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Standard Specification for Tensile Testing Machines for Textiles[1]

This standard is issued under the fixed designation D76/D76M; 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 specification covers the operating characteristics of three types of tensile testing machines used for the determination of the force-elongation properties of textile materials. These types of tensile testing machines are:

1.1.1 Constant-rate-of-extension, CRE.

1.1.2 Constant-rate-of-traverse, CRT.

1.1.3 Constant-rate-of-loading (force), CRL.

1.2 Specifications for tensile testing machines to measure other tensile-related properties of textile materials not covered by this standard are given in the ASTM standards using those machines.

~~1.3The values stated in SI units are to be regarded as standard; the values in inch-pound units are provided as information only and are not exact equivalents.~~

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 The following safety hazards caveat pertains only to the test methods described in this specification: *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:*[2]

D123 Terminology Relating to Textiles

D2256 Test Method for Tensile Properties of Yarns by the Single-Strand Method

D4849 Terminology Related to Yarns and Fibers

E4 Practices for Force Verification of Testing Machines

E74 Practice of Calibration of Force-Measuring Instruments for Verifying the Force Indication of Testing Machines

3. Terminology

~~3.1*Definitions:*~~

~~3.1.1*bench marks*, *n*—marks placed on a specimen to define gage length, that is, the portion of the specimen that will be evaluated in a specific test.~~

~~3.1.2*calibrate*, *v*—to determine and record the relationship between a set of standard units of measure and the output of an instrument or test procedure.~~

~~3.1.2.1*Discussion*—This term is also commonly used to describe the checking of previously marked instruments, an operation more properly described as a description of verification.~~

~~3.1.3*capacity*, *n—for tensile testing machines*, the maximum force for which the machine is designed.~~

~~3.1.3.1*Discussion*—Capacity is the maximum force the tester-frame and the drive system can exercise on the specimen without inadmissible deformations of the tester-frame, etc. Within its capacity, there are available load-cells with different full-scale-ranges which may be chosen to select an appropriate full-scale-range for a special test.~~

~~3.1.4*clamp*, *n*—that part of a testing machine used to grip the specimen by means of suitable jaws.~~

~~3.1.5*constant-rate-of-extension (CRE) type tensile testing machine (CRE)*, *n—in tensile testing*, an apparatus in which the~~

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[1] This specification is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.58 ~~on Yarn Test Methods, General. Current edition approved April 1, 2005. Published June 2005. Originally approved in 1920. Last previous edition approved in 1999 as D76–99. DOI: 10.1520/D0076-99R05.~~on Yarns and Fibers.

Current edition approved Dec. 1, 2011. Published December 2011. Originally approved in 1920 . Last previous edition approved in 2005 as D76 – 99(2005). DOI: 10.1520/D0076_D0076M-11.

[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.

pulling clamp moves at a uniform rate, and the force-measuring mechanism moves a negligible distance with increasing force, less than 0.13 mm (0.005 in.).

3.1.6*constant-rate-of-load tensile testing machine (CRL)*, *n—in tensile testing*, an apparatus in which the rate of increase of the force is uniform with time after the first 3 s and the specimen is free to elongate, this elongation being dependent on the extension characteristics of the specimen at any applied force.

3.1.7*constant-rate-of-traverse tensile testing machine (CRT)*, *n—in tensile testing*, an apparatus in which the pulling clamp moves at a uniform rate and the force is applied through the other clamp, which moves appreciably to actuate a force-measuring mechanism, producing a rate of increase of force or extension that is usually not constant and is dependent on the extension characteristics of the specimen.

3.1.8*effective carriage mass*, *n— in CRL-type tensile testing machine*, the force actually applied to a specimen by the mass of the carriage, plus any added weight.

3.1.9*effective gage length*, *n— in tensile testing*, the estimated length of the specimen subjected to a strain equal to that observed for the true gage length.

3.1.9.1*Discussion*—The effective gage length can be calculated using the following equation:

(1) $GE=GN \times ENET$

where:

G_E = effective gage length,
G_N = nominal gage length,
E_N = percent elongation based on nominal gage length, and
E_T = percent elongation based on true gage length.

3.1.10*grip*, *v—in tensile testing*, to hold, grasp, or secure, for example, to grip the specimen by the jaws of the clamps.

3.1.11*jaw face*, *n—in tensile testing machines*, the surface of a jaw which in the absence of a liner contacts the specimen.

3.1.12*jaw liner*, *n—in tensile testing machines*, any material placed between the jaw face and the specimen to improve the holding power of the jaws.

3.1.13*jaws*, *n—in tensile testing machines*, the elements of a clamp which grip the specimen.

3.1.14*least count*, *n— in tensile testing machines*, the smallest change in the indicated property that can customarily be determined (*see also sensitivity*).

3.1.14.1*Discussion*—In tensile testing machines with close graduations for force or elongation indications, the least count may be the value of a graduation interval; with open graduations, or with magnifiers for reading, the least count may be an estimated fraction (rarely as fine as 0.1) of a graduation interval; and with verniers, the least count is ordinarily the difference between the scale and vernier graduations measured in terms of scale units. If the indicating mechanism includes a stepped detent, the detent action may determine the least count. (See also *sensitivity, in mechanical systems.*)

3.1.15*nominal gage length*, *n— in tensile testing*, (*1*) the length of a specimen under specified pretension measured from nip-to-nip of the jaws of the holding clamps in their starting position at the beginning of the test, and including any portion of the specimen in contact with bollard or snubbing surfaces.

(*2*) the length of a specimen under specific pretension between frets, in instruments where the specimen is not held by clamps, for example, in a vibroscope.

(*3*) the length of a specimen measured between the points of attachment to the tabs while under specified pretension.

3.1.15.1*Discussion*—The calculated percentage of elongation based on the nominal gage length may be in error due to extension of that part of the specimen which lies between the jaws of the clamps.

3.1.16*response time*, *n— in tensile testing machines*, the time required by the indicating or recording device to reflect an instantaneous change in force, usually 0 to 90% of full scale.

3.1.17*sensitivity*, *n—*

3.1 For terminology related to tensile testing, see Terminology D4849.

3.1.1 The following terms are relevant for this standard: bench marks, calibrate, capacity, clamp, constant-rate-of extension type tensile testing machine (CRE), constant-rate-of-load tensile testing machine (CRL), constant-rate-of-traverse tensile testing machine (CRT), effective carriage mass, effective gauge length, grip, jaw face, jaw liner, jaws, least count, nominal gauge length, response time, sensitivity, *in electronic systems*, sensitivity, stress, tensile testing machine, test skein, time-to-break, true gauge length.

3.1.2 For all other terminology related to textiles, see Terminology D123.

4. Performance Requirements

4.1 Individual ASTM methods for tensile testing of textile materials that prescribe apparatus which conforms to this specification shall also include such other detailed specifications as may be necessary to describe the testing machine and its operation completely.

4.1.1 This specification shall not be construed as being intended to preclude the evolution of improved methods of testing or testing apparatus, which is recognized as being vital in an advancing technology.

4.2 Comparison of results from tensile testing machines operating on different principles is not recommended. When these machines are used for comparison testing however, constant time-to-break at 20 ± 3 s is the established way of producing data, but even then the data may differ significantly.

4.2.1 Comparison of test data from machines of the same type, especially two or more CRT-type or two or more CRL-type machines, requires consideration of the effect of individual machine characteristics; for example, inertia effects, capacity, sensitivity, type of loadcell, etc., which may cause significant differences in results even though uniform procedures are employed. Data from different CRE-type testing machines, however, should not be significantly different.

4.2.2 In any case, all types of tensile testing machines must satisfy the accuracy requirements as given in Section 7.

4.3 While changes in humidity affect the tensile properties of many textile materials, changes in humidity normally do not affect the testing machines themselves.

4.4 When machines are moved to different locations, their calibration shall be verified to make sure that they still meet the specified tolerances.

4.5 When each of the sub-systems (force, extension, clamping) has been individually calibrated, verified, or checked, it is recommended that the total system be verified using a standard material appropriate for the type testing to be carried out.[3] This testing of the total system is the established way of ensuring that the clamping system is operating properly.

5. Apparatus

5.1 *Tensile Testing Machines*—Tensile testing machines for textile materials are classified according to their operating principle as follows:

Type	Principle of Operation
CRE	Constant-rate-of-extension
CRT	Constant-rate-of-traverse (pendulum type)
CRL	Constant-rate-of-load (inclined plane type)

5.1.1 *CRE-Type*—A testing machine in which the pulling clamp moves at a uniform rate, and when loaded at the maximum allowable force the force-measuring mechanism (load cell) moves a negligible distance of less than 0.13 mm [0.005 in.].

5.1.2 *CRT-Type*—A testing machine in which the pulling clamp moves at a uniform rate and the force is applied through the other clamp, which moves appreciably to actuate a force-measuring mechanism, producing a rate of increase of force or extension which is usually not constant and is dependent on the extension characteristics of the specimen.

5.1.3 *CRL-Type*—A testing machine in which the rate of increase of the force is uniform with time after the first 3 s and the specimen is free to elongate, this elongation being dependent upon the extension characteristics of the specimen at any applied force.

5.1.4 *Multiple-Purpose Type*—Machines capable of being operated as both a CRE-type and a CRL-type may be used.

5.2 *Measuring Devices*—Machines shall be equipped with a suitable device for measuring the force and, when needed, a device to measure extension. Preferably, the data must be electronically stored using a data-acquisition system, or at least the curve shall be recorded graphically, or the force and extension data may be indicated on appropriate scales or displays.

5.2.1 Most testing machines record only force-extension data. When the capacity of a testing machine is adjusted to fit the predetermined linear density or cross-sectional area of the specimen, instead of force the stress will be recorded. When the machine is adjusted to record extension in terms of unit specimen length, the chart can be read directly in percent elongation or strain. When these conditions do not exist, the force-extension curve must be converted to obtain stress-strain characteristics.

5.2.2 The force-indicating and force-recording devices shall be in conformance with the requirements of this specification as to accuracy, sensitivity, and response time, and shall permit calibration or verification by appropriate methods described or referenced herein.

5.3 *Clamping or Holding Devices*—Specimen clamping or holding devices shall be prescribed in the individual test methods in sufficient detail for all users to employ the same or comparable devices.

5.3.1 The prescribed specimen clamping or holding devices shall be designed to ensure that the pulling axis of the testing machine and the central axis of a properly mounted specimen coincide.

5.3.2 The clamping or holding device may be designed for manual or automatic mounting of specimens.

5.3.3 The required clamping force can be obtained with the clamping or holding devices by any suitable mechanism; for example, screw, cam action, pneumatic, or toggle.

5.3.4 Clamping surfaces in contact with a test specimen shall be of any suitable material and configuration which provides the required restraint, preclude slippage, and minimize specimen failure in the clamped areas. Clamp liners may be used, provided the above conditions are met.

5.3.5 When the flat-faced type clamp proves unsatisfactory because of slippage or excessive breakage in the clamp, snubbing type devices (capstan, drum, split-drum, etc.) may be used.

5.4 *Calibrating Devices*—Calibrating weights or other calibrating devices conforming to Practice E74 are required for verification of calibration. Calipers, a steel rule that can be read to 0.25 mm [0.01 in.], or a suitable cathetometer, and a stop watch are required for verification of recorded elongation, and crosshead and chart speed.

[3] Two styles of standard break fabrics obtained from Testfabrics, Inc., P.O. Drawer O, Middlesex, NJ 08846 have been found satisfactory for this purpose. See also A1.3 of this specification.

6. Machine Operational Design

6.1 The use of motor-driven machines is preferred over manually driven machines because of improved control of testing.

6.2 Testing machines of the CRT-type shall not be used for measuring forces below fifty times their resolution. For example, if the minimum force that can be read is 0.5 cN [0.5 gf], the testing machine may not be used for materials which test at 25.0 cN [25 gf] or less.

6.2.1 Choose the full scale force such that the expected maximum force falls within:

6.2.1.1 10 to 90% full scale for the CRE-type testing machines,

6.2.1.2 15 to 85% full scale for the CRT-type testing machines,

6.2.1.3 15 to 85% full scale for the CRL-type testing machines,

6.3 Machines shall operate at a uniform rate of pulling clamp (CRE), and (CRT), or loading (CRL) as specified in 6.4, 6.5, and 6.6.

6.3.1 Machines may be built for operating at various rates of operation or at a single constant rate.

6.3.2 When machines are intended for operation at a specified or required average time to break as specified in individual standards (for example, 20 s to break as in Test Method D2256 and Test Methods D1682) then their rate of operation must be adjustable. The adjustment may be continuous or in steps not exceeding 125:100. Machines with a continuously adjustable rate of operation shall be equipped with a device indicating the rate of operation.

6.3.3 The machine rate of operation shall be within the tolerances prescribed in the individual standards.

6.4 *CRE-Type*:

6.4.1 Machines shall be designed for operation at such uniform rates of pulling clamp as are specified in individual standards.

6.4.2 Using a data-acquisition system, the sampling rate should be set to approximately 500/(time-to-break). Using a graphical recording system, the force-measuring system, including the recording mechanism, shall have a full-scale pen response time less than 2 s in either direction. In addition, the response time for pen deflections of less than full scale shall be proportional to the fraction of full-scale time represented by those deflections within a tolerance of ±10 % of the nominal full-scale response time.

NOTE 1—The response time of the recording mechanism is the limiting factor affecting the choice of a rate for testing. The rate chosen shall give the maximum slope of the recorded curve which does not exceed one half of the slope of the maximum pen speed. See Fig. 1.

6.5 *CRT-Type*—Machines shall be designed for operation of the pulling clamp at a uniform rate as specified in individual standards.

6.6 *CRL-Type*—Machines shall be designed to apply forces at a uniform rate, or at a uniform rate of loading per unit of specimen linear density, as specified in individual standards.

6.7 Machines may be built for either manual or automatic mounting of the specimen into the clamp or holding devices.

7. Tolerance on Indicated Force, Recorded Elongation, Nominal Gauge Length, and Speed of Moving Clamp

7.1 On instruments where the capacity of the force measuring mechanism (load cell) is used for digital analysis without regard to the full scale force displayed on the recorder, the maximum allowable error in force indication shall be ±0.5 % of the reading for CRE-type machines and ±1.0 % for CRT- and CRL-type machines (see Section 8).

7.2 The maximum allowable error in recorded grip displacement shall be ±1% of the recorded values for CRE-type machines and ±2.5 mm [0.5 in.] for CRT- and CRL-type machines (see Section 9 for CRE-type machines and Section 10 for CRT- and CRL-type machines).

7.3 The maximum allowable variation in nominal gauge length on repeated return of the clamps to their starting position shall be less than 0.25 mm [0.01 in.].

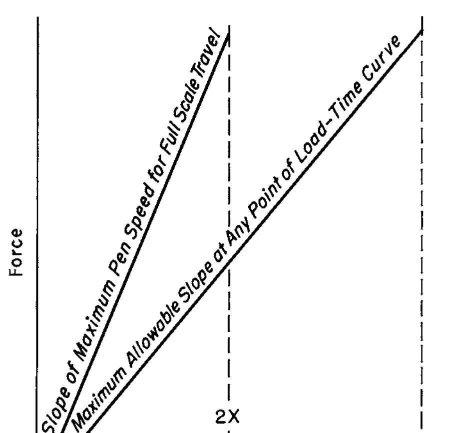

FIG. 1 Limitations on Response Speed of Recorder Pen