Designation: D4885 – 01 (Reapproved 2023)

Standard Test Method for Determining Performance Strength of Geomembranes by the Wide Strip Tensile Method[1]

This standard is issued under the fixed designation D4885; 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 performance strength of synthetic geomembranes by subjecting wide strips of material to tensile loading.

1.2 This test method covers the measurement of tensile strength and elongation of geomembranes and includes directions for calculating initial modulus, offset modulus, secant modulus, and breaking toughness.

1.3 The basic distinctions between this test method and other methods measuring tensile strength of geomembranes are the width of the specimens tested and the speed of applied force. The greater width of the specimens specified in this test method minimizes the contraction edge effect (necking) which occurs in many geosynthetics and provides a closer relationship to actual material behavior in service. The slower speed of applied strain also provides a closer relationship to actual material behavior in service.

1.4 As a performance test, this method will be used relatively infrequently, and to test large lots of material. This test method is not intended for routine quality control testing of geomembranes.

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

1.6 *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.*

1.7 *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]

D76/D76M Specification for Tensile Testing Machines for Textiles
D123 Terminology Relating to Textiles
D751 Test Methods for Coated Fabrics
D882 Test Method for Tensile Properties of Thin Plastic Sheeting
D1593 Specification for Nonrigid Vinyl Chloride Plastic Film and Sheeting
D1909 Standard Tables of Commercial Moisture Regains and Commercial Allowances for Textile Fibers
D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing
D4439 Terminology for Geosynthetics

3. Terminology

3.1 *Definitions:*

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

3.1.1.1 *Discussion*—Within the range of 50 to 70 % relative humidity, moisture content is not expected to affect the tensile properties of geomembrane materials. In addition, geotextile standard test methods restrict the range of relative humidity to 65 ± 5 %, while geomembrane standard test methods restrict the range of relative humidity to 55 ± 5 %. The restricted range in this test method is made broader to reduce the need for testing laboratories to change laboratory conditions, and considering the lack of expected effect of moisture on geomembranes. The user should consult Table D1909 to resolve questions regarding moisture regains of textile fibers, especially if the user is testing a new or unknown material.

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

3.1.3 *breaking toughness, T, (FL^{-1}), Jm^{-2}, n—for geosynthetics*, the actual work per unit volume of a material corresponding to the breaking force.

[1] This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.10 on Geomembranes.

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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.

3.1.3.1 *Discussion*—Breaking toughness is proportional to the area under the force-elongation curve from the origin to the breaking point (see also, *work-to-break*). Breaking toughness is calculated from work-to-break and width of a specimen. In geomembranes, breaking toughness is often expressed as force per unit width of material in inch-pound values. In other materials, breaking toughness is often expressed as work per unit mass of material.

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

3.1.5 *elastic limit, n—in mechanics*, the stress intensity at which stress and deformation of a material subjected to an increasing force cease to be proportional; the limit of stress within which a material will return to its original size and shape when the force is removed, and hence, not a permanent set.

3.1.6 *failure, n*—an arbitrary point beyond which a material ceases to be functionally capable of its intended use.

3.1.6.1 *Discussion*—In wide strip tensile testing of geosynthetics, failure occurs either at the rupture point or at the yield point in the force-elongation curve, whichever occurs first. For reinforced geomembranes, failure occurs at rupture of the reinforcing fabric. For nonreinforced geomembranes that exhibit a yield point, such as polyethylene materials, failure occurs at the yield point. Even though the geomembrane continues to elongate, the force-elongation relationship has been irreversibly altered. For nonreinforced geomembranes that do not exhibit a yield point, such as plasticized PVC materials, failure occurs at rupture of the geomembrane.

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

3.1.8 *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*.)

3.1.9 *geomembrane, n*—an essentially impermeable geosynthetic used with foundation soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a manmade project, structure, or system.

3.1.9.1 *Discussion*—Other names under which geomembranes are recognized include: flexible membrane liners (FMLs), liners, and membranes.

3.1.10 *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 the property of interest.

3.1.11 *inflection point, n*—the first point of the force-elongation curve at which the second derivative equals zero.

3.1.11.1 *Discussion*—The inflection point occurs at the first point on the force-elongation curve at which the curve ceases to curve upward and begins to curve downward (or vice versa).

3.1.12 *initial tensile modulus, J_i, (FL^{-1}), Nm^{-1}, n—for geosynthetics*, the ratio of the change in force per unit width to the change in elongation of the initial portion of a force-elongation curve.

3.1.13 *offset modulus, J_o, (FL^{-1}), Nm^{-1}, n—for geosynthetics*, the ratio of the change in force per unit width to the change in elongation below an arbitrary offset point at which there is a proportional relationship between force and elongation, and above the inflection point on the force-elongation curve.

3.1.14 *performance test, n*—a test which simulates in the laboratory as closely as practicable selected conditions experienced in the field and which can be used in design. (Synonym for *design test*.)

3.1.15 *secant modulus, J_{sec}, (FL^{-1}), Nm^{-1}, n—for geosynthetics*, the ratio of change in force per unit width to the change in elongation between two points on a force-elongation curve.

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

3.1.17 *tensile modulus, J, (FL^{-1}), Nm^{-1}, n—for geosynthetics*, the ratio of the change in tensile force per unit width to a corresponding change in elongation.

3.1.18 *tensile strength, n*—the maximum resistance to deformation developed by a specific material when subjected to tension by an external force.

3.1.19 *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.

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

3.1.21 *wide strip tensile test, n—for geosynthetics*, a tensile test in which the entire width of a 200-mm (8.0-in.) wide specimen is gripped in the clamps and the gauge length is 100 mm (4.0 in.).

3.1.22 *work-to-break, W, (LF), J, n—in tensile testing*, the total energy required to rupture a specimen.

3.1.22.1 *Discussion*—For geomembranes, work-to-break is proportional to the area under the force-elongation curve from the origin to the breaking point.

3.1.23 *yield point, n—in geosynthetics*, the point on the force-elongation curve at which the first derivative equals zero (the first maximum).

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

4. Summary of Test Method

4.1 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, elongation, initial and secant modulus, and breaking toughness of the test specimen can be calculated from machine scales, dials, recording charts, or an interfaced computer.

5. Significance and Use

5.1 This test method is a performance test intended as a design aid used to determine the ability of geomembranes to