Designation: D6706 – 01 (Reapproved 2021)

Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil[1]

This standard is issued under the fixed designation D6706; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 Resistance of a geosynthetic to pullout from soil is determined using a laboratory pullout box.

1.2 The test method is intended to be a performance test conducted as closely as possible to replicate design or as-built conditions. It can also be used to compare different geosynthetics, soil types, etc., and thereby be used as a research and development test procedure.

1.3 The values stated in SI units are to be regarded as standard. The values stated in parentheses are provided for information only.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D123 Terminology Relating to Textiles

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D3080 Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions

D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing

D4439 Terminology for Geosynthetics

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *apertures, n*—the open spaces in geogrids which enable soil interlocking to occur.

3.1.2 *atmosphere for testing geosynthetics, n*—air maintained at a relative humidity of 60 ± 10 % and a temperature of 21 ± 2 °C (70 ± 4 °F).

3.1.3 *cross-machine direction, n*—the direction in the plane of the geosynthetic perpendicular to the direction of manufacture.

3.1.4 *failure, n*—a defined point at which a material ceases to be functionally capable of its intended use.

3.1.5 *geosynthetic, n*—a planar product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering related material as an integral part of a man-made project, structure, or system. **(D4439)**

3.1.6 *junction, n*—the point where geogrid ribs are interconnected in order to provide structure and dimensional stability.

3.1.7 *machine direction, n*—the direction in the plane of the geosynthetic parallel to the direction of manufacture.

3.1.8 *pullout, n*—the movement of a geosynthetic over its entire embedded length, with initial pullout occurring when the back of the specimen moves, and ultimate pullout occurring when the movement is uniform over the entire embedded length.

3.1.9 *pullout force,* (kN), *n*—force required to pull a geosynthetic out of the soil during a pullout test.

3.1.10 *pullout resistance,* (kN/m), *n*—the pullout force per width of geosynthetic measured at a specified condition of displacement.

3.1.11 *rib, n*—the continuous elements of a geogrid which are either in the machine or cross-machine direction as manufactured.

3.1.12 *ultimate pullout resistance,* (kN/m), *n*—the maximum pullout resistance measured during a pullout test.

3.1.13 *wire gauge, n*—a displacement gauge consisting of a non-extensible wire attached to the geosynthetic and monitored by connection to a dial extensometer or electronic displacement transducer.

[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.

3.2 For definitions of other terms used in this test method, refer to Terminologies D123, D653, and D4439.

4. Summary of Test Method

4.1 In this method, a geosynthetic is embedded between two layers of soil, horizontal force is applied to the geosynthetic, and the force required to pull the geosynthetic out of the soil is recorded.

4.2 Pullout resistance is obtained by dividing the maximum load by the test specimen width.

4.3 The test is performed while subjected to normal compressive stresses which are applied to the top soil layer.

4.4 A plot of maximum pullout resistance versus applied normal stress is obtained by conducting a series of such tests.

5. Significance and Use

5.1 The pullout test method is intended as a performance test to provide the user with a set of design values for the test conditions examined.

5.1.1 The test method is applicable to all geosynthetics and all soils.

5.1.2 This test method produces test data, which can be used in the design of geosynthetic-reinforced retaining walls, slopes, and embankments, or in other applications where resistance of a geosynthetic to pullout under simulated field conditions is important.

5.1.3 The test results may also provide information related to the in-soil stress-strain response of a geosynthetic under confined loading conditions.

5.2 The pullout resistance versus normal stress plot obtained from this test is a function of soil gradation, plasticity, as-placed dry unit weight, moisture content, length and surface characteristics of the geosynthetic, and other test parameters. Therefore, results are expressed in terms of the actual test conditions. The test measures the net effect of a combination of pullout mechanisms, which may vary depending on type of geosynthetic specimen, embedment length, relative opening size, soil type, displacement rate, normal stress, and other factors.

5.3 Information between laboratories on precision is incomplete. In cases of dispute, comparative tests to determine if there is a statistical bias between laboratories may be advisable.

6. Apparatus

6.1 *Pullout Box*—An open rigid box consisting of two smooth parallel sides, a back wall, a horizontal split removable door, a bottom plate, and a load transfer sleeve. The door is at the front as defined by the direction of applied pullout force. A typical box is shown in Fig. 1.

6.1.1 The box should be square or rectangular with minimum dimensions 610 mm (24 in.) long by 460 mm (18 in.) wide by 305 mm (12 in.) deep, if sidewall friction is minimized, otherwise the minimum width should be 760 mm (30 in.). The dimensions should be increased, if necessary, so that minimum width is the greater of 20 times the D85 of the soil or six times the maximum soil particle size, and the minimum length greater than five times the maximum geosynthetic aperture size. The box shall allow for a minimum depth of 150 mm (6 in.) above and below the geosynthetic. The depth of the soil in the box above or below the geosynthetic shall be a minimum of six times the D85 of the soil or three times the maximum particle size of the soil, whichever is greater. The box must allow for at least 610 mm (24 in.) embedment length beyond the load transfer sleeve and a minimum specimen length to width ratio of 2.0. It should be understood that when testing large aperture geosynthetics the actual pullout box may have to be larger than the stated minimum dimensions.

NOTE 1—To remove sidewall friction as much as possible, a high-density polyethylene (HDPE) geomembrane should be bonded to the inside surfaces of the pullout box. The sidewalls may also be covered with a layer of silk fabric, which has been shown to eliminate adhesion and has a very low friction value. Alternatively, a lubricant can be spread on the

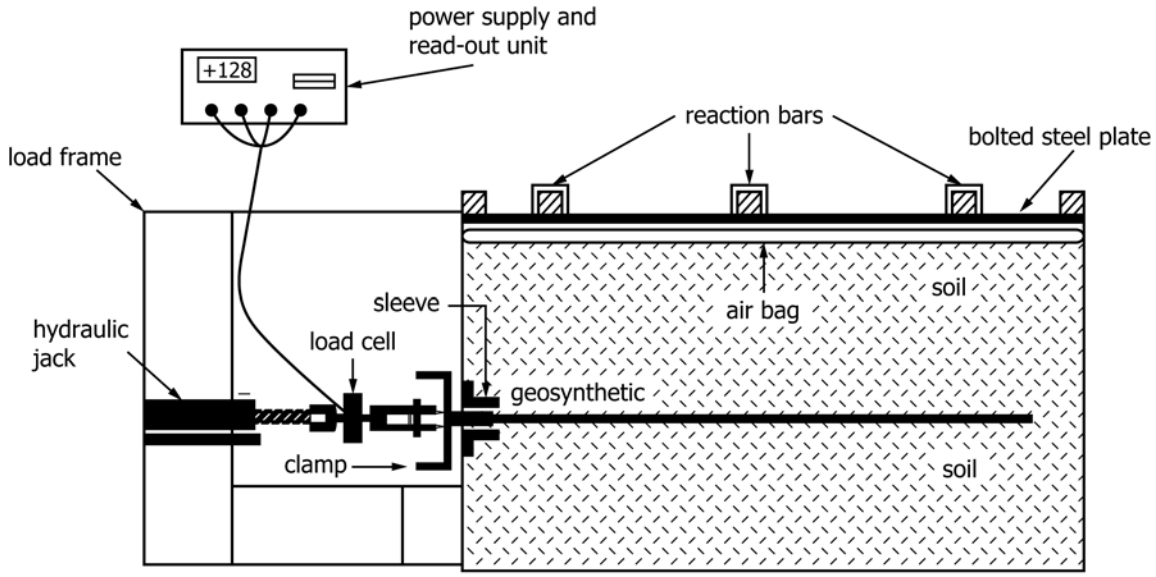

FIG. 1 Experimental Setup for Geosynthetic Pullout Testing