vapor Transmission of Materials

2.2 GRI Standards

- GM16 Observation of Surface Cracking of Geomembranes

GM19b Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes/Barriers

2.3 Other

Guglielmetti, J. I., Sprague, C. J. and Coyle, M. J. (1977), "Geomembrane Installation and Construction Survivability," Proc. Geosynthetics '97, IFAI, St. Paul, MN, pp. 236-252.

3. Definitions

Reinforced Composite Polyethylene (RCPE) Geomembranes - In geosynthetics, these materials represent composite polymeric sheets that consist of a woven slit film geotextile coated with polyethylene on each side to achieve a lower permeability composite product. RCPE geomembranes may also include additional laminated polyethylene film layers to enhance hydrostatic and UV resistance, as well as seam welding. Materials that fall below 30 mils (0.75 mm) in thickness are defined as barriers, and not geomembranes.

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.

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 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.

Soft Conversion of Units - Action involving the changing of a measurement from imperial units to equivalent metric units (or vice versa) within "acceptable measurement tolerances". This is done to convert the measurements without physically changing the item, and it is typically used to specify a requirement. For example, a 60 mil material would be converted to 1.5 mm using an approximate (or "soft") conversion.

4. Material Classification and Formulation

- 4.1 The textile for this type of geomembrane is of the woven tape product (also called slit or split) film type. The base resin is polyethylene, having a formulation consistent with typical practice for geosynthetic engineering applications.

- 4.2 The polyethylene resin with which the textile is coated will generally be in the density range of 0.90 to 0.94 g/cc. This refers to the natural, i.e., nonformulated, resin.
- 4.3 The polyethylene coating shall be of a formulation such that the endurance criterion in the specification is met or exceeded.
- 4.4 The resin shall be virgin material with no more than 25% rework. If rework is used, it must be the same formulation (or other approved formulation) as the parent material.
- 4.5 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Endurance Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for RCPE geomembranes in American units and Table 2 is for RCPE geomembranes in SI units. The conversion from American to SI units is “soft”, see definition section. It is also to be understood that the tables refer to the latest revision of the referenced test methods and practices.

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. The physical and mechanical properties are all “min. ave.” values.

Note 6: In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 In an effort to try to quantify the difference between Category 1-Severe and Category 2-Moderate conditions, Table 3 is presented to suggest targeted survivability performance of these geomembranes. This table is meant to be a guide and the site-specific installation survivability conditions may take precedence.

5.4 The various properties of the RCPE geomembranes shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent, it must be followed.

Note 7: This specification is focused on manufacturing quality control (MQC). Conformance and/or acceptance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer respectively. Communication and interaction with the manufacturer is strongly suggested.

6. Workmanship and Appearance

- 6.1 RCPE geomembranes generally have a uniform undulating appearance. They shall be essentially free from irregular filaments, filaments that are bunched together, crossing over one another, and such defects that mechanically affect the specified properties of the composite material. Strictly cosmetic flaws that do not affect the specified properties are generally acceptable.
- 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 roll width.
- 7.2 The number of 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 and are designated as "min. ave."

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 Marketing

- 9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequately protected for safe transportation to the point of delivery, unless otherwise specified in the contract or order.
- 9.2 Marking of the geomembrane rolls shall be done in accordance with the manufacturers accepted procedure as set forth in their quality manual.

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.

Adoption and Revision Schedule

GRI GM30

“Test Methods, Test Properties and Testing Frequency Reinforced Composite Polyethylene Geomembrane (RCPE)”

Adopted: May 25, 2016

Revision #1: April 4, 2019

1. Specification underwent a name change from “Test Methods, Test Properties and Testing Frequency for Barriers to “Test Methods, Test Properties and Testing Frequency for Reinforced Composite Polyethylene (RCPE) Geomembranes as a result of elimination of thicknesses less than 30 mils (0.75 mm).
2. Wholesale changes to verbage, identifying material as a geomembrane instead of a barrier were made as a result of eliminating the “light” category 24 mil (0.61 mm) thickness within the specification. Since the U.S. EPA requires a minimum thickness of 30 mils (0.75 mm) for waste containment facilities in its RCRA regulations, materials that fall into the light category are considered to be barriers (and not geomembranes). Use of these materials for applications other than temporary liners or covers should be done with caution and appropriate engineering judgement.
3. Several notes were removed regarding shortcomings of CPE barriers.
4. Requirements were added for HP-OIT and several mechanical property values for both the severe and moderate categories were increased.

Revision#2: April 3, 2020

1. Removal of Note 6 in regards to the purpose of endurance tests.
2. Weight testing frequency changed from 20,000 lb. & 9,000 kg to “per roll” in Tables 1 and 2 respectively.
3. Strip Tensile Strength units changed from lb. and N to lb/in and kN/m in Tables 1 and 2 respectively.
4. Addition of footnotes 8, 9 and 10 respectively in Tables 1 and 2 for additional clarification.

Table 1 – Specification Values for Reinforced Composite Polyethylene (RCPE) Geomembranes

Property and Units ⁽¹⁾	ASTM or GRI Test Methods	Category 1 – Severe ⁽²⁾ (40 mil – nominal)	Category 2 – Moderate ⁽²⁾ (30 mil – nominal)	Testing Frequency
Thickness (mils) (min. ave.)	ASTM D751	36	27	per roll
Weight, (oz/yd ²) (min. ave.)	ASTM D751	18	16	per roll
Strip Tensile Strength ⁽³⁾ (lb/in) (min. ave.)	ASTM D7003	250	225	20,000 lb
Strip Tensile Elongation ⁽³⁾ (%) (min. ave.)	ASTM D7003	20	20	20,000 lb
Tongue Tear ⁽³⁾ (lb) (min. ave.)	ASTM D5884	50	45	20,000 lb
CBR Puncture (lb) (min. ave.)	ASTM D6241	1000	700	45,000 lb
Index Pin Puncture-Resistance (lb) (min. ave.)	ASTM D4833	200	180	45,000 lb
Hydrostatic Resistance (psi) (min. ave.) ⁽¹⁰⁾	ASTM D751	700	500	45,000 lb
Dimensional Stability (% change) (max. ave. of MD or X-MD) ⁽⁸⁾	ASTM D1204	3	3	45,000 lb
Water Vapor Transmission (WVT) (g/m ² -day) ⁽⁴⁾ (max. ave.)	ASTM E96	0.3	0.4	per each formulation
Oxidative Induction Time (OIT) High Pressure (min.) ⁽⁹⁾	ASTM D5885	400	400	per each formulation
UV Resistance (fluorescent light method) ⁽⁵⁾ (a) Strength and Elongation retained after 10,000 light hours ⁽⁶⁾ (b) High Pressure OIT (min. ave.) % retained after 1600 hours ^{(7) (9)}	ASTM D7238 ASTM D7003 ASTM D5885	 > 50% retained 50%	 > 50% retained 50%	 per each formulation

Notes

- (1) All values are minimum, or minimum average, except dimensionally stability and WVT, which are maximum values.
- (2) The categories refer to the type of subgrade, manner of installation, anchorage/tie downs, and site-specific conditions, see Table 3.
- (3) If the tape reinforcement is aligned in any direction other than the machine and transverse directions, specimen shall be cut such that reinforcing yarns are oriented parallel to the central axis of the tension testing machine.
- (4) Performed at 23° ± 0.5°C temperature and 50% ± 5% relative humidity.
- (5) The condition of the test should be 20 hour UV cycle at 75°C followed by 4 hour condensation at 60°C.
- (6) It is strongly recommended that visual observation of the exposed material be subjected to GRI-GM16 “response to bending evaluation”. No cracking, flaking, or powdering of the material should be witnessed after 10,000 light hours of exposure.
- (7) UV resistance is based on percent retained value regardless of the original HP-OIT value.
- (8) Specimens placed in oven at 100°C ± 1°C for 60 min. for ASTM D1204.
- (9) Sample shall be homogenized using Appendix X1, X2 or X3 of ASTM D5885.
- (10) Only procedure A is to be used per ASTM D751.

Table 2 – Specification Values for Reinforced Composite Polyethylene (RCPE) Geomembranes

Property and Units ⁽¹⁾	ASTM or GRI Test Methods	Category 1 – Severe ⁽²⁾ (1 mm – nominal)	Category 2 – Moderate ⁽²⁾ (0.75 mm – nominal)	Testing Frequency
Thickness (mm) (min. ave.)	ASTM D751	0.91	0.69	per roll
Weight, (g/m ²) (min. ave.)	ASTM D751	610	540	per roll
Strip Tensile Strength ⁽³⁾ (kN/m) (min. ave.)	ASTM D7003	44	39	9,000 kg
Strip Tensile Elongation ⁽³⁾ (%) (min. ave.)	ASTM D7003	20	20	9,000 kg
Tongue Tear ⁽³⁾ (N) (min. ave.)	ASTM D5884	225	200	9,000 kg
CBR Puncture (N) (min. ave.)	ASTM D6241	4400	3100	20,000 kg
Index Pin Puncture-Resistance (N) (min. ave.)	ASTM D4833	890	800	20,000 kg
Hydrostatic Resistance (kPa) (min. ave.) ⁽¹⁰⁾	ASTM D751	4800	3400	20,000 kg
Dimensional Stability (% change) (Max) ⁽⁸⁾	ASTM D1204	3	3	20,000 kg
Water Vapor Transmission (WVT) (g/m ² -day) ⁽⁴⁾ (max. ave.)	ASTM E96	0.3	0.4	per each formulation
Oxidative Induction Time (OIT) High Pressure (min.) ⁽⁹⁾	ASTM D5885	400	400	per each formulation
UV Resistance (fluorescent light method) (a) Strength and Elongation retained after 10,000 light hours ⁽⁶⁾ (b) High Pressure OIT (min. ave.) % retained after 1600 hours ^{(7) (9)}	ASTM D7238 ASTM D7003 ASTM D5885	> 50% retained 50%	> 50% retained 50%	per each formulation

Notes

- (1) All values are minimum, or minimum average, except dimensionally stability and WVT, which are maximum values.
- (2) The categories refer to the type of subgrade, manner of installation, anchorage/tie downs, and site-specific conditions.
- (3) If the tape reinforcement is aligned in any direction other than the machine and transverse directions, specimen shall be cut such that reinforcing yarns are oriented parallel to the central axis of the tension testing machine.
- (4) Performed at 23° ± 0.5°C temperature and 50% ± 5% relative humidity.
- (5) The condition of the test should be 20 hour UV cycle at 75°C followed by 4 hour condensation at 60°C.
- (6) It is strongly recommended that visual observation of the exposed material be subjected to GRI-GM16 “response to bending evaluation”. No cracking, flaking, or powdering of the material should be witnessed after 10,000 light hours of exposure.
- (7) UV resistance is based on percent retained value regardless of the original HP-OIT value.
- (8) Specimens placed in oven at 100°C ± 1°C for 60 min. for ASTM D1204.
- (9) Sample shall be homogenized using Appendix X1, X2 or X3 of ASTM D5885.
- (10) Only procedure A is to be used per ASTM D751.

Table 3 - Required Degree of Survivability as a Function of Site Conditions*

Subgrade Conditions	Low ground-pressure equipment ≤1 psi (7 kPa)	Medium ground-pressure equipment (> 1 psi < 3 psi)	Heavy ground-pressure equipment > 3psi (20 kPa)
Subgrade has been cleared of all obstacles. Surface is smooth and level so that any shallow depressions and humps do not exceed 10 mm in depth or height. All larger depressions are filled.	Moderate	Moderate	Severe
Subgrade has been cleared of obstacles larger than 20 mm in size. Depressions and humps should not exceed 20 mm in depth or height. Larger depressions should be filled.	Moderate	Severe	Not Recommended
Subgrade has been cleared of obstacles larger than 30 mm in size. Depressions and humps should not exceed 30 mm in depth or height. Larger depressions should be filled.	Severe	Not Recommended	Not Recommended

EPA/600/R-93 - Section 3.3.4.1 suggests "...using small pneumatic tire lifting units with maximum tire inflation pressure of 6 lb/sq. in. (40 kPa) is acceptable directly on the geosynthetic during the deployment of the material. This in turn has resulted in allowing contractors to use ATV's or specially adapted construction equipment with low ground contact pressure during the installation process. The following provisions are also recommended in this regard; no sudden stops/starts, no tire spinning, only smooth and clean tires, 90° entrance and exits with protection apron, no excessive turning, no driving over wrinkles, one person per vehicle and no vehicles on slopes.

Geomembranes must be covered before receiving repeated vehicular traffic. A minimum cover soil thickness of 12 in. (300 mm) is recommended by the US EPA where the US Corps of Engineers requires 18 in. (450 mm). This cover soil must be free of stones greater than 0.6 in. (15 mm) in size. Placement of the cover soil over the geomembrane should progress up gradient. It is highly recommended that the geomembrane is protected against puncture from above or below by a geotextile or a GCL.