



Designation: D 2731 – 01

Standard Test Method for Elastic Properties of Elastomeric Yarns (CRE Type Tensile Testing Machines)¹

This standard is issued under the fixed designation D 2731; 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 elastic properties of “as produced” elastomeric yarns made from rubber, spandex or other elastomers. Elastic properties include force at specified elongations, permanent deformation and stress decay. Other hysteresis related properties can be calculated.

NOTE 1—For a method designed specifically for testing rubber threads, refer to Test Method D 2433.

1.2 This test method is not applicable to covered, wrapped, or core-spun yarns or yarns spun from elastomeric staple.

1.3 This test method is applicable to elastomeric yarns having a range of 40 to 3200 dtex (36 to 2900 denier).

1.4 The values stated in either SI units or U.S. Customary units are to be regarded separately as standard. Within the text, the U.S. Customary units are in parentheses. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other.

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.*

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 and Testing Textiles²
- D 2258 Practice for Sampling Yarn for Testing²
- D 2433 Test Methods for Rubber Thread³
- D 2591 Test Method for Linear Density of Elastomeric Yarns (Short-Length Specimens)²
- D 2653 Test Method for Tensile Properties of Elastomeric Yarns (CRE Type Tensile Testing Machines)²

D 4848 Terminology for Force, Deformation and Related Properties of Textiles⁴

D 6717 Test Method for Linear Density of Elastomeric Yarns (Skein Specimens)⁴

3. Terminology

3.1 Definitions:

3.1.1 *deformation, n*—a change in shape of a material caused by forces of compression, shear, tension, or torsion.

3.1.2 *elastomeric yarn, n*—a nontextured yarn which can be stretched repeatedly at room temperature to at least twice its original length and which after removal of the tensile force will immediately and forcibly return to approximately its original length.

3.1.3 *elongation, n*—the ratio of the extension of a material to the length of the material prior to stretching.

3.1.4 *force at specified elongation (FASE), n*—the force associated with a specific elongation on the force-extension or force-elongation curve.

3.1.5 *linear density, n*—for fiber and yarn, mass per unit length.

3.1.6 *permanent deformation, n*—the net long-term change in a dimension of a specimen after deformation and relaxation under specified conditions.

3.1.6.1 *Discussion*—Permanent deformation in elastomeric yarns is frequently referred to as “set”. Elastomeric yarns which have been deformed will eventually return to, or nearly to, the original dimension with relaxation.

3.1.7 *stress, n*—the resistance to deformation developed within a material subjected to an external force.

3.1.8 *stress decay, n*—in mechanics, the reduction in force to hold a material at a fixed deformation over a period of time.

3.1.9 For definitions of other terms related to force and deformation, refer to Terminology D 4848. For definitions of other terms related to textiles used in this standard, refer to Terminology D 123.

4. Summary of Test Method

4.1 A specimen, mounted in a CRE-type tensile machine, is initially subjected to a series of five loading/unloading cycles in which the specimen is extended and relaxed between zero

¹ This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.58 on Yarns.

Current edition approved Sept. 10, 2001. Published November 2001. Originally published as D 2731 – 68. Discontinued 1979 and reinstated as D 2731 – 01.

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

³ *Annual Book of ASTM Standards*, Vol 09.02.

⁴ *Annual Book of ASTM Standards*, Vol 07.02.

and 75 % of the elongation at first filament break (FFB). During the fifth cycle, the specimen is held at the maximum extension point for 30 s, then unloaded to allow a return to its original gage length position. The specimen is then subjected to a sixth load/unload cycle.

4.2 Force at specified elongations are calculated from the force-elongation curve for the first and fifth loadings and for the fifth unloading. Stress decay is calculated on the fifth cycle. Extension at a specified force is determined on the sixth loading and is used to calculate the permanent deformation.

5. Significance and Use

5.1 This test method is considered satisfactory for acceptance testing of commercial shipments since current estimates of between-laboratory precision are acceptable and the method is used extensively in the trade for acceptance testing.

5.1.1 If there are differences of practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, use samples for such comparative tests that are as homogeneous as possible, drawn from the same lot of material as the samples that resulted in disparate results during initial testing, and randomly assigned in equal numbers to each laboratory. The test results from the laboratories involved should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If bias is found, either its cause must be found and corrected, or future test results for that material must be adjusted in consideration of the known bias.

5.2 Force at Specified Elongation (FASE) is a measure of the tensile force required to extend a textile material within specified limits. This characteristic of elastomeric yarn indicates the resistance that will have to be overcome by the wearer while putting on a garment made of the material and is also an indication of the garment's resistance to deformation caused by normal body movements during wear. The elongations used for these measurements are typically 100 %, 200 % and 300 %.

5.3 Permanent Deformation (set) is a measure of the increase in length of an elastomeric yarn resulting from cyclic stretching and relaxation. The characteristic is a visible indication of the realignment of intermolecular bonds within the elastic material. As with stress decay, the amount of set increases with yarn extension; however, for any particular extension, little or no additional set takes place after five cycles of exercising. Generally, the characteristic set of the yarn is developed during fabric preparation and the fabric itself shows a negligible amount of set.

5.4 Stress decay increases with yarn extension, but at any specified extension the stress decay takes place in the first 30 s with insignificant decay after 5 min. This characteristic is caused by the gradual realignment of intermolecular bonds within the elastic material, and helps to explain the changes in yarn properties that accompany cyclic stretching and relaxing. The realignment of the bonds is a reversible effect. Following complete relaxation of the yarn, the molecules tend to assume their original configuration with just about complete elimination of the previously observed strain.

5.5 This test method was developed using elastomeric yarns in the "as-produced" condition, but may be used for treated elastomeric yarns provided the treatment is specified. The method does not cover the removal of finish for the determination of elastic properties of "finish-free" elastomeric yarns.

6. Apparatus

6.1 *Specimen Boards*, with short pile or plush surfaces of black or contrasting color, for storing specimens during conditioning.

6.2 *Tensile Testing Machine*, CRE-type, conforming to Specification D 76 with respect to force indication, working range, capacity and verification of recorded elongation, capable of cycling, and designed for operation at a pulling speed of 500 mm/min (20 in./min).

6.3 *Clamping Assembly*, pneumatically operated, with jaws as described in Test Method D 2653.

6.4 *Computer or Microprocessor*, interfaced, with automatic data gathering system, optional.

6.5 *Tensioning Weights*, with various masses from 10 mg to 3 g to pretension the specimen to 30 to 50 mN/tex (0.3 to 0.5 mgf/d) before testing.

6.6 *Air Supply*, capable of providing 415 kPa (60 psi) to the pneumatic clamps.

7. Sampling, Test Specimens, and Test Units

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

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

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

7.3 *Test Specimens*—From each package or end in the laboratory sample, take six specimens as directed in 7.3.1.

7.3.1 Remove the outer layer of yarn from the package. Avoid any damaged areas in selecting segments for testing. Carefully unwind yarn from the package with as low as tension as possible to avoid stretching. As test specimens, cut approximately 125 mm (5 in.) long segments of yarn from each package, taking them at intervals of at least 1 m (1 yd). Three of the six specimens are used as spare to allow for unacceptable breaks, such as caused by slippage or breaking in the clamps.