Designation: D7864/D7864M − 15

Standard Test Method for Determining the Aperture Stability Modulus of Geogrids[1]

This standard is issued under the fixed designation D7864/D7864M; 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 This test method covers the procedure for measuring the "Aperture Stability Modulus" of a geogrid. (The terms "Secant Aperture Stability Modulus," "Torsional Rigidity Modulus," "In-plane Shear Modulus," and "Torsional Stiffness Modulus" have been used in the literature to describe this same property.)

1.2 This test method is intended to determine the in-plane stability of a geogrid by clamping a center node and measuring the stiffness over an area of the geogrid. This test method is applicable for various types of geogrid.

1.3 This test method is intended to provide characteristic properties for design. The test method was developed for pavement and subgrade improvement calibrated design methods requiring input of aperture stability modulus.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *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]
D4439 Terminology for Geosynthetics
D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products(RECPs) for Testing

2.2 *FHWA Document:*[3]
FHWA Geosynthetic Design and Construction Guidelines (2008)

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of general terms used in this test method, refer to Terminology D4439.

3.1.2 *geogrid, n*—a geosynthetic formed by a regular network of integrally connected elements with apertures greater than 6.35 mm [¼ in.] to allow interlocking with surrounding soil, rock, earth, and other surrounding materials to primarily function as reinforcement.

3.1.3 *index test, n*—a test procedure which may contain a known bias but which may be used to establish an order for a set of specimens with respect to property of interest.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *aperture*—the openings between adjacent ribs forming an angle which enable soil interlocking to occur.

3.2.2 *aperture stability modulus*—a measure of the in-plane torsional stiffness of a geogrid. This is defined as torque, divided by the rotation at that torque.

3.2.3 *geosynthetic, n*—a product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering material as integral part of a man made project, structure, or system.

3.2.4 *initial aperture stability modulus, n*—the change in moment at 0.5 and 1.0 N-m [4.4 and 8.8 lbf-in.], respectively, divided by the change in angular rotation at these two moment values.

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

3.2.6 *offset aperture stability modulus*—the change in moment at 2.0 and 2.5 N-m [17.7 and 22.1 lbf-in.], respectively, divided by the change in angular rotation at these two moment values.

3.2.7 *rib, n*—for geogrids, the continuous oriented elements of a geogrid which are interconnected to a node or junction.

[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.

Current edition approved June 1, 2015. Published July 2015. DOI: 10.1520/D7864_D7864M-15

[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] Available from U.S. Department of Transportation, Federal Highway Administration, 1200 New Jersey Ave., SE, Washington, DC 20590, http://www.fhwa.dot.gov.

4. Summary of Test Method

4.1 A geogrid sample is placed over a square, horizontal opening and the edges are anchored just outside the opening. A rod is clamped vertically on the single center node or junction. A torque is applied to the rod, which twists the clamped node or junction and the geogrid rib matrix, thereby applying a moment causing bending to each of the ribs that intersects the single clamped center node or junction. The torque divided by the angle of rotation is termed the Aperture Stability Modulus expressed in units of N-m/degree [lbf-in./degree].

5. Significance and Use

5.1 The Aperture Stability Modulus is a measure of the in-plane shear modulus, which is a function of other geogrid characteristics, most notably junction stability, flexural rib stiffness, and rib tensile modulus.

5.2 The test data can be used in conjunction with interpretive methods to evaluate the geogrid aperture stability at various traffic loads and base/subgrade conditions.

NOTE 1—Aperture stability modulus is referenced in the FHWA Geosynthetics Design and Construction Guidelines (2008) as an input parameter for the design of geogrid-reinforced unpaved roads using punched and drawn biaxial geogrids. Geogrids of different manufacturing process and material composition may use this property in calibration and validation of their material within the associated design.

5.3 This test method is not intended for routine acceptance testing of geogrid. This test method should be used to characterize geogrid intended for use in applications in which aperture stability is considered relevant.

6. Apparatus

6.1 The apparatus consists of a table, table clamps for the edges of the geogrid, a rod with a center clamp that attaches to the ribs around a node or junction, a loading mechanism, and a method of measuring the moment and the angle of rotation of the rod. A cross section of the apparatus used originally to develop the test method is shown in Figs. 1-4. Other methods of clamping, applying a moment, loading, and measuring have been used by others and are acceptable, subject to the constraints discussed in the following subsections. Details of each part follow.

6.1.1 *Table*—The table shall be constructed so that the geogrid can be laid over a 229-mm [9-in.]-square hole and anchored in place. The geogrid must be placed as it would be in the field, flat but not stretched. This requires a supporting plate beneath the geogrid and a loading plate over the geogrid to keep it flat while it is being laid over the table and clamped around the edges with table clamps. The plate must be large enough to support every node or junction and any part of the geogrid that tends to protrude above or below the planes of the

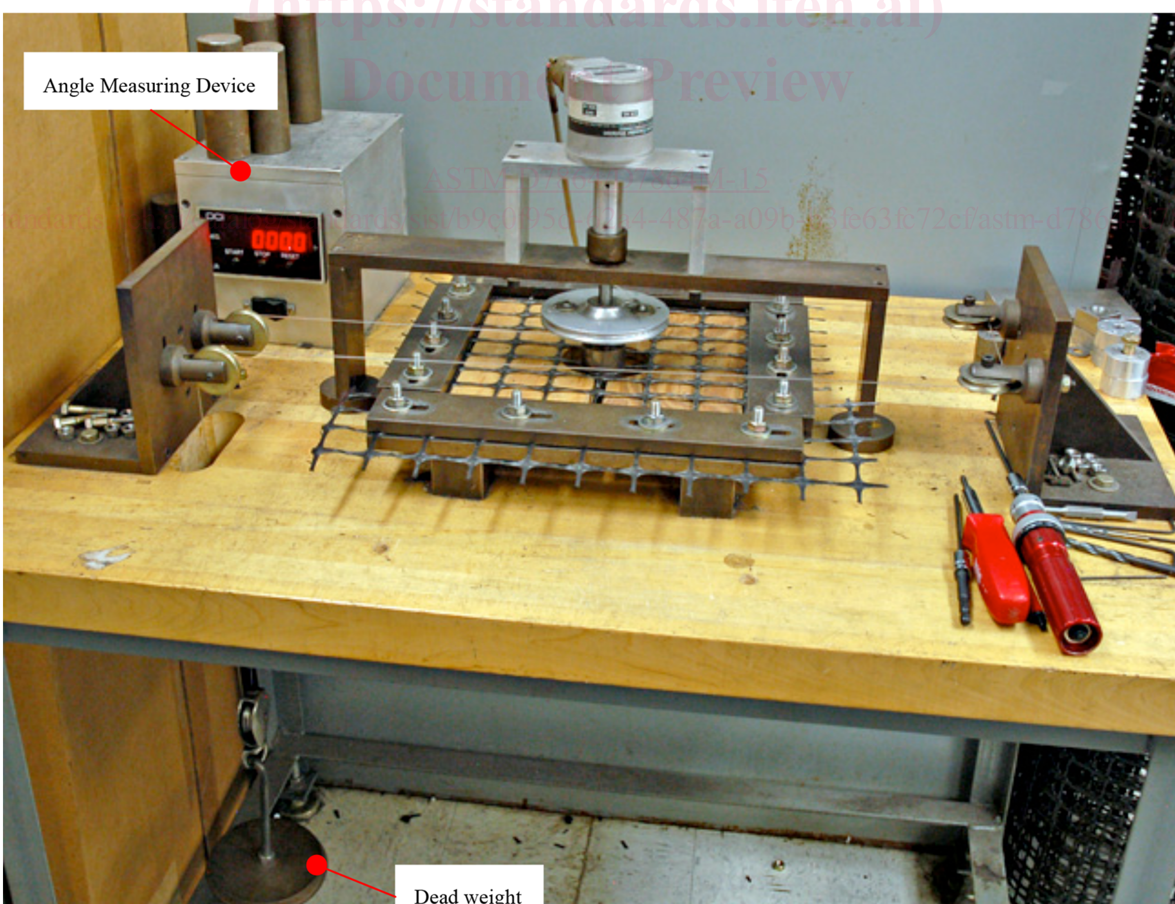

FIG. 1 Test Apparatus during Test (Loading Plates and Weights Not Shown)

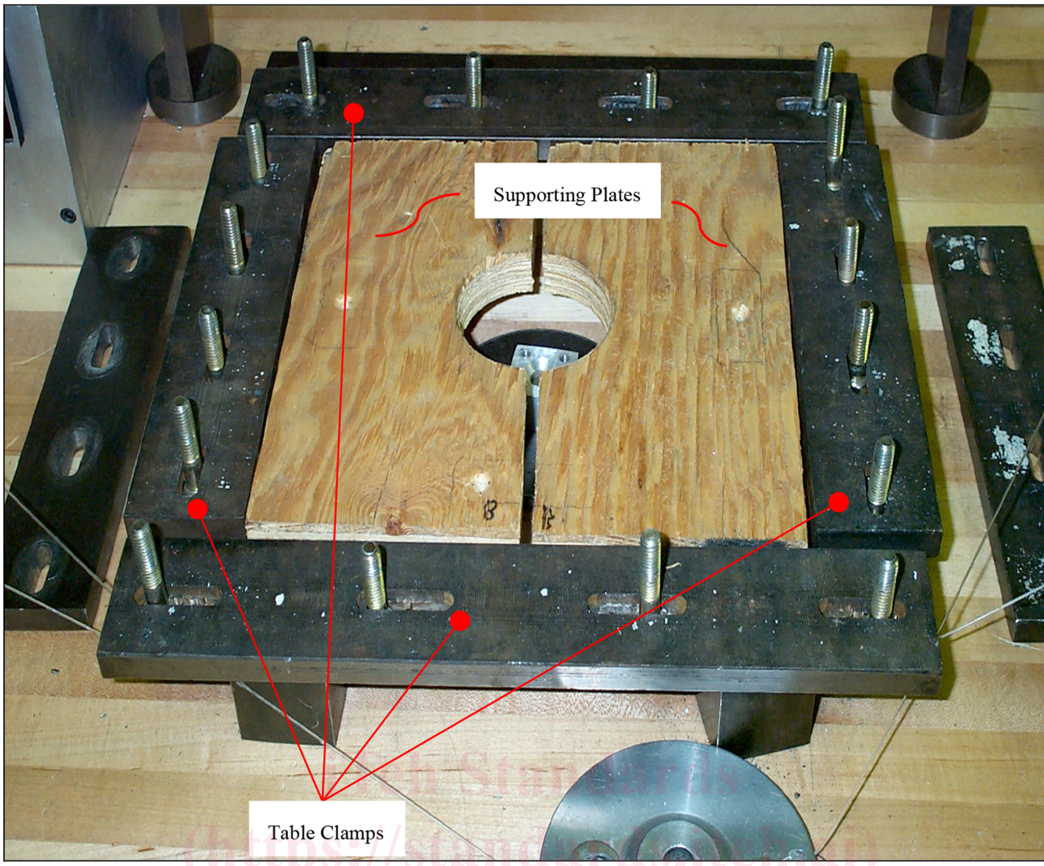

FIG. 2 Details of Table Clamps and Supporting Plates

tops and bottoms of the nodes or junction. The loading plate must cover the same nodes or junctions and be weighted with not less than 100 N [22.5 lbf] to sufficiently maintain the geogrid flat during clamping. These plates must be removed before test loads are applied and the sample inspected to insure that it is completely flat. No additional tensioning of the geogrid should be done.

6.1.2 *Table Clamps*—Clamps for the outside edges of the geogrid. The table clamps should have smooth surfaces and be rectangular in shape (Fig. 2). The table clamps hold the geogrid ribs firmly in place with respect to lateral movement at a distance of 8 mm [0.31 in.] ± 6 mm [0.24 in.] from the edge of the hole. If the node or junction is more than 12.7 mm [0.5 in.] outside the hole then the rib must be clamped between the node or junction and the edge of the hole. If the node or junction is within 12.7 mm [0.5 in.] of the edge of the hole, the node or junction must be clamped. Each rib must be held so that it does not move laterally more than 0.1 mm [0.004 in.] during the test. The tension in some ribs may be very high, perhaps on the order of several thousand N [several hundred lbf] for geogrids with high modulus values and large aperture sizes. The higher the Aperture Stability Modulus, the more important it is that the clamps do not allow lateral movement. The direction of maximum movement will be in the general direction of the rib. If the clamped point moves more than 0.1 mm [0.004 in.], the test should be discarded. Once confidence has been developed in a particular clamping technique with a particular geogrid, it will not be necessary to measure the potential movement in every test. However, while developing the clamping technique for a particular geogrid, the clamping efficiency must be checked. One method of doing this is to measure the distance from the edge of the clamp to a point close to the clamp on the rib. The clamping technique used to develop this test method was determined to be adequate for the geogrids tested and is shown in Figs. 1 and 2. The table clamps are made of steel bars with 9.5-mm [3/8-in.] bolts with 16 threads per 25 mm [1 in.] on about 50 mm [2 in.] spacing. The bolts were torqued to 13.5 N-m [120 lbf-in.].

6.1.3 *Torqueing Rod*—The torquing rod must have a clamp at one end to attach it to the ribs around the single center node or junction of the geogrid. The rod must be supported so that it does not apply a vertical force on the geogrid. In addition, the rod must be held in a vertical orientation to avoid applying an out-of-plane torque to the geogrid structure. The same displacement is required on each rib. The clamp that connects the torquing rod to the center node or junction is the center clamp. The center clamp is made of stainless steel and must apply a horizontal force to each intersecting rib at a uniform distance of 12.7 ± 1.0 mm [0.5 ± 0.04 in.] from the center of the center node or junction. The maximum torque expected is 2.5 N-m [22.1 lbf-in.]. Therefore, each contact point must be able to resist at least 250 N [55 lbf]. The clamping method used to develop the test method consists of two stainless steel metal blocks (center clamp) 35 ± 0.5 mm [1⅜ in.] in diameter, with a central hole to clear the geogrid node of 15.5 ± 0.5mm [⅜ in.] and with a clamp bolt circle diameter of 25.4 ± 0.5 mm