Designation: D 4848 – 98

Standard Terminology of Force, Deformation and Related Properties of Textiles[1]

This standard is issued under the fixed designation D 4848; 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 terminology standard is a compilation of definitions of technical terms related to force and deformation properties when evaluating a stress-strain curve of a textile. (See Figs. X1.1 and X1.2.) A chart showing the relationship of the basic terms is shown in Table 1. Terms that are generally understood or adequately defined in other readily available sources are not included.

1.2 For other terms associated with textiles, refer to Terminology D 123.

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[2]

3. Terminology

breaking elongation—See **elongation at break**.

breaking force, *n*—the maximum force applied to a material carried to rupture. (Compare **breaking point, breaking strength.** *Syn.* **force-at-break**)

DISCUSSION—Materials that are brittle usually rupture at the maximum force. Materials that are ductile usually experience a maximum force before rupturing.

breaking load—deprecated term. Use the preferred term **breaking force**.

breaking point, *n—on a force-elongation curve, or stress-strain curve*, the point corresponding with the breaking force or the breaking stress in a tensile test. (Compare **breaking force**.)

breaking strength, *n*—strength expressed in terms of breaking force. (See also **breaking force** and **strength**. *Syn.*, strength at break)

breaking tenacity, *n*—the tenacity at the breaking force. (See also **breaking force, tenacity**.)

breaking toughness, *n*—toughness up to the breaking force of a material.

TABLE 1 Relationship of Force and Deformation Terms

Term	Symbol	Mathematical Expression	Unit
Length	L		mm (in.)
Extension	ΔL		mm (in.)
Strain		ΔL/L	
Elongation		ΔL/L × 100	%
Linear density	D_1[A]		tex (den)
Cross-sectional area	A		mm^2($in.^2$)
Force	F		N (lbf)
Tension	T		N (lbf)
Strength	S		N (lbf)
Tenacity		F/D_1[A]	mN/tex (lbf/den)[B]
Stress		F/A	N/m^2(lbf/yd^2)[B]

[A] In computers, this may be given as "LD" instead of "D_1".
[B] For fibers, these inch-pound units are usually gf/den and gf/$in.^2$

DISCUSSION—Breaking toughness is represented by the area and the stress-strain curve from the origin to the breaking force per unit length, and, in textile strands, is expressed as work (joules) per unit of linear density of the material. In textile fabrics, the unit is joules per gram.

chord modulus, *n—in a stress-strain curve*, the ratio of the change in stress to the change in strain between two specified points on the curve.

compression, *n*—the act, process, or result of compacting, condensing, or concentrating.

compressive force, *n*—the perpendicular force applied to surface(s) of a material in compaction.

compression recovery, *n*—the degree to which a material returns to its original dimension(s) after removal of a compressive force.

compression resistance, *n*—the ability of a material to oppose deformation under a compressive force.

corresponding elongation—See **elongation at specified force**.

corresponding force—See **force-at-specified-elongation.**

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

DISCUSSION—Deformation may be immediate or delayed. Delayed deformation may be either recoverable or nonrecoverable.

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.**

DISCUSSION—Permanent deformation is usually expressed as a percentage of the original dimension.

[1] This terminology is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.58 on Yarn and Fiber Test Methods.

Current edition approved April 10, 1998. Published July 1998. Originally published as D 4848 – 88. Last previous edition D 4848 – 97.

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

delayed deformation, *n*—deformation which is time-dependload of a skein of yarn adjusted for the linear density of the yarn expressed in an indirect system.

DISCUSSION—Deformation may be recoverable or nonrecoverable following removal of the applied force.

elastic limit, *n*—*in mechanics*, the maximum stress which can be obtained in a material without causing permanent deformation of the material. (Compare *yield point*.)

DISCUSSION—Elastic limit is a property of a material whereas yield point is a specific point on a stress-strain curve.

elasticity, *n*—that property of a material by virtue of which it tends to recover its original size and shape immediately after removal of the force causing deformation.

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

DISCUSSION—Elongation may be measured at any specified force or at rupture.

elongation at break, *n*—the elongation corresponding to the breaking force. (Compare **elongation at rupture**. See also **elongation**.) Syn. **breaking elongation**.

elongation at the breaking load, *n*—deprecated term. Use the preferred term **elongation at break**.

elongation at specified force, (EASF), *n*—the elongation associated with a specified force on the force-extension curve. (Syn. **corresponding elongation**).

elongation at rupture, *n*—the elongation corresponding to the force-at-rupture. (Compare **elongation at break**.)

DISCUSSION—The elongation at rupture for a brittle material is usually equal to the elongation at break; but for ductile materials this elongation may be greater.

extensibility, *n*—that property by virtue of which a material can undergo extension or elongation following the application of sufficient force.

extension, *n*—the change in length of a material due to stretching. (Compare **elongation**.)

DISCUSSION—Extension may be measured at any specified force or at rupture and is expressed in units of length, for example, millimetres and inches.

extension-recovery cycle, *n*—*in tension testing*, the continuous extension of a specimen, with a momentary hold at a specified extension, followed by a controlled rate of return to zero extension.

failure, *n*—an arbitrary point beyond which a material ceases to be functionally capable of its intended use. (Compare **rupture**.)

DISCUSSION—A material may be considered to have failed without having ruptured.

force, *n*—a physical influence exerted by one body on another which produces acceleration of bodies that are free to move and deformation of bodies that are not free to move. (Compare **strength**.)

DISCUSSION—Force is properly expressed in newtons (N) or multiples and submultiples of newtons, for example kilonewtons (kN) and millinewtons (mN). Force is also expressed as grams-force (gf), kilograms-force (kgf), or pounds-force (lbf), but the use of these terms is deprecated.

force at break, *n*—See **breaking force**.

force at rupture, *n*—the force applied to a material immediately preceding rupture. (Compare **breaking force**. See also **rupture**.)

DISCUSSION—Materials that are brittle usually rupture at the maximum force. Materials that are ductile usually experience a maximum force before rupturing.

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

force-deformation curve, *n*—a graphical representation of the force and deformation relationship of a material under conditions of compression, shear, tension or torsion. (Compare **force-elongation curve, force-extension curve** and **stress-strain curve**.)

DISCUSSION—Force-deformation related curves include force-extension, force-compression, force-shear (displacement), force-torque and stress-strain curves. The shape of the force-extension curve of a material and the shape of the corresponding stress-strain curve are the same, only the units are different. Force is expressed in such units as newton, kilogram-force, pound force. In tension, shear or compression tests, deformation is expressed in such units of length as metre, millimetre or inches. In torsion tests, deformation is expressed in such units for plane angles as radians or degrees.

force-elongation curve, *n*—a graphical representation of the force and elongation relationship of a material under tension. (Compare **force-deformation curve, force-extension curve** and **stress-strain curve.)**

force-extension curve, *n*—a graphical representation of the force and extension relationship of a material under tension. (Compare **force-deformation curve, force-elongation curve** and **stress-strain curve**.)

immediate elastic recovery, *n*—recoverable deformation which is essentially independent of time, that is, occurring in (a time approaching) zero time and recoverable in (a time approaching) zero time after removal of the applied force. (Compare **delayed deformation** and **delayed elastic recovery**.)

initial modulus, *n*—*in a stress-strain curve*, the slope of the initial straight-line portion of the curve.

knot breaking force, *n*—*in tensile testing*, the breaking force of a strand having a specified knot configuration tied in the portion of the strand mounted between the clamps of a tensile testing machine. (Compare **knot breaking strength**. See also **breaking force**.)

knot breaking load, *n*—deprecated term. Use the preferred term, **knot breaking force**.

knot breaking strength, *n*—strength expressed in terms of knot breaking force. (See also **knot breaking force**.)

linear density, *n*—mass per unit length.

load—deprecated term. Use the preferred term, **force**.