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Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method[1]

This standard is issued under the fixed designation D6637; 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 determination of the tensile strength properties of geogrids by subjecting strips of varying width to tensile loading.

1.2 Three alternative procedures are provided to determine the tensile strength, as follows:

1.2.1 *Method A*—Testing a single geogrid rib in tension (N or lbf).

1.2.2 *Method B*—Testing multiple geogrid ribs in tension (kN/m or lbf/ft).

1.2.3 *Method C*—Testing multiple layers of multiple geogrid ribs in tension (kN/m or lbf/ft).

1.3 This test method is intended for quality control and conformance testing of geogrids.

1.4 The values stated in SI units are to be regarded as the standard. The inch-pound values stated in parentheses are provided for information only.

1.5 *This standard may involve hazardous materials, operations, and equipment. 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]

D76 Specification for Tensile Testing Machines for Textiles
D123 Terminology Relating to Textiles
D1909 Standard Table of Commercial Moisture Regains for Textile Fibers
D4354 Practice for Sampling of Geosynthetics for Testing
D4439 Terminology for Geosynthetics
D5262 Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

3. Terminology

3.1 *Definitions:*

3.1.1 *atmosphere for testing geosynthetics*, *n*—air maintained at a relative humidity of 50 to 70 % and a temperature of 21 ± 2°C (70 ± 4°F).

3.1.2 *breaking force, (F)*, *n*—the force at failure.

3.1.3 *corresponding force*, *n*—synonym for force at specified elongation.

3.1.4 *force at specified elongation, FASE*, *n*—a force associated with a specific elongation on the force-elongation curve (synonym for corresponding force.)

3.1.5 *force-elongation curve*, *n*—in a tensile test, a graphical representation of the relationship between the magnitude of an externally applied force and the change in length of the specimen in the direction of the applied force (synonym for stress-strain curve.)

3.1.6 *geogrid*, *n*—a geosynthetic formed by a regular network of integrally connected elements with aperetures greater than 6.35 mm (¼ in.) to allow interlocking with surrounding soil, rock, earth, and other surrounding materials to primarily function as reinforcement. **D5262**

3.1.7 *geosynthetic*, *n*—a 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.

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[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.

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

3.1.9 *integral*, *adj*—in geosynthetics, forming a necessary part of the whole; a constituent.

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

3.1.11 *rib*, *n*—~~for geogrids, the continuous elements of a geogrid which are either in the machine or cross-machine direction as manufactured.~~ —for geogrids, the continuous elements of a geogrid which are interconnected to a node or junction.

3.1.12 *rupture*, *n*—for geogrids, the breaking or tearing apart of ribs.

3.1.13 *tensile*, *adj*—capable of tensions, or relating to tension of a material.

3.1.14 *tensile strength, (α_f)*, *n*—for geogrids the maximum resistance to deformation developed for a specific material when subjected to tension by an external force. Tensile strength of geogrids is the characteristic of a sample as distinct from a specimen and is expressed in force per unit width.

3.1.15 *tensile test*, *n*—for geosynthetics, a test in which a material is stretched uniaxially to determine the force-elongation characteristics, the breaking force, or the breaking elongation.

3.1.16 *tension*, *n*—the force that produces a specified elongation.

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

4. Summary of Test Method

4.1 *Method A*—In this method, a single, representative rib specimen of a geogrid is clamped and placed under a tensile force using a constant rate of extension testing machine. The tensile force required to fail (rupture) the specimen is recorded. The ultimate single rib tensile strength (N or lbf) is then determined based on the average of six single rib tensile tests.

4.2 *Method B*—A relatively wide specimen is gripped across its entire width in the clamps of a constant rate of extension type tensile testing machine operated at a prescribed rate of extension, applying a uniaxial load to the specimen until the specimen ruptures. Tensile strength (kN/m or lbf/ft), elongation, and secant modulus of the test specimen can be calculated from machine scales, dials, recording charts, or an interfaced computer.

4.3 *Method C*—A relatively wide, multiple layered specimen is gripped across its entire width in the clamps of a constant rate of extension type tensile testing machine operated at a prescribed rate of extension, applying a uniaxial load to the specimen until the specimen ruptures. Tensile strength (kN/m or lbf/ft), elongation and secant modulus of the test specimen can be calculated from machine scales, dials recording charts, or an interfaced computer.

5. Significance and Use

5.1 The determination of the tensile force-elongation values of geogrids provides index property values. This test method shall be used for quality control and acceptance testing of commercial shipments of geogrids.

5.2 In cases of dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens which are as homogeneous as possible and which are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Student's t-test for unpaired data and an acceptable probability level chosen by the two parties before the testing began. If a bias is found, either its cause must be found and corrected or the purchaser and supplier must agree to interpret future test results in light of the known bias.

5.3 All geogrids can be tested by any of these methods. Some modification of techniques may be necessary for a given geogrid depending upon its physical make-up. Special adaptations may be necessary with strong geogrids, multiple layered geogrids, or geogrids that tend to slip in the clamps or those which tend to be damaged by the clamps.

6. Apparatus

6.1 *Testing Clamps*—The clamps shall be sufficiently wide to grip the entire width of the specimen (as determined by the test method) and with appropriate clamping power to prevent slipping or crushing (damage). For a given product, the same clamps shall be used in testing methods A, B, and C prior to making any comparison between results.

6.1.1 *Size of Jaw Faces*—Each clamp shall have jaw faces measuring wider than the width of the specimen.

6.2 *Tensile Testing Machine*—A testing machine of the constant rate of extension type as described in Specification D76 shall be used. The machine shall be equipped with a device for recording the tensile force and the amount of separation of the grips. Both of these measuring systems shall be accurate to ± 1.0 % and, preferably, shall be external to the testing machine. The rate of separation shall be uniform and capable of adjustment within the range of the test.

6.3 *Distilled Water and Nonionic Wetting Agent*, shall be used for wet specimens only.

6.4 *Extensometer*—When required by the method, a device capable of measuring the distance between two reference points on the specimen without any damage to the specimen or slippage, care being taken to ensure that the measurement represents the true movement of the reference points. Examples of extensometers include mechanical, optical, infrared or electrical devices.

7. Sampling

7.1 *Lot Sample*—Divide the product into lots and take the lot sample as directed in Practice D4354.

7.2 *Laboratory Sample*—For the laboratory sample, take a full roll width swatch long enough in the machine direction from each roll in the lot sample to ensure that the requirements in 8.1 can be met. The sample may be taken from the end portion of a roll provided there is no evidence it is distorted or different from other portions of the roll.

8. Test Specimen

8.1 The specimens shall consist of three (3) junctions or 300 mm in length (12 in.), in order to establish a minimum specimen length in the direction of the test (either the machine or cross-machine direction). All specimens should be free of surface defects, etc., not typical of the laboratory sample. Take no specimens nearer the selvage edge along the geogrid than 1⁄10 the width of the sample.

NOTE 1—If a comparison of one geogrid to another is to be made the length of each specimen shall be the same (as similar as possibly) and agreed upon by all parties.

8.2 *Preparation*:

8.2.1 *Method A*—Prepare each finished specimen, as shown in Fig. 1, to contain one rib in the cross-test wide by at least three junctions (two apertures) long in the direction of the testing, with the length dimension being designated and accurately cut parallel to the direction for which the tensile strength is being measured.

8.2.2 *Method B*—Prepare each finished specimen, as shown in Fig. 2, to be a minimum of 200 mm wide and contain five ribs in the cross-test direction wide by at least three junctions (two apertures) or 300 mm (12 in.) long in the direction of the testing, with the length dimension being designated and accurately cut parallel to the direction for which the tensile strength is being measured.

8.2.3 *Method C*—Prepare each finished specimen, as shown in Fig. 2, to be a minimum of 200 mm wide and contain five ribs in the cross-test direction wide by at least three junctions (two apertures) or 300 mm (12 in.) long in the direction of the testing, with the length dimension being designated and accurately cut parallel to the direction for which the tensile strength is being measured. This must be repeated for each layer of geogrid included in the test.

8.2.4 Within Test Methods A, B, and C, the outermost ribs are commonly cut prior to testing to permit extra width of material in the clamps to minimize slippage within the clamps. If this procedure causes nonuniform distribution of load to the gauge length area of the specimen, the same width of material shall be included in the clamps as will be tested in the gauge length area. In either case, the test results shall be based on the unit of width associated with the number of intact ribs.

8.3 *Number of Test Specimens*:

8.3.1 Unless otherwise agreed upon as when provided in an applicable material specification, take a number of test specimens per swatch in the laboratory sample such that the user may expect at the 95 % probability level that the test result is no more than 5 % above the true average for each swatch in the laboratory sample for each required direction, see Note 2.

NOTE 2—In some applications, it may be necessary to perform tensile tests in both the machine and the cross-machine directions. In all cases, the direction of the tensile test specimen(s) should be clearly noted.

8.3.2 *Reliable Estimate of v*—When there is a reliable estimate of v based upon extensive past records for similar materials tested in the user's laboratory as directed in the method, calculate the required number of specimens using Eq 1, as follows:

$$n = (tv/A)^2 \quad (1)$$

where:

n = number of test specimens (rounded upward to a whole number),
v = reliable estimate of the coefficient of variation of individual observations on similar materials in the user's laboratory under conditions of single-operator precision, %,
t = the value of Student's t for one-sided limits, a 95 % probability level, and the degrees of freedom associated with the estimate of v, and;
A = 5.0 % of the average, the value of allowable variation.

8.3.3 *No Reliable Estimate of v*—When there is no reliable estimate of v for the user's laboratory, Eq 1 should not be used directly. Instead, specify the fixed number of 5 specimens for the required direction. The number of specimens is calculated using

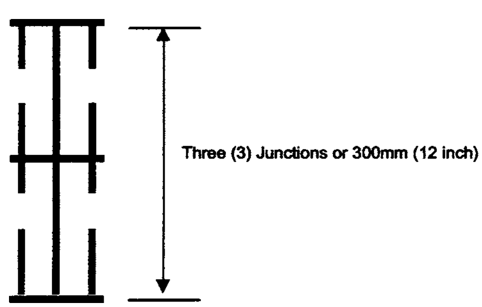

FIG. 1 Specimen Dimensions for Method A