Designation: D7744/D7744M – 25

Standard Test Methods for Tensile Testing of High-Performance Polyethylene Films[1]

This standard is issued under the fixed designation D7744/D7744M; 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 tensile testing of high-performance polyethylene films. The methods include testing procedure only and include no specifications or tolerances.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.3 This standard includes the following test methods:

	Section
Breaking Force	11
Breaking Tenacity	12
Toughness at Break	17
Elongation at Break	13
Force at Specified Elongation (FASE)	14
Linear Density	10
Modulus	15
Work-to-Break	16

1.4 *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.*

1.5 *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
D883 Terminology Relating to Plastics
D1776/D1776M Practice for Conditioning and Testing Textiles
D1907 Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method
D2258/D2258M Practice for Sampling Yarn for Testing
D3800 Test Method for Density of High-Modulus Fibers
D4848 Terminology Related to Force, Deformation and Related Properties of Textiles
D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens
D6477 Terminology Relating to Tire Cord, Bead Wire, Hose Reinforcing Wire, and Fabrics
D7269/D7269M Test Methods for Tensile Testing of Aramid Yarns
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions:*

3.2 The following terms are relevant to this standard: breaking force; breaking tenacity; elongation at break; force at specified elongation (FASE); linear density; modulus; toughness at break.

3.2.1 For definitions of these terms and others related to force, and deformation and related properties in textiles, refer to Terminology D4848.

3.3 The following terms are relevant to this standard: high-performance polyethylene; work-to-break.

3.3.1 For the definitions of these terms and others relating to tire cord, bead wire, hose reinforcing wire, and fabrics, refer to Terminology D6477.

3.4 The following term is relevant to this standard: film

3.4.1 For the definition of this term and others related to plastics, refer to Terminology D883.

3.5 For definitions of other terms related to textiles, refer to Terminology D123.

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.19 on Industrial Fibers and Metallic Reinforcements.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4. Summary of Test Method

4.1 A conditioned high performance polyethylene film is clamped in a constant rate of extension tensile testing machine (CRE) and then stretched or loaded until broken.

4.2 Breaking force, elongation, and force at specified elongation (FASE) are determined directly. Modulus and work-to-break are calculated from the force-elongation curve.

5. Significance and Use

5.1 The levels of tensile properties obtained when testing high performance polyethylene films are dependent on the age and history of the specimen and on the specific conditions used during the test. Among these conditions are rate of stretching, type of clamps, gauge length of specimen, temperature and humidity of the atmosphere, rate of airflow across the specimen, and temperature and moisture content of the specimen. Testing conditions accordingly are specified precisely to obtain reproducible test results on a specific sample.

5.2 *Breaking force* is used in engineering calculations when designing various types of products. When needed to compare intrinsic strength characteristics, films of different sizes or different types of film, breaking tenacity is very useful because, for a given type of film, breaking force is approximately proportional to linear density.

5.3 *Elongation* of film is taken into consideration in the design and engineering of reinforced products because of its effect on uniformity of the finished product and its dimensional stability during service.

5.4 The *FASE* is used to monitor changes in characteristics of the material during the various stages involved in the processing.

5.5 *Modulus* is a measure of the resistance of film to extension as a tensile force is applied. Although modulus may be determined at any specified force, initial modulus is the value most commonly used.

5.6 *Work-to-break* is dependent on the relationship of force to elongation. It is a measure of the ability of a textile structure to absorb mechanical energy. *Toughness at break* is work-to-break per unit mass.

5.7 Shape, size, and internal construction of the end-product can have appreciable effects on product performance. It is not possible, therefore, to evaluate the performance of an end product in terms of the reinforcing material alone.

5.8 If there are differences of practical significance between reported test results for two laboratories (or more), comparative tests shall be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, test samples shall be used that are as homogeneous as possible, that are drawn from the material from which the disparate test results were obtained, and that are randomly assigned in equal numbers to each laboratory for testing. Other materials with established test values may be used for this purpose. The test results from the two laboratories shall be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If a bias is found, either its cause must be found and corrected, or future test results must be adjusted in consideration of the known bias.

6. Apparatus

6.1 *Tensile Testing Machine*—A single-strand tensile testing machine of the constant rate of extension (CRE) type. The specifications and methods of calibration and verification of these machines shall conform to Specification D76/D76M. The tensile testing machines shall be equipped with a data acquisition and a data evaluation system.

6.2 *Clamps*—Side action grips with flat jaw faces shall be used. The test specimen shall be held in such a way that slippage relative to the grips is prevented insofar as possible. Flat faced grips were found to fulfill this requirement. The width of the jaw faces shall be equal or larger than the sample width. The use of paper has been found to reduce slippage. Air-actuated or hydraulic grips have been found advantageous. In cases where samples frequently fail at the edge of the grips, it may be advantageous to increase slightly the radius of curvature of these edges where the grips come in contact with the test area of the specimen.

6.3 *Gauge Length*—The gauge length shall be the total length between the jaw faces.

6.4 The compliance of the total testing system (tensile tester, loadcell and clamping system) shall be less than 0.2 µm [10^{-6} in.] per Newton.

6.5 Use a crosshead travel rate in mm/min [in./min] of either 50 or 100 % of the nominal gauge length in millimeters [inches] of the specimen. The rate used must be reported.

NOTE 1—The selected testing equipment (tester, clamp) and gauge length are known to have an influence on the properties measured. When required, the influences introduced by the selected testing equipment can be eliminated using the method as given in Test Methods D7269/D7269M, Appendix X1.

7. Sampling

7.1 *Film:*

7.1.1 For acceptance testing, sample each lot as directed in Practice D2258/D2258M. Take the number of specimens for testing specified for the specific property measurement to be made.

8. Conditioning

8.1 Bring all specimens to equilibrium in the atmosphere prior to testing as directed in Practice D1776/D1776M.

9. Sample Preparation

9.1 The width and the thickness of the samples are determined in accordance with Practice D5947, Option C. The thickness must be equal or less than 250 µm [10^{-3} in.]. The width of the samples shall not exceed 150 mm [6 in.]. Due to constraints of the tensile equipment, the test cannot be used for films wider than that limit. If the width exceeds 150 mm [6 in.], the sample must be cut to width so that it fulfills this requirement.