Standard Test Method for Hydraulic Pullout Resistance of a Geomembrane with Locking Extensions Embedded in Concrete[1]

1. Scope

1.1 This test method covers the determination of the hydraulic pullout resistance of a geomembrane with locking extensions embedded in concrete by determining the pressure required for locking extensions of the embedded specimen to pullout of the concrete.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are provided for information only and are not considered standard.

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 standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A1064 Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C31 Practice for Making and Curing Concrete Test Specimens in the Field
C39 Test Method for Compressive Strength of Cylindrical Concrete Specimens
C94 Specification for Ready-Mixed Concrete
D618 Practice for Conditioning Plastics for Testing
D4439 Terminology for Geosynthetics
D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens

3. Terminology

3.1 Definitions of terms applying to this test method appear in Terminology D4439.

4. Summary of Test Method

4.1 A geomembrane with locking extensions on at least one surface is embedded into concrete. The pullout resistance is determined by measuring the maximum pressure required to initiate pullout of the locking extensions from the concrete. Alternatively, the geomembrane with locking extensions is embedded in concrete and pressurized to a specified pressure to verify whether a minimum level of in-place strength has been attained.

5. Significance and Use

5.1 Due to hydraulic pressure that may be present on some applications, engineers need to understand the capability of these products to resist this pressure. This test allows engineers to compare products and verify pullout strength.

5.2 Hydraulic pullout resistance is a function of locking extension dimensions, locking extension geometry, locking extensions per area, locking extension polymer composition, and the properties of the concrete in which the locking extensions are embedded.

5.3 The data from this test method provides comparative information for rating hydraulic pullout resistance of different geomembranes with locking extensions embedded in concrete. Hydraulic pullout resistance, while partly dependent on locking extension dimensions, has no simple correlation to locking extension dimensions and geometry. Hence, hydraulic pullout resistance cannot be determined with a small sample without potentially producing misleading data to the actual hydraulic pullout resistance of the material. Therefore, the hydraulic pullout resistance is expressed in kPa (lbs/ft^2).

5.4 The apparatus can be circular or square in nature must have a test area of 0.36 m^2 (558 in.^{2}).

5.5 Fig. 1 shows an example of a circular test apparatus that can be used in the performance of this test. The apparatus requires a pressure vessel rated to a minimum 690 kPa (14 410 lbs/ft^2). The vessel test diameter should be a minimum of 677.04 mm (26.655 in.) as shown in Fig. 1.

NOTE 1—Larger vessels may be used but it is up to user to establish correlation to the standard size vessel. The use of a smaller diameter vessel than denoted in standard may contribute to higher pullout resistance due to thickness or stiffness of some products.

[1] This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.01 on Mechanical Properties.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

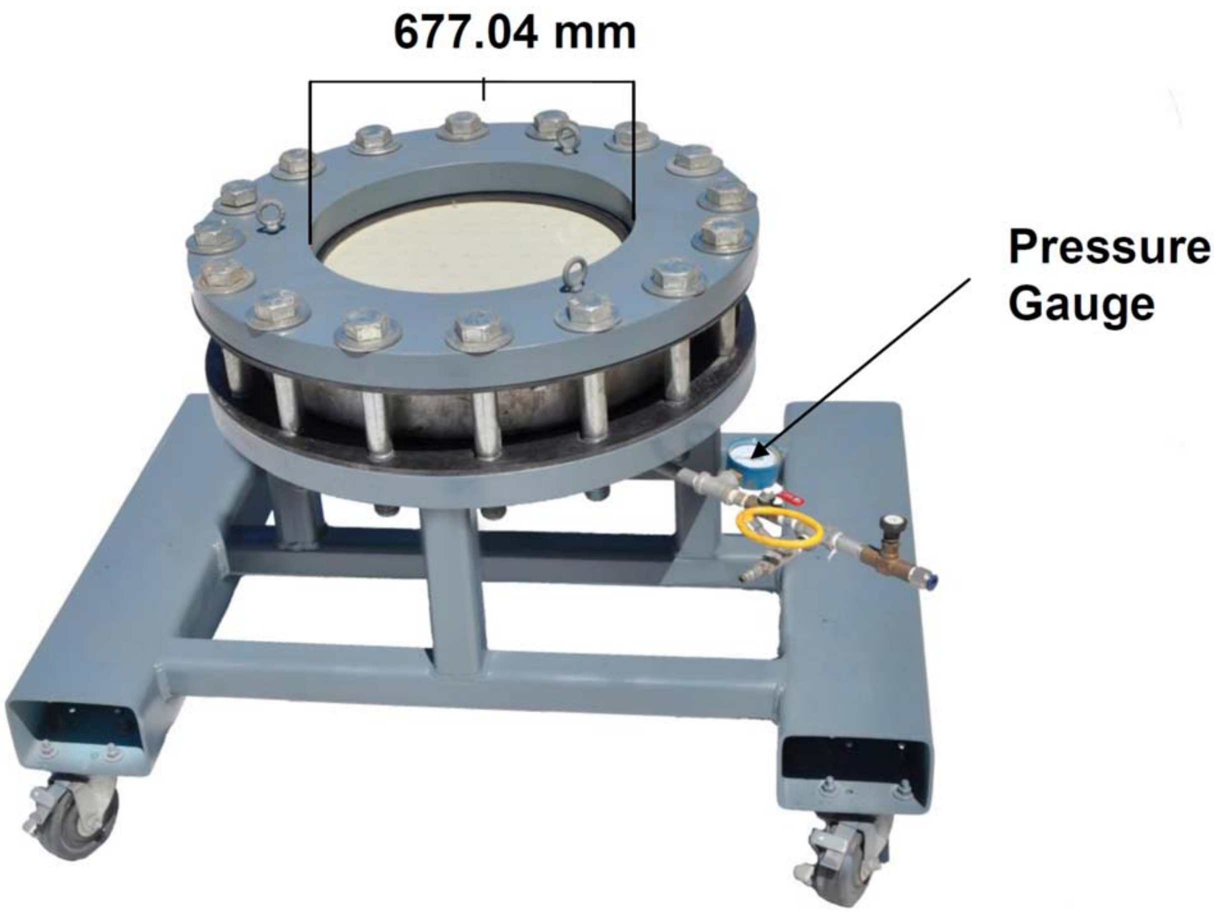

FIG. 1 Picture of Circular test apparatus

5.6 *Test Pedestal*—the base of the testing apparatus which holds the test specimen.

5.7 *Upper Flange*—is the flange that is bolted down on top of specimen to create a seal.

5.8 *Form*—is an aluminum ring used to form test specimen as shown in Fig. 2.

5.9 *Specimen Ring*—the solid ring that is placed around test specimen to contain leakage through the concrete.

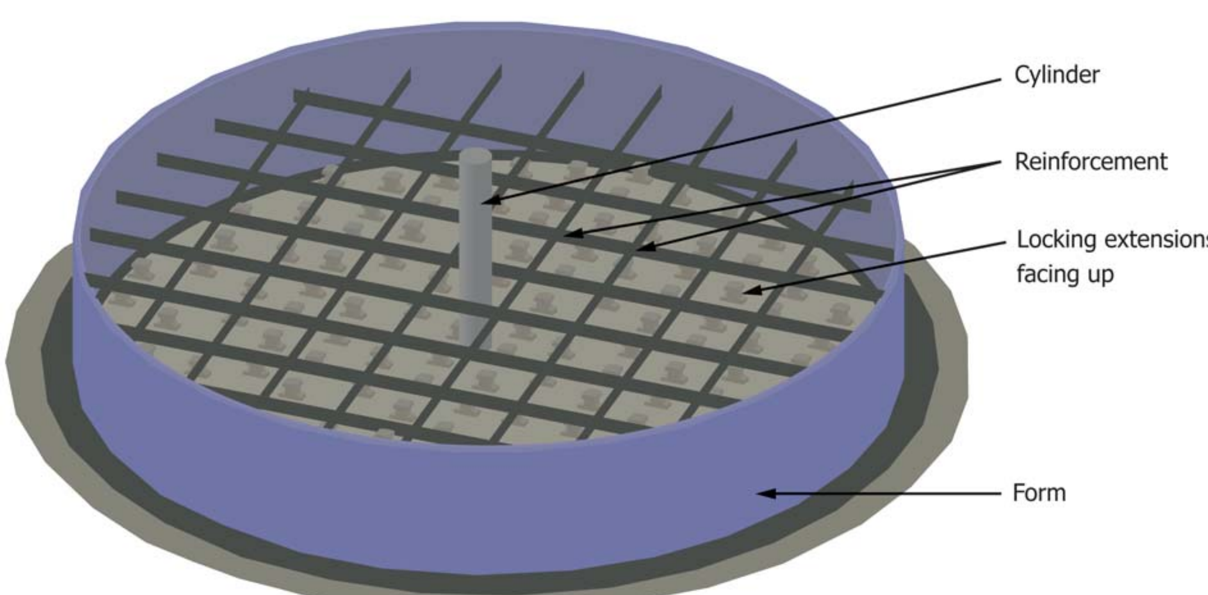

FIG. 2 Bottom of Form with Studs facing up and cylinder spacer

5.10 The vessel will have a system to measure pressure.

5.10.1 The system for measuring pressure shall be capable of being read to an accuracy of 3.5 kPa (0.5 psi).

5.11 Concrete shall be a ready-mixed concrete per Specification C94 with a minimum cured compressive strength of 34 473.8 kPa (5 000 psi).

NOTE 2—Alternate concrete or grout mixtures may be used for project specific applications with the approval of the owner or engineer.

5.12 All tests shall be conducted at standard laboratory temperatures of 23 ± 2°C (73.4 ± 3.6°F).

6. Test Specimens

6.1 Cut the test specimens large enough to ensure a good seal while maintaining a 677.04 mm (26.655 inches) in diameter testable specimen.

6.2 Do not use test specimens with defects or any other abnormalities, unless this is the item of interest.

6.3 Test three replicate specimens on each sample unless otherwise noted.

NOTE 3—This test may be used to test the seamed areas of different products.

7. Preparation of Embedded Specimen

7.1 Geomembrane is placed in bottom of form with locking extensions in the direction, as shown in Fig. 2.

7.2 Outer perimeter locking extensions are removed to allow upper flange to compress against lower gasket and geomembrane surface to complete seal.

7.2.1 Locking extensions can be removed with a grinder or planar device.

NOTE 4—Caution should be used to avoid damage to the specimen.

7.3 Reinforcement for the concrete test specimen shall consist of reinforcement meeting the requirements of Specification A1064.

7.4 A 6.35 mm (0.25 in.) cylinder is inserted in middle of specimen to provide void space to assure water pressure reaches the specimen surface during testing per Fig. 2. There shall be as many ports as needed to assure that the test pressure is uniform throughout the complete test area of the specimen.

7.5 Concrete shall be placed into the form in a minimum of two layers with each layer being consolidated by rodding or vibration. The final layer shall be compacted and flush with the top of the test specimen and allowed to set.

7.6 Curing of concrete shall be per Practice C31.

7.7 Cylinder is removed and any concrete blocking passageway is removed.

8. Conditioning

8.1 *Conditioning*—Concrete should be allowed to cure to the specified compressive strength prior to any testing. Curing time and conditions are as specified by Practice C31.

8.1.1 Specimens may be tested once the material has reached temperature equilibrium. The time required to reach temperature equilibrium may vary according to the manufacturing process, material type, and material structure.

8.1.2 Compressive strength will be determined per Test Method C39.

8.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 23 ± 2 °C (73.4 ± 3.6 °F).

9. Procedure

9.1 The embedded specimen is placed onto test vessel.

9.2 Gaskets are placed between the concrete and test pedestal, between the geomembrane and concrete at the sealing perimeter, and between the geomembrane and upper flange as shown in Fig. 3.

9.3 The specimen ring is placed around the specimen.

9.4 The upper flange is clamped to the pedestal.

NOTE 5—Caution must be used to prevent fracture of the concrete during tightening of the bolts.

9.5 An initial holding pressure of 206.9 kPa (30 psi) is applied to specimen for a minimum of 200 h.

NOTE 6—Engineers may need to perform test with longer duration times at a single pressure and other site specific conditions to consider concerns of creep for the product they are using for their project.

NOTE 7—A lower initial holding pressure may be required for some products. This should be agreed on by the owner or engineer.

9.6 Increase pressure in 34.7 kPa (5 psi) increments every hour until locking extension pullout from concrete occurs.

9.7 Failure is determined by visual observation of locking extensions pulled out of concrete.

9.8 Record the failure mode, as listed in Table 1.

9.9 Repeat the above with two additional specimens from the same product sample.

NOTE 8—A failure mode in concrete is not acceptable for direct product comparison. However, it may be acceptable if the pullout resistance is higher than project specific requirement for which testing is being done.

10. Report

10.1 Report the following information:

10.1.1 Complete identification of the material tested, including type, material thickness, source, manufacturer's code number.

10.1.2 Size of test area, if other than standard.

10.1.3 A complete description of the concrete or grout used in performing the test.

10.1.4 Value of compressive strength of concrete used.

10.1.5 Conditions under which test was performed, if other than standard.

10.1.6 Average thickness of material.

10.1.7 Number of specimens tested.

10.1.8 Average value of hydraulic pullout resistance in kPa (lbs/ft^2).

10.1.9 Description of the failure with the failure mode of test as listed in Table 1.

11. Precision and Bias

11.1 *Precision*—The precision of this test has not been established yet.

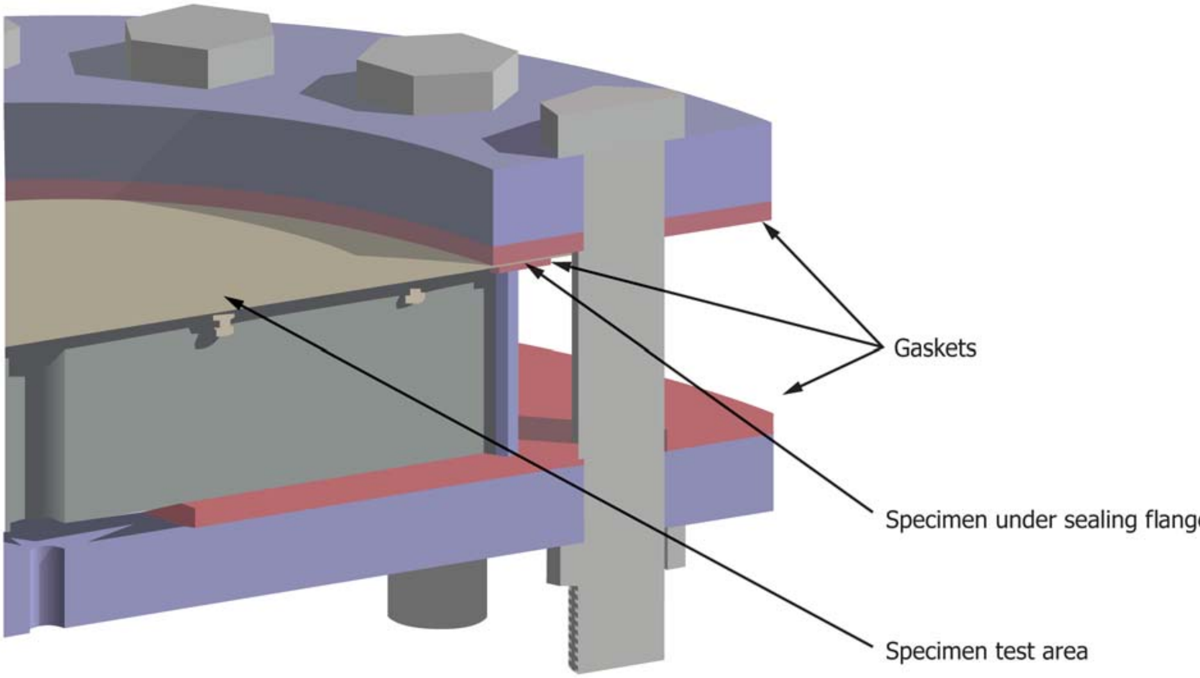

FIG. 3 Cross-section view for Gasket placement

TABLE 1 Failure Modes of Test

Failure Mode Designation	Failure Mode
LP	Locking extensions pullout from embedment
LB	Locking extensions break from liner surface
CF	Concrete fails before locking extension failure
LF	Liner in between studs fail

11.2 *Bias*—The bias of this test method cannot be evaluated since hydraulic pullout resistance can only be determined in terms of this test method.

12. Keywords

12.1 concrete liners; concrete protection; geomembranes; liners; pullout resistance; studs