Geosynthetic Institute
475 Kedron Avenue
Folsom, PA 19033-1208 USA
TEL (610) 522-8440
FAX (610) 522-8441

Original: October 19, 2012

GRI Guide GS11*

Standard Guide for

Constructing Test Pads to Assess Protection Materials Intended to Avoid Geomembrane Puncture

This guide 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 It is completely optional in this regard and can be superseded by other existing or new test methods on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any projects developed according to this test method either at this time or in the future.

1. Scope

1.1 This guide focuses on the methodology and construction of field test pads used to assess different types of protection materials intended to avoid puncture of geomembranes.

Note 1: The protection material most often used is a relatively thick needle punched nonwoven geotextile. This guide is written accordingly. However, other geosynthetics such as geonet drainage composites and geosynthetic clay liners have also been used (Koerner, et al., 2012).

Note 2: The puncture performance of any type and thickness of geomembrane can be assessed in the construction of test pads per this guide.

1.2 This guide is limited to site-specific and product-specific test sections, and is meant to simulate field conditions as closely as possible.

1.3 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this guide to establish appropriate

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This guide will be reviewed 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.

safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards

D5818 Standard Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage to Geosynthetics

D4439 Terminology for Geosynthetics

2.2 GRI Standards

GT12(a) ASTM and 12(b) ISO – Standard specification for Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials

2.3 Literature Citations

Nosko, V. and Touze-Foltz, N. (2000), "Geomembrane Liner Failure," Proc. EuroGeo 2000, Bologna, Italy, pp. 557-560.

Bergstrom, W. R. et al. (1995), "Field Performance of a Double Liner Test Pad," Proc. Geoenvironment 2000, Geotech Spec Publ. No. 46, ASCE, pp. 608-623.

Koerner, R. M. (2012), Designing With Geosynthetics, 6th Edition, Xlibris Publ. Co., 914 pgs.

Koerner, R. M., Wong, W. K. and Koerner, G. R. (2012), "Index Puncture Resistance of Geomembranes Using Various Puncture Protection Materials," Geotechnical Testing Journal, ASTM, Vol. 35, No. 5, pp. 1-9.

3. Terminology

3.1 Definitions

3.1.1 geosynthetic, n – a planar product manufactured from polymeric material used with foundation soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a man-made project, structure, or system.

3.1.2 sample, n – (1) a portion of material that is taken for testing or for record purposes; (2) a group of specimens used, or of observations made, which provide information that can be used for making statistical inferences about the population(s) from which the specimens are drawn.

3.1.3 test section, n – a distinct area of actual or simulated full-scale construction.

Note 3: Test section and test pads are considered to be synonymous for the sake of this guide.

3.1.4 For definitions of other geosynthetic terms used in this practice, refer to Terminology D4439.

4. Background and Practice

4.1 Damage to geomembranes by puncturing from stones, gravel, rock or other sharp objects is necessary to prevent but oftentimes difficult to accomplish. The data of Table 1 obtained from 16 countries, 300 sites and approximately 3,250,000 m^2 of installed geomembranes clearly shows that stones either above or beneath the geomembranes (evaluated by the electrical leak location survey method) accounted for 71.17% of the total damage assessed.

Table 1 – Cause of Geomembrane Damage versus Size of Damage
(after Nosko and Touze-Foltz 2000)

Size of Damage, cm^2	Stones	%	Heavy Equip-ment	%	Welds	%	Cuts	%	Worker Directly	%	Total Number of Holes
>0.5	332	11.1	-	-	115	43.4	5	8.5	-	-	452
0.5 to 2.0	1720	57.6	41	6.3	105	39.6	36	61.0	195	84.4	2097
2.0-10	843	28.2	116	17.9	30	11.3	18	30.5	36	15.6	1044
>10	90	3.0	496	75.8	15	5.7	-	-	-	-	601
Amount	2985		654		265		59		231		4194
Total, %	71.17		15.59		6.32		1.41		5.51		

Clearly, such puncturing damage to geomembranes is unacceptable and must be prevented for a properly functioning barrier in any containment scenario.

By far the most commonly used protection materials are relatively thick needle-punched nonwoven geotextiles for which a generic specification is available. GRI-GT12 lists required properties, test methods and values for such geotextiles with unit weights from 350 to 2000 g/m^2. The standard, however, does not provide design guidance which is left to the consulting engineer and is based on site-specific conditions.

While such generic design guidance is available, see Koerner (2012) for example, questions as to the adequacy of the design invariably arise for many unique circumstances. In such cases it may prove prudent to constrict a field test pad, traffic it accordingly, and then excavate and exam the now exhumed geomembrane. This guide gives guidance in so doing. It should be noted that test pads are not uncommon in assessing many design assumptions; see Bergstrom, et al. (1995).

5. Summary of Practice

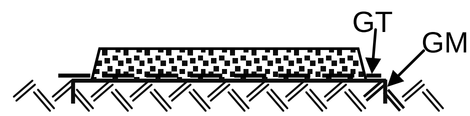
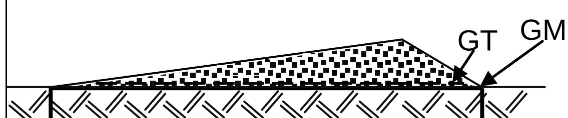
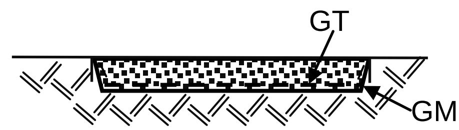
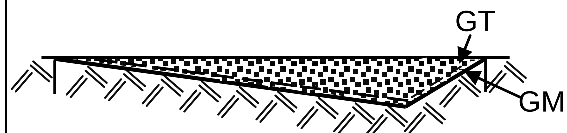
5.1 Damage to geomembranes from installation operations may be quantified by evaluating specimens from a sample(s) exhumed from a full-scale installation. The sample(s) should be installed using project specific procedures and materials. When project specific materials and/or procedures are unknown, generally accepted representative materials and procedures should be used and thoroughly documented and reported. Addressed within this guide are several strategies for constructing the test pad cross-section, procedures for trafficking it, procedures for exhuming the sample(s) and methods to assess the damage that may have occurred. While the assessment is usually visual, a comparison of mechanical test results on exhumed versus control specimens may also be used in the assessment.

6. Significance and Use

6.1 The ability for a geomembrane to maintain its design function as a barrier for containing liquids or gases is negatively affected by the presence of holes. Such holes are usually caused by stones, gravel, rock or other sharp objects due to the nonexistence of or inadequate protection materials. Visual examination and/or mechanical testing of test pad retrieved geomembranes will give a clear indication of geomembrane damage based on the conditions imposed.

6.2 The test pad configuration is an important consideration and Table 2 is crafted so as to present several of the various options. In this regard, test pads are either above or below the ground surface and either used for specific design confirmation or to investigate various stone thicknesses.

Table 2 – Different Test Pad Configurations

Location	Purpose	Longitudinal Cross Section
Above ground surface	Confirm a given design cross section	
Above ground surface	Investigate damage from various stone thicknesses	
Below ground surface	Confirm a given design cross section	
Below ground surface	Investigate damage from various stone thicknesses	

7. Procedures

7.1 Test Pad Configuration

The four test pad configurations shown in Table 2 are described as follows:

7.1.1 Above ground with uniform stone thickness. This cross-section is meant to confirm a given design including the intended geomembrane, geotextile, stone type and thickness. Lateral confinement of the stone may be problematic for thicknesses greater than 300 mm (12 in.).

7.1.2 Above ground with variable stone thickness. This investigative type cross section is meant to discover what minimum stone thickness is necessary to avoid puncture to the underlying geomembrane. The geomembrane and geotextile are held constant along with the stone type, but not its thickness. Again, stone confinement for thickness ≥ 300 mm (12 in.) may be difficult.

7.1.3 Below ground with uniform stone thickness. Unlike the above ground configuration the given design stone thickness cross section will be contained from lateral movement by the surrounding soil. It is meant to confirm the adequacy of a given set of materials, i.e., geomembrane, geotextile, stone type and thickness. It can be used for stone thicknesses >> 300 mm (12 in.).

7.1.4 Below ground with variable stone thickness. This investigative type cross section is meant to discover what minimum stone thickness is necessary to avoid puncture to the underlying geomembrane. Unlike the above ground configuration, however, the stone will be laterally contained which is an advantage for thick layers of stone. It can be used for stone thicknesses >> 300 mm (12 in.).

7.2 The type of soil and/or rock of the foundation material upon which the geomembrane is placed is a critical item. If stones (or rock) are present the geomembrane will likely be punctured from below. It might be necessary to place an additional protection geotextile beneath the geomembrane. If this is not the intent, then a proper foundation material must be agreed upon by the parties involved.

7.3 The type(s) of traffic loading/repetitions is another critical item and must be agreed upon by the various parties involved.

7.4 Size of Test Pad

7.4.1 The width of the test pad should be at least 100% greater than the agreed-upon placement and compaction equipment for the two above ground options and 50% greater for the two below ground options. In this regard the confinement by natural soil is an advantage. Other advantages are that equipment will not have to ramp-up or ramp-down from an elevated test pad placed on the original ground surface as well as the associated safety considerations.

7.4.2 The length of the test pad should be 300% greater than the agreed-upon placement and compaction equipment for the constant thickness option and from 5 to 10 times greater for the variable thickness options.

Note 4: The test pad length might be longer than above stated values and it depends upon the degree of accuracy required to obtain the critical stone thickness for the variable thickness option.

7.5 Placement and compaction equipment must be decided upon by the parties involved. Dump trucks will generally deliver the stone and a bulldozer will generally spread it. Compaction will be achieved by both tire-pressure from trucks and caterpillar pressure from the bulldozer. A separate roller may also be involved for additional compaction. Some important considerations which must be agreed upon are as follows:

- weight and tire pressure of trucks
- weight and caterpillar size of bulldozer
- method of dumping stone on the protection geotextile
- number of truck and/or bulldozer passes along length of test pad
- turning of bulldozer on the test pad; e.g., where and how often
- dwell-time of trucks and/or bulldozer staying in a fixed position
- details of a separate compactor if used

7.6 Exhuming of the geomembrane will generally begin as soon as the test pad trafficking concludes. Most of the stone can be removed using a backhoe but its bucket should be fitted with rubber teeth. Within about 100 mm of the protection geotextile, however, stone removal should be by hand so as not to unintentionally damage the geomembrane.

Note 5: This is a short-term installation damage assessment. If long-term creep puncture is a concern the test pad experiment can be continued as long as necessary.

7.7 Once the geomembrane is removed, examination for holes should proceed. If more than a few holes are present a hole density assessment should be performed. Not only the number of holes, but also the size of the holes are important. This is to be done visually with ample photographs and or video taken as well. If indentations, and not holes per se, are present, wide-width or axi-symmetric tension tests (compared to the as-received geomembrane) may be performed for a more complete assessment.

7.8 Site reclamation should be conducted in a proper manner which depends on the future use of the site, its location and other local issues.

8. Report

8.1 Report the following information:

8.1.1 The location and geometry of the test pad.

8.1.2 Details of the soil or rock subgrade in particular its identification as well as compressibility, moisture content and uniformity.

8.1.3 The construction equipment, procedures and materials used for the test section(s) including, but not limited to, equipment types, equipment operation, gravel type and size, placement details, compaction requirements, fill compaction control technique(s), and the exhumation system employed.

8.1.4 Geomembrane and geotextile material identification such as manufacturer or supplier, style number, roll numbers, material grade and type.

8.1.5 Test section construction quality control measurements such as lift thickness, density, moisture content, gradation curves, number of soil lifts, type and number of passes of construction equipment and the number of passes of the compactor.

8.1.6 Details of method of damage assessment, e.g., visual or mechanical testing.

8.1.7 Typical photographs and/or video of test section construction, exhuming and assessment activities.