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Standard Practice for Determination of the Radial Tensile Properties of Geogrids Under Low Radial Strain[1]

This standard is issued under the fixed designation D8212; 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.

ε[1] NOTE—The title of Appendix X1 was editorially corrected in March 2024.

1. Scope

1.1 This practice presents a method for determining in-air index values (see Note 1) of the radial load and radial stiffness at low strain in each symmetric direction of a balanced geogrid (see Note 2) subjected to 360° radial strain. This determination is based on tensile test results from testing in accordance with Test Method D6637/D6637M and an analysis of the radial force balance in each symmetric direction across a circle of geogrid that is assumed to be strained uniformly in all radial directions to a low strain level.

1.2 Symmetric directions relative to the machine direction:

1.2.1 For geogrids with square or rectangular apertures: 0°, 45°, 90°, 135°.

1.2.2 For geogrids with triangular apertures: 0°, 30°, 60°, 90°, 120°, 150°.

NOTE 1—These index properties are not to be used for design or performance purposes.

NOTE 2—A balanced geogrid is one in which the manufacturer's specification indicates that variation of tensile properties between different sets of parallel ribs is 20 % or less.

1.3 This practice will facilitate comparisons of the radial tensile properties of different balanced geogrids and judgment of conformity of product manufactured and acceptance of commercial shipments of geogrids by standardizing the data used and the method by which the calculations are performed.

1.4 This standard practice is restricted in application to geogrids with two sets of parallel ribs arranged at nominally 90° to each other or three sets of parallel ribs arranged at nominally 60° to each other with one set lying in the cross-machine direction.

1.5 Further, this practice is restricted to 20 % variation in the specified unit tensile properties of the different sets of ribs in a geogrid in order to enable the development of the mathematics that use these properties of each set of ribs in the geogrid. This generates index values for the unit tensile properties in the nominal directions as outlined in 1.2.1 and 1.2.2 of a geogrid that is under 360° radial strain at any designated strain level. A 2 % strain level is set as the default strain of choice as it has been found that this is the lowest strain level at which most test laboratories can achieve consistent low-strain tensile test results on geogrids.

1.6 Calculations in accordance with this practice determine the radial component of the unit tensions generated in the geogrid. Differences in the unit tensions of different rib sets will also give tangential components of force. With a difference in tension between rib sets restricted to 20 % or less, it has been found that these tangential components will be approximately 10 % or less of the values of the radial components. Therefore, the resultant of the radial and tangential component in any symmetric direction will be less than 0.5 % greater than the radial component. As this is less than the variation normally found in tensile testing of a set of rib or wide-width specimens, it does not detract from the calculated radial tensions being valid index properties of the geogrid.

1.7 This practice is not applicable to uniaxial geogrids.

1.8 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.9 *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.*

1.10 *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.*

[1] This practice 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. Referenced Documents

2.1 *ASTM Standards:*[2]

D4439 Terminology for Geosynthetics

D6637/D6637M Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method

3. Terminology

3.1 *Definitions:*

3.1.1 *radial*—of or arranged like rays or the radii of a circle, diverging in lines from a common center.

3.1.2 *unit load*—the load per unit width of geogrid expressed as kN/m (lbf/ft).

3.2 Other definitions required for the understanding of this standard practice are available in Terminology D4439.

4. Significance and Use

4.1 The determination of the tensile force-elongation values of geogrids provides index property values. This standard practice shall be used for the determination of radial properties, judgment of conformity of product manufactured, and acceptance of commercial shipments of geogrids.

4.2 The standard strain at which this practice is applied is 2 %, as this has been established and accepted over the years as the lowest strain at which consistent measurement of the properties of geogrids can be achieved. However, if a customer or specifier requires calculation at a lower strain, this can be done provided the higher standard deviation this can give is accepted.

4.3 In cases of dispute arising from differences in reported results when using this standard practice for acceptance testing of commercial shipments, the purchaser and supplier should conduct comparative tests and calculations 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 results in light of the known bias.

4.4 This standard practice is applicable to all geogrids with two or three sets of ribs in which variation of tensile properties between different sets of parallel ribs is 20 % or less. For multiple-layered geogrids, it should be applied to each layer individually and the results for all layers summed in each radial direction.

[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.

5. Procedure

5.1 For geogrids with square or rectangular apertures:

5.1.1 Obtain the average wide-width unit tensile load in kN/m (lbf/ft) at 2 % strain and any other strain level designated by the designer or customer for the machine direction (MD) and cross-machine direction (CMD) ribs in the geogrid under consideration from tests in accordance with Test Method D6637/D6637M, Method B.

5.1.2 Calculate the radial loads in the geogrid at 2 % strain and any other designated strain in each symmetric direction around 360° (MD = 0°) using the following formulae:

5.1.2.1 Rib directions (0° and 90°):

$$L_0 \text{ or } L_{90} = \text{wide width unit tensile load in MD or CMD} \quad (1)$$

5.1.2.2 Between rib directions (45° and 135°):

$$L_{45} \text{ or } L_{135} = (L_0 * \cos 45 + L_{90} * \cos 45) * \cos 45 = (L_0 + L_{90}) / 2 \quad (2)$$

where:

L_Θ = the radial load in a designated direction Θ.

5.2 For geogrids with triangular apertures:

5.2.1 Obtain the average single rib tensile load in kN (lbf) at 2 % strain and any other strain level designated by the designer or customer for each set of ribs in the geogrid under consideration from tests in accordance with Method A of Test Method D6637/D6637M, modified to include load-strain recording.

5.2.2 Obtain the number of ribs per meter (ribs per foot) for each set of ribs in the geogrid under consideration (see Note 3).

5.2.3 Calculate the load per unit width at 2 % strain and at any designated strain for each set of ribs using the following formula:

$$L_x = F_x * N_t \text{ kN/m (lbf/ft)} \quad (3)$$

where:

L_x = load per unit width of a particular set of ribs at 2 % strain or a designated strain, kN/m (lbf/ft),

F_x = average individual rib tensile load at 2 % strain or a designated strain of the set of ribs concerned from tests to Test Method D6637/D6637M, Method A, kN (lbf), and

N_t = number of ribs per unit width of the set of ribs concerned, equal to the average value of N_i / b_i (see Note 3 and Appendix X2), m^{-1} (ft^{-1}).

NOTE 3—N_t is determined by taking the average of three measurements from a sample that is, if possible, 95 % of the manufactured product roll width. Each measurement is performed by measuring the distance from the leading edge of an undamaged rib near to one edge of the sample that is transverse to the direction of measurement to the leading edge of an undamaged rib a distance equal to about 95 % of the sample width away from the starting rib (this establishes the value b_i). The number of tensile elements within this distance b_i is N_i, and N_t is determined by averaging the values of N_i divided by b_i. See Appendix X2 for clarification. Normally, N_t will be a fractional number that should be reported to at least three significant figures.

5.2.4 Calculate the radial loads in the geogrid at 2 % strain or other designated strain in each symmetric direction around 360° (MD = 0°) using the following formulae:

5.2.4.1 Rib directions (30°, 90°, and 150°):

$$L_{30} \text{ or } L_{90} \text{ or } L_{150} = L_R + (L_A * \cos 60 + L_B * \cos 60) * \cos 60 = L_R + (L_A + L_B) / 4 \quad (4)$$