



Standard Test Methods for Elastic Properties of Textile Fibers¹

This standard is issued under the fixed designation D 1774; 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 measurement of the elastic behavior of fibers by assessing their ability to recover strain-induced energy, and to recover their original dimensions following a known extension. Since the crimp in a fiber alters the initial shape of the stress-strain curve, separate procedures are described for uncrimped and crimped fibers.

NOTE 1—For the determination of the elastic properties of elastomeric yarns, refer to Test Method D 2731, Test Method for Elastic Properties of Elastomeric Yarns (Constant-Rate-of-Extension Machines).²

1.2 *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 Specification for Tensile Testing Machines for Textiles²
- D 123 Terminology Relating to Textiles²
- D 1776 Practice for Conditioning Textiles for Testing²
- D 2258 Practice for Sampling Yarn for Testing²
- D 3333 Practice for Sampling Man-Made Staple Fibers, Sliver, or Tow for Testing³
- D 4848 Terminology of Force, Deformation and Related Properties of Textiles³

3. Terminology

3.1 Definitions:

3.1.1 *deformation, permanent, n*—the net long-term change in a dimension of a specimen after deformation and relaxation under specified conditions. (*Syn.* permanent set, nonrecoverable deformation, and nonrecoverable stretch.)

3.1.1.1 *Discussion*—Permanent deformation is usually expressed as a percentage of the original dimension.

3.1.2 *elongation, n*—the ratio of the extension of a material to the length of the material prior to stretching, expressed as a percent.

3.1.2.1 *Discussion*—Elongation may be measured at any specified force or at rupture.

3.1.3 *tensile strain recovery, n*—the percent of recoverable

extension to the total extension impressed on a fiber under specified conditions.

3.1.3.1 *Discussion*—The tensile strain recovery includes both immediate elastic recovery and delayed recovery and is equivalent to the quantity 100 – percent permanent deformation.

3.1.4 *work recovery, n*—the percent of recoverable work to the total work required to strain a fiber a specified amount under specified conditions.

3.1.5 For definitions of other terms related to force and deformation in textiles, refer to Terminology D 4848. For definitions of other textile terms used in this test method, refer to Terminology D 123.

4. Summary of Test Methods

4.1 The elastic properties of fibers are measured by (1) determining the amount of recoverable energy exhibited by a fiber when it is stretched to a predetermined extension at a specific rate of strain, held at this extension for a specified length of time, and finally relaxed at the same rate at which it was extended; and (2) determining the dimensional recovery of the fiber following the strain history described in Item (1).

5. Significance and Use

5.1 Elastic properties are related to a fiber's ability to recover from a tensile deformation. These properties are important in the selection of fibers for specific end-use application and in determining processing characteristics.

5.2 This test method specifies that the fiber is to be tested at each of three levels of extension (2.0 %, 5.0 %, and 10.0 %) to describe the elastic behavior of the fiber at both small and large deformations.

5.3 This method of testing the elastic properties of fibers is not recommended for acceptance testing of commercial shipments of fibers because the between-laboratory precision has not been established. In some cases the purchaser and the seller may have to test a commercial shipment of one or more specific materials by the best available method, even though the method has not been recommended for acceptance testing of commercial shipments. In such a case, if there is a disagreement arising from differences in values reported by the purchaser and the seller when using this test method for acceptance testing, the statistical bias, if any, between the laboratory of the purchaser and the laboratory of the seller should be determined with each comparison being based on testing specimens randomly drawn from one sample of material of the type being evaluated.

6. Apparatus

6.1 *Constant-Rate-of-Specimen-Extension- (CRE) Type Tensile Testing Machine*, conforming to 5.1.1 and 6.1

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

³ *Annual Book of ASTM Standards*, Vol 07.02.

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through 6.4.2 of Specification D 76, capable of stretching a fiber at a specified rate of strain to a predetermined extension, holding the fiber at this extension for a specified amount of time, and then relaxing it at a constant rate. A recording system that allows continuous plotting of load and extension concurrently is required.

6.2 *Suitable Fiber Clamps*, designed to minimize fiber slippage. These may take the form of mechanical clamps or the use of various tab cementing techniques.

6.3 *Stopwatch*.

6.4 *Planimeter or Automatic Integrator*, for measuring the area under the load-elongation curve.

7. Sampling

7.1 *Lot Sampling*—As a lot sample for acceptance testing, take at random the number of shipping containers directed in the applicable material specification or other agreement between the purchaser and supplier, such as an agreement to use Practice D 3333 or Practice D 2258. Consider shipping containers to be the primary sampling units.

NOTE 2—An adequate specification or other agreement between the purchaser or supplier requires taking into account the variability between shipping units, between packages, ends, or other laboratory sampling unit within a shipping unit if applicable, and within specimens from a single package, end, or other laboratory sampling unit to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quantity level.

7.2 *Laboratory Sample*—As a laboratory sample for acceptance testing, take at random from each shipping container in the lot sample the number of laboratory sampling units as directed in an applicable material specification or other agreement between the purchaser and the supplier such as an agreement to use Practice D 3333 or Practice D 2258. Preferably, the same number of laboratory sampling units are taken from each shipping container in the lot sample. If differing numbers of laboratory sampling units are to be taken from shipping containers in the lot sample, determine at random which shipping containers are to have each number of laboratory units drawn.

7.2.1 *For Staple Fiber*—Take 50-g samples from laboratory sampling units.

7.2.2 *For Sliver (or Top) or Tow*—Take 1 m from the leading end which has a clean, uniform appearance.

7.2.3 *For Yarns*—Prepare at least a 50-m skein from each package.

7.3 *Test Specimens*—From each laboratory sampling unit, take ten specimens at random. If the standard deviation determined for the ten specimens is more than a value agreed upon between the purchaser and the supplier, continue testing in groups of ten specimens from the same laboratory sampling unit until the standard deviation for all specimens tested is not more than the agreed to value or, by agreement, stop testing after a specified number.

7.3.1 Carefully remove twist before taking specimens from yarn. Using tweezers and grasping the specimens at the ends, gently remove the required number of specimens from the laboratory sampling units for testing. In some cases, if specimens are not to be tested immediately, place them on an identified short-pile of plush surface for storage until ready to test.

8. Conditioning

8.1 Condition the specimens in the standard atmosphere for testing textiles as directed in Practice D 1776. Specimens of rayon, acetate, or nylon must be preconditioned before conditioning.

PROCEDURE A—FOR UNCRIMPED FIBERS

9. Procedure

9.1 Test the adequately conditioned specimens in the standard atmosphere for testing textiles which is $70 \pm 2^\circ\text{F}$ ($21 \pm 1^\circ\text{C}$) and $65 \pm 2\%$ relative humidity.

9.2 Calibrate the weighing system of the testing machine with dead weights (as directed in Sections 8 and 9 of Specification D 76). Select a load range such that the portion of the load-extension curve to be studied utilizes at least 50 % of the chart load axis.

9.3 Set the crosshead for a gage length compatible with the length of the shortest fiber being tested.

9.3.1 When possible, a gage length of 5 or 10 in. (127 or 265 mm) is recommended.

9.4 Adjust the rate of crosshead travel of the testing machine to give a rate of specimen extension of 10 %/min.

9.5 Adjust the rate of chart travel so that the portion of the load-extension curve to be studied utilizes at least 2 in. (50 mm) of the chart extension axis.

9.6 Place a specimen in the clamps of the testing machine in such a manner that the axis of the specimen coincides with the axis of loading and the specimen is free of "slack" after tightening the clamps.

NOTE 3—Improper location of the specimen in the clamps is probably the greatest source of variability in the test method and extreme care must be taken to ensure that the above conditions are met. The use of a preloading weight exerting a stress no greater than 0.05

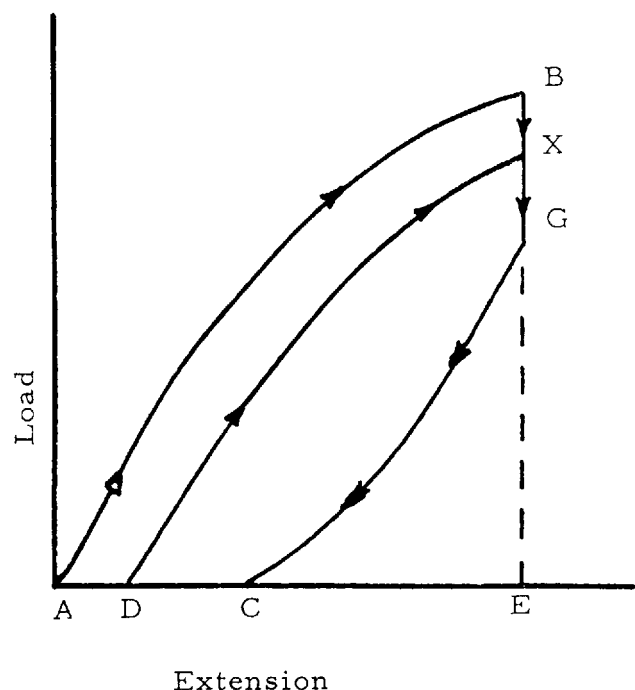


FIG. 1 Determination of the Elastic Properties of Uncrimped Fibers