



Designation: D6693 – 04(Reapproved 2010)

# Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes<sup>1</sup>

This standard is issued under the fixed designation D6693; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the determination of the tensile properties of nonreinforced geomembranes in the form of standard dumbbell-shaped test specimens when tested under defined conditions of pretreatment, temperature, and machine speed.

1.2 This test method can be used for testing materials thickness between 0.25 mm (0.010 in.) and 6.3 mm (0.25 in.).

NOTE 1—This test method is not intended to cover precise physical procedures. The constant rate of crosshead movement of this test lacks accuracy from a theoretical standpoint. A wide difference may exist between the rate of crosshead movement and the rate of strain of the specimen indicating that the testing speeds specified may disguise important effects or characteristics of these materials in the plastic state. Further, it is realized that variations in the thicknesses of test specimens, as permitted by this test method, produce variations in the surface-volume ratios of such specimens, and that these variations may influence the test results. Hence, where directly comparable results are desired, all samples should be of equal thickness. Special additional tests should be used where more precise physical data are needed.

1.3 Test data obtained by this test method are relevant and may be appropriate for use in engineering design with consideration of test conditions as compared with in-service conditions.

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

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.*

<sup>1</sup> 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. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

D638 Test Method for Tensile Properties of Plastics

D4000 Classification System for Specifying Plastic Materials

D4439 Terminology for Geosynthetics

D5199 Test Method for Measuring the Nominal Thickness of Geosynthetics

D5994 Test Method for Measuring Core Thickness of Textured Geomembranes

E4 Practices for Force Verification of Testing Machines

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

## 3. Terminology

3.1 *Definitions*—Definitions of terms applying to this test method appear in Terminology D4439.

## 4. Significance and Use

4.1 This test method is designed to produce tensile property data for the control and specification of nonreinforced polyethylene and flexible nonreinforced polypropylene geomembranes. These data are also useful for qualitative characterization and for research and development. It may be necessary to modify this procedure for use in testing certain materials as recommended by the material specifications. Therefore, it is advisable to refer to that material's specification before using this test method. Table 1 in Classification D4000 lists the ASTM materials standards that currently exist.

4.2 Tensile properties may vary with specimen preparation, test speed, and environment of testing. Consequently, where precise comparative results are desired, these factors must be carefully monitored and controlled.

4.2.1 It is realized that a material cannot be tested without also testing the method of preparation of that material. Hence, when comparative tests of materials are desired, the care must

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

be exercised to ensure that all samples are prepared in exactly the same way, unless the test is to include the effects of sample preparation. Similarly, for referee purposes or comparisons within any given series of specimens, care must be taken to secure the maximum degree of uniformity in details of preparation, treatment, and handling.

NOTE 2—Tensile properties may provide useful data for plastics engineering design purposes. However, because of the high degree of sensitivity exhibited by many plastics to rate of straining and environmental conditions, data obtained by this test method cannot be considered valid for applications involving load-time scales or environments widely different from those of this test method. In cases of such dissimilarity, no reliable estimation of the limit of usefulness can be made for most plastics. This sensitivity to rate of straining and environment necessitates testing over a broad load-time scale and range of environmental conditions if tensile properties are to suffice for engineering design purposes.

## 5. Apparatus

5.1 *Testing Machine*—A testing machine of the constant-rate-of-crosshead-movement type and comprising essentially the following:

5.1.1 *Fixed Member*—A fixed or essentially stationary member carrying one grip.

5.1.2 *Movable Member*—A movable member carrying a second grip.

5.1.3 *Grips*—Grips for holding the test specimen between the fixed member and the movable member of the test apparatus can be either a fixed or self-aligning type.

5.1.3.1 Fixed grips are rigidly attached to the fixed and movable members of the test apparatus. Extreme care should be taken when this type of grip is used to ensure that the test specimen is inserted and clamped so that the long axis of the test specimen coincides with the direction of pull through the centerline of the grip assembly.

5.1.3.2 Self-aligning grips are attached to the fixed and movable members of the test apparatus. This type of grip assembly is such that they will move freely into alignment as soon as any load is applied as long as the long axis of the test specimen will coincide with the direction of the applied pull through the centerline of the grip assembly. The specimens should be aligned as perfectly as possible with the direction of pull so that no rotary motion will occur in the grips thereby inducing slippage; there is a limit to the amount of misalignment self-aligning grips will accommodate.

5.1.3.3 The test specimen shall be held in such a way that slippage relative to the grips is prevented as much as possible. Grip surfaces that are deeply scored or serrated with a pattern similar to those of a coarse single-cut file, serrations about 2.4 mm (0.09 in.) apart and about 1.6 mm (0.06 in.) deep, have been found satisfactory for most thermoplastics. Finer serrations have been found to be more satisfactory for harder plastics, such as the thermosetting materials. The serrations should be kept clean and sharp. Breaking in the grips may occur at times, even when deep serrations or abraded specimen surfaces are used; other techniques must be used in these cases. Other techniques that have been found useful, particularly with smooth-faced grips, are abrading that portion of the surface of the specimen that will be in the grips, and interposing thin pieces of abrasive cloth, abrasive paper, plastic, or rubber-coated fabric, commonly called hospital sheeting, between the

specimen and the grip surface. No. 80 double-sided abrasive paper has been found effective in many cases. An open-mesh fabric, in which the threads are coated with abrasive, has also been effective. Reducing the cross-sectional area of the specimen may also be effective. The use of special types of grips is sometimes necessary to eliminate slippage and breakage in the grips.

5.1.4 *Drive Mechanism*—A drive mechanism for imparting to the movable member a uniform, controlled velocity with respect to the stationary member, with this velocity to be regulated as specified in Section 9.

5.1.5 *Load Indicator*—A suitable load-indicating mechanism capable of showing the total tensile load carried by the test specimen when held by the grips. This mechanism shall be essentially free of inertia lag at the specified rate of testing and shall indicate the load with an accuracy of  $\pm 1\%$  of the indicated value, or better. The accuracy of the testing machine shall be verified in accordance with Practices E4.

NOTE 3—Experience has shown that many testing machines now in use are incapable of maintaining accuracy for as long as the periods between inspection recommended in Practices E4. Hence, it is recommended that each machine be studied individually and verified as often as may be found necessary. It frequently will be necessary to perform this function daily.

## 6. Test Specimens

### 6.1 *Sheet, Plate, and Molded Plastics:*

6.1.1 The test specimens shall conform to the dimensions shown in Fig. 1. This specimen geometry was adopted from Test Method D638 and is therefore equivalent to Type IV of said standard.

6.1.2 Test specimens shall be prepared by die cutting from materials in sheet, plate, slab, or similar form.

6.2 All surfaces of the specimen shall be free of visible flaws, scratches, or imperfections. If the specimen exhibits such markings, it should be discarded and replaced. If these flaws or imperfections are present in the new specimen, the die should be inspected for flaws.

NOTE 4—Negative effects from imperfections on the edge of the specimens can severely impact the results of this test and should therefore be carefully monitored. In cases of dispute over the results, inspection of the die and specimen preparation should take place.

## 7. Conditioning

7.1 *Conditioning*—Specimens should be tested once the material has reached temperature equilibrium. The time required to reach a temperature equilibrium may vary according to the manufacturing process, material type, and material thickness.

7.2 *Test Conditions*—Conduct tests in the Standard Laboratory Atmosphere of  $21 \pm 2^\circ\text{C}$  ( $69.8 \pm 3.6^\circ\text{F}$ ) unless otherwise specified in the test methods.

NOTE 5—A humidity requirement has intentionally been left out of the test conditions due to the fact that polyolefins are not significantly affected by large fluctuations in humidity thereby making such a restriction unnecessary.

NOTE 6—The tensile properties of some plastics change rapidly with small changes in temperature. Since heat may be generated as a result of straining the specimen at high rates, conduct tests without forced cooling