



Designation: D 6637 – 01

Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method¹

This standard is issued under the fixed designation D 6637; 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 These test methods cover 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:

D 76 Specifications for Tensile Testing Machines for Textiles²

D 123 Terminology Relating to Textiles²

D 1909 Table of Commercial Moisture Regains for Textile Fibers²

D 4354 Practice for Sampling of Geosynthetics for Testing³

D 4439 Terminology for Geosynthetics³

3. Terminology

3.1 Definitions:

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 Feb. 10, 2001. Published May 2001.

² *Annual Book of ASTM Standards*, Vol 07.01.

³ *Annual Book of ASTM Standards*, Vol 04.13.

3.1.1 *atmosphere for testing geosynthetics, n*—air maintained at a relative humidity of 50 to 70 % and a temperature of $21 \pm 2^\circ\text{C}$ ($70 \pm 4^\circ\text{F}$).

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 apertures greater than 6.35 mm ($1/4$ inch) to allow interlocking with surrounding soil, rock, earth, and other surrounding materials to primarily function as reinforcement. **(D 5262)**

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

3.1.8 *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.

3.1.9 *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.

3.1.10 *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.

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_t), 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 D 123 and D 4439.

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 D 76 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 $\pm 1.0\%$ 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 D 4354.

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 $\frac{1}{10}$ 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.

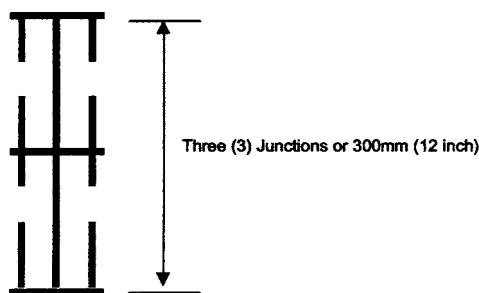


FIG. 1 Specimen Dimensions for Method A

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 cut prior to testing to prevent slippage from occurring within the clamps. For those cases where the outermost ribs are severed, 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:

$$n = (tv/A)^2 \tag{1}$$

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 $v = 9.5$ % of the average for the required direction. This value for v is somewhat larger than usually found in practice. When a reliable estimate of v for the user’s laboratory becomes available, Eq 1 will usually require fewer than the fixed number of specimens.

9. **Conditioning**

9.1 Expose the specimens to the atmosphere for testing geosynthetics for a period long enough to allow the geogrid to reach equilibrium within this standard atmosphere. Consider the specimen to be at moisture equilibrium when the change in mass of the specimen in successive weighings made at intervals of not less than 2 h does not exceed 0.1 % of the mass of the specimen. Consider the specimen to be at temperature equilibrium after 1 h of exposure to the atmosphere for testing geosynthetics.

9.2 Specimens to be tested in the wet condition shall be immersed in water for a minimum of one hour, maintained at a temperature of $21 \pm 2^\circ\text{C}$ ($70 \pm 4^\circ\text{F}$). The time of immersion must be sufficient to wet-out the specimens thoroughly, as indicated by no significant change in strength or elongation following a longer period of immersion, and at least 2 min. To obtain thorough wetting, it may be necessary or advisable to use distilled water.

9.3 Geogrids may be received in the laboratory rolled, thus it is important to flatten the specimens to avoid misleading elongation measurements. Geogrids which exhibit curl memory should be laid flat and weighted, until the geogrid remains flat without weight.

10. **Procedure**

10.1 Zero the testing system.

10.2 *Machine Set-Up Conditions*—At the start of the test, adjust the distance between the clamps or the distance from centerline to centerline of rollers to the greater distance of three junctions or 200 ± 3 mm (8.0 ± 0.1 in.), such that at least one transverse rib is contained centrally within the gage length. At least one clamp should be supported by a free swivel or universal joint which will allow the clamp to rotate in the plane of the geogrid. Select the force range of the testing machine so the break occurs between 10 and 90 % of full-scale force. The

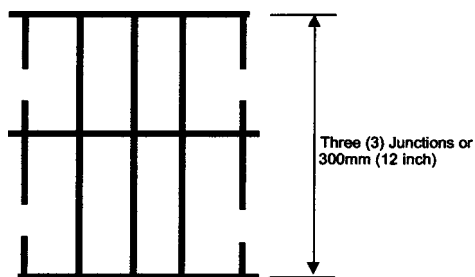


FIG. 2 Specimen Dimensions for Methods B and C