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Standard Test Method for Determining the Tensile-Impact Resistance of Plastics¹

This standard is issued under the fixed designation D1822; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This test method covers the determination of the energy required to rupture standard tension-impact specimens of plastic materials. Rigid materials are suitable for testing by this method as well as specimens that are too flexible or thin to be tested in accordance with other impact test methods.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

NOTE 1—This test method and [ISO 8256](#) address the same subject matter, but differ in technical content.

1.3 *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.*

1.4 *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

- [D256](#) Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
- [D618](#) Practice for Conditioning Plastics for Testing
- [D638](#) Test Method for Tensile Properties of Plastics
- [D883](#) Terminology Relating to Plastics
- [D4000](#) Classification System for Specifying Plastic Materials
- [D5947](#) Test Methods for Physical Dimensions of Solid Plastics Specimens

¹ This test method is under the jurisdiction of ASTM Committee [D20](#) on Plastics and is the direct responsibility of Subcommittee [D20.10](#) on Mechanical Properties. Current edition approved Oct. 1, 2021. Published November 2021. Originally approved in 1961. Last previous edition approved in 2013 as D1822-13. DOI:10.1520/D1822-21.

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. DOI: 10.1520/D1822-06.

[D6988](#) Guide for Determination of Thickness of Plastic Film Test Specimens

[E177](#) Practice for Use of the Terms Precision and Bias in ASTM Test Methods

[E456](#) Terminology Relating to Quality and Statistics

[E691](#) Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 ISO Standards:

[ISO 8256](#) Plastics—Determination of Tensile-Impact Strength

3. Terminology

3.1 *Definitions*—Terms used in this standard are defined in accordance with Terminology [D883](#), unless otherwise specified. For terms relating to precision and bias and associated issues, the terms used in this standard are defined in accordance with Terminology [E456](#).

4. Summary of Test Method

4.1 The energy utilized in this test method is delivered by a single swing of a calibrated pendulum of a standardized tension-impact machine. The energy to fracture a specimen, by shock in tension, is determined by the kinetic energy extracted from the pendulum of the impact machine in the process of breaking the specimen. One end of the specimen is mounted in the pendulum. The other end of the specimen is gripped by a crosshead which travels with the pendulum until the instant of impact (and instant of maximum pendulum kinetic energy), when the crosshead is arrested.

5. Significance and Use

5.1 Tensile-impact energy is the energy required to break a standard tension-impact specimen in tension by a single swing of a standard calibrated pendulum under a set of standard conditions (see [Note 2](#)). To compensate for the minor differences in cross-sectional area of the specimens, the energy to break is normalized to units of kilojoules per square metre (or foot-pounds-force per square inch) of minimum cross-sectional area. An alternative approach to normalizing the impact energy that compensates for these minor differences and still retains the test unit as joules (foot-pounds) is shown in [Section 10](#). For a perfectly elastic material, the impact energy is usually reported per unit volume of material undergoing deformation. However, since much of the energy to break the plastic

*A Summary of Changes section appears at the end of this standard

materials for which this test method is written is dissipated in drawing of only a portion of the test region, such normalization on a volume basis is not feasible. In order to observe the effect of elongation or rate of extension, or both, upon the result, the test method permits two specimen geometries. Results obtained with different capacity machines generally are not comparable.

5.1.1 With the Type S (short) specimen the extension is comparatively low, while with the Type L (long) specimen the extension is comparatively high. In general, the Type S specimen (with its greater occurrence of brittle fracture) gives greater reproducibility, but less differentiation among materials.

NOTE 2—Friction losses are largely eliminated by careful design and proper operation of the testing machine.

5.2 Scatter of data is sometimes attributed to different failure mechanisms within a group of specimens. Some materials exhibit a transition between different failure mechanisms. If so, the elongation will be critically dependent on the rate of extension encountered in the test. The impact energy values for a group of such specimens will have an abnormally large dispersion.

5.2.1 Some materials retract at failure with insignificant permanent set. With such materials, determining the type of failure, ductile or brittle, by examining the broken pieces is difficult, if not impossible. It is helpful to sort a set of specimens into two groups by observing the broken pieces to ascertain whether or not there was necking during the test. Qualitatively, the strain rates encountered here are intermediate between the high rate of the Izod test of Test Methods D256 and the low rate of usual tension testing in accordance with Test Method D638.

5.3 The energy for fracture is a function of the force times the distance through which the force operates. Therefore, given the same specimen geometry, it is possible that one material will produce tensile-impact energies for fracture due to a large force associated with a small elongation, and another material will produce the same energy for fracture result due to a small force associated with a large elongation. It shall not be assumed that this test method will correlate with other tests or end uses unless such a correlation has been established by experiment.

5.4 Comparisons among specimens from different sources are to be made with confidence only to the extent that specimen preparation, for example, molding history, has been precisely duplicated. Comparisons between molded and machined specimens must not be made without first establishing quantitatively the differences inherent between the two methods of preparation.

5.5 Only results from specimens of nominally equal thickness and tab width shall be compared unless it has been shown that the tensile-impact energy normalized to kilojoules per square metre (or foot-pounds-force per square inch) of cross-sectional area is independent of the thickness over the range of thicknesses under consideration.

5.6 The bounce of the crosshead supplies part of the energy to fracture test specimen (see Appendix X1).

5.7 For many materials, there are specifications that require the use of this test method, but with some procedural modifications that take precedence when adhering to the specification. Therefore, it is advisable to refer to that material specification before using this test method. Table 1 of Classification System D4000 lists the ASTM materials standards that currently exist.

6. Apparatus

6.1 The machine shall be of the pendulum type shown schematically in Fig. 1 and Fig. 2. The base and suspending frame shall be of sufficiently rigid and massive construction to prevent or minimize energy losses to or through the base and frame. The position of the pendulum holding and releasing mechanism shall be such that the vertical height of fall of the striker shall be 610 ± 2 mm (24.0 ± 0.1 in.). This will produce a velocity of the striker at the moment of impact of approximately 3.5 m (11.5 ft/second). The mechanism shall be so constructed and operated that it will release the pendulum without imparting additional acceleration or vibration.

6.2 The pendulum shall be constructed of a single- or multiple-membered arm holding the head, in which the greatest mass is concentrated. A rigid pendulum is essential to maintain the proper clearances and geometric relationships between related parts and to minimize energy losses, which always are included in the measured impact energy value. It is imperative that the center of percussion of the pendulum system and the point of impact are within ± 2.54 mm (± 0.100 in.) of each other and that the point of contact occurs in the neutral (free hanging) position of the pendulum within 2.54 mm (0.100 in.), both with and without the crosshead in place.

NOTE 3—The distance from the axis of support to the center of percussion is determined experimentally from the period of small amplitude oscillations of the pendulum by means of the following equation:

$$L = (g/4\pi^2) p^2 \quad (1)$$

where:

- L = distance from the axis of support to the center of percussion, mm (ft),
- g = local gravitational acceleration (known to an accuracy of one part in one thousand), in mm/s² (ft/s²),
- π = 3.14159, and
- p = period, s, of a single complete swing (to and fro) determined from at least 50 consecutive and uninterrupted swings (known to one part in two thousand). The angle of swing shall be less than 0.09 radians (5°) each side of the center.

6.3 The positions of the rigid pendulum and crosshead clamps on the specimen are shown in Fig. 2. The crosshead is designed to be rigid and light in weight. The crosshead shall be supported by the pendulum so that the test region of the specimen is not under stress until the moment of impact, when the specimen shall be subjected to a pure tensile force. The clamps shall have file-like serrated jaws to prevent the specimen from slipping. The edge of the serrated jaws shall have a 0.40-mm ($1/64$ -in.) radius to break the edge of the first serrations. The size of serrations will vary and shall be selected according to experience with hard and tough materials, and with the thickness of the specimen.