INTERNATIONAL

Designation: D256 – 23$^{\varepsilon 1}$

Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics[1]

This standard is issued under the fixed designation D256; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

ε[1] NOTE—Summary of Changes section was editorially added in April 2023.

1. Scope*

1.1 These test methods cover the determination of the resistance of plastics to "standardized" (see Note 1) pendulum-type hammers, mounted in "standardized" machines, in breaking standard specimens with one pendulum swing (see Note 2). The standard tests for these test methods require specimens made with a milled notch (see Note 3). In Test Methods A, C, and D, the notch produces a stress concentration that increases the probability of a brittle, rather than a ductile, fracture. In Test Method E, the impact resistance is obtained by reversing the notched specimen 180° in the clamping vise. The results of all test methods are reported in terms of energy absorbed per unit of specimen width or per unit of cross-sectional area under the notch. (See Note 4.)

NOTE 1—The machines with their pendulum-type hammers have been "standardized" in that they must comply with certain requirements, including a fixed height of hammer fall that results in a substantially fixed velocity of the hammer at the moment of impact. However, hammers of different initial energies (produced by varying their effective weights) are recommended for use with specimens of different impact resistance. Moreover, manufacturers of the equipment are permitted to use different lengths and constructions of pendulums with possible differences in pendulum rigidities resulting. (See Section 5.) Be aware that other differences in machine design may exist. The specimens are "standardized" in that they are required to have one fixed length, one fixed depth, and one particular design of milled notch. The width of the specimens is permitted to vary between limits.

NOTE 2—Results generated using pendulums that utilize a load cell to record the impact force and thus impact energy, may not be equivalent to results that are generated using manually or digitally encoded testers that measure the energy remaining in the pendulum after impact.

NOTE 3—The notch in the Izod specimen serves to concentrate the stress, minimize plastic deformation, and direct the fracture to the part of the specimen behind the notch. Scatter in energy-to-break is thus reduced. However, because of differences in the elastic and viscoelastic properties of plastics, response to a given notch varies among materials. A measure of a plastic's "notch sensitivity" may be obtained with Test Method D by comparing the energies to break specimens having different radii at the base of the notch.

NOTE 4—Caution must be exercised in interpreting the results of these standard test methods. The following testing parameters may affect test results significantly:

Method of fabrication, including but not limited to processing technology, molding conditions, mold design, and thermal treatments;
Method of notching;
Speed of notching tool;
Design of notching apparatus;
Quality of the notch;
Time between notching and test;
Test specimen thickness,
Test specimen width under notch, and
Environmental conditioning.

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

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.*

NOTE 5—These test methods resemble ISO 180:1993 in regard to title only. The contents are significantly different.

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]

D618 Practice for Conditioning Plastics for Testing

[1] These test methods are under the jurisdiction of ASTM Committee D20 on Plastics and are the direct responsibility of Subcommittee D20.10 on Mechanical Properties.

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[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.

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

D883 Terminology Relating to Plastics
D3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials
D4066 Classification System for Nylon Injection and Extrusion Materials (PA)
D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens
D6110 Test Method for Determining the Charpy Impact Resistance of Notched Specimens of Plastics
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *ISO Standard:*
ISO 180:1993 Plastics—Determination of Izod Impact Strength of Rigid Materials[3]

3. Terminology

3.1 *Definitions*—For definitions related to plastics see Terminology D883.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cantilever*—a projecting beam clamped at only one end.

3.2.2 *notch sensitivity*—a measure of the variation of impact energy as a function of notch radius.

4. Types of Tests

4.1 Four similar methods are presented in these test methods. (See Note 6.) All test methods use the same testing machine and specimen dimensions. There is no known means for correlating the results from the different test methods.

NOTE 6—Previous versions of this test method contained Test Method B for Charpy. It has been removed from this test method and has been published as D6110.

4.1.1 In Test Method A, the specimen is held as a vertical cantilever beam and is broken by a single swing of the pendulum. The line of initial contact is at a fixed distance from the specimen clamp and from the centerline of the notch and on the same face as the notch.

4.1.2 Test Method C is similar to Test Method A, except for the addition of a procedure for determining the energy expended in tossing a portion of the specimen. The value reported is called the "estimated net Izod impact resistance." Test Method C is preferred over Test Method A for materials that have an Izod impact resistance of less than 27 J/m (0.5 ft·lbf/in.) under notch. (See Appendix X4 for optional units.) The differences between Test Methods A and C become unimportant for materials that have an Izod impact resistance higher than this value.

4.1.3 Test Method D provides a measure of the notch sensitivity of a material. The stress-concentration at the notch increases with decreasing notch radius.

4.1.3.1 For a given system, greater stress concentration results in higher localized rates-of-strain. Since the effect of strain-rate on energy-to-break varies among materials, a measure of this effect may be obtained by testing specimens with different notch radii. In the Izod-type test it has been demonstrated that the function, energy-to-break versus notch radius, is reasonably linear from a radius of 0.03 to 2.5 mm (0.001 to 0.100 in.), provided that all specimens have the same type of break. (See 5.8 and 22.1.)

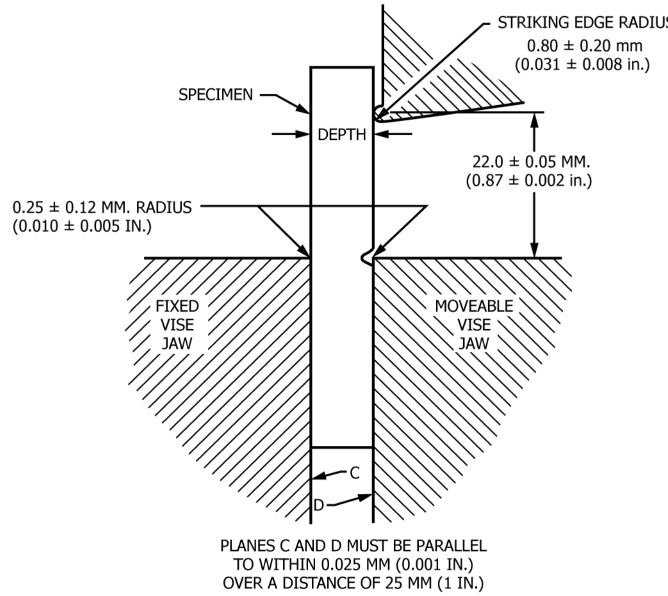

FIG. 1 Relationship of Vise, Specimen, and Striking Edge to Each Other for Izod Test Methods A and C

4.1.3.2 For the purpose of this test, the slope, *b* (see 22.1), of the line between radii of 0.25 and 1.0 mm (0.010 and 0.040 in.) is used, unless tests with the 1.0-mm radius give "non-break" results. In that case, 0.25 and 0.50-mm (0.010 and 0.020-in.) radii may be used. The effect of notch radius on the impact energy to break a specimen under the conditions of this test is measured by the value *b*. Materials with low values of *b*, whether high or low energy-to-break with the standard notch, are relatively insensitive to differences in notch radius; while the energy-to-break materials with high values of *b* is highly dependent on notch radius. The parameter *b* cannot be used in design calculations but may serve as a guide to the designer and in selection of materials.

4.2 Test Method E is similar to Test Method A, except that the specimen is reversed in the vise of the machine 180° to the usual striking position, such that the striker of the apparatus impacts the specimen on the face opposite the notch. (See Fig. 1, Fig. 2.) Test Method E is used to give an indication of the unnotched impact resistance of plastics; however, results obtained by the reversed notch method may not always agree with those obtained on a completely unnotched specimen. (See 28.1.)[4,5]

5. Significance and Use

5.1 Before proceeding with these test methods, reference should be made to the specification of the material being tested.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Supporting data giving results of the interlaboratory tests are available from ASTM Headquarters. Request RR:D20-1021.

[5] Supporting data giving results of the interlaboratory tests are available from ASTM Headquarters. Request RR:D20-1026.

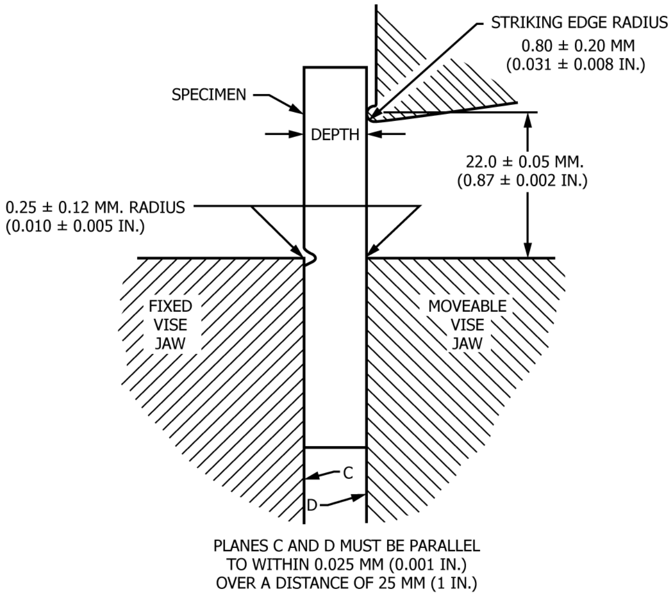

FIG. 2 Relationship of Vise, Specimen, and Striking Edge to Each Other for Test Method E

Any test specimen preparation, conditioning, dimensions, and testing parameters covered in the materials specification shall take precedence over those mentioned in these test methods. If there is no material specification, then the default conditions apply.

5.2 The pendulum impact test indicates the energy to break standard test specimens of specified size under stipulated parameters of specimen mounting, notching, and pendulum velocity-at-impact.

5.3 The energy lost by the pendulum during the breakage of the specimen is the sum of the following:

5.3.1 Energy to initiate fracture of the specimen;

5.3.2 Energy to propagate the fracture across the specimen;

5.3.3 Energy to throw the free end (or ends) of the broken specimen ("toss correction");

5.3.4 Energy to bend the specimen;

5.3.5 Energy to produce vibration in the pendulum arm;

5.3.6 Energy to produce vibration or horizontal movement of the machine frame or base;

5.3.7 Energy to overcome friction in the pendulum bearing and in the indicating mechanism, and to overcome windage (pendulum air drag);

5.3.8 Energy to indent or deform plastically the specimen at the line of impact; and

5.3.9 Energy to overcome the friction caused by the rubbing of the striker (or other part of the pendulum) over the face of the bent specimen.

5.4 For relatively brittle materials, for which fracture propagation energy is small in comparison with the fracture initiation energy, the indicated impact energy absorbed is, for all practical purposes, the sum of factors 5.3.1 and 5.3.3. The toss correction (see 5.3.3) may represent a very large fraction of the total energy absorbed when testing relatively dense and brittle materials. Test Method C shall be used for materials that have an Izod impact resistance of less than 27 J/m (0.5 ft·lbf/in.). (See Appendix X4 for optional units.) The toss correction obtained in Test Method C is only an approximation of the toss error, since the rotational and rectilinear velocities may not be the same during the re-toss of the specimen as for the original toss, and because stored stresses in the specimen may have been released as kinetic energy during the specimen fracture.

5.5 For tough, ductile, fiber filled, or cloth-laminated materials, the fracture propagation energy (see 5.3.2) may be large compared to the fracture initiation energy (see 5.3.1). When testing these materials, factors (see 5.3.2, 5.3.5, and 5.3.9) can become quite significant, even when the specimen is accurately machined and positioned and the machine is in good condition with adequate capacity. (See Note 7.) Bending (see 5.3.4) and indentation losses (see 5.3.8) may be appreciable when testing soft materials.

NOTE 7—Although the frame and base of the machine should be sufficiently rigid and massive to handle the energies of tough specimens without motion or excessive vibration, the design must ensure that the center of percussion be at the center of strike. Locating the striker precisely at the center of percussion reduces vibration of the pendulum arm when used with brittle specimens. However, some losses due to pendulum arm vibration, the amount varying with the design of the pendulum, will occur with tough specimens, even when the striker is properly positioned.

5.6 In a well-designed machine of sufficient rigidity and mass, the losses due to factors 5.3.6 and 5.3.7 should be very small. Vibrational losses (see 5.3.6) can be quite large when wide specimens of tough materials are tested in machines of insufficient mass, not securely fastened to a heavy base.

5.7 With some materials, a critical width of specimen may be found below which specimens will appear ductile, as evidenced by considerable drawing or necking down in the region behind the notch and by a relatively high-energy absorption, and above which they will appear brittle as evidenced by little or no drawing down or necking and by a relatively low-energy absorption. Since these methods permit a variation in the width of the specimens, and since the width dictates, for many materials, whether a brittle, low-energy break or a ductile, high energy break will occur, it is necessary that the width be stated in the specification covering that material and that the width be reported along with the impact resistance. In view of the preceding, one should not make comparisons between data from specimens having widths that differ by more than a few mils.

5.8 The type of failure for each specimen shall be recorded as one of the four categories listed as follows:

C =	*Complete Break*—A break where the specimen separates into two or more pieces.
H =	*Hinge Break*—An incomplete break, such that one part of the specimen cannot support itself above the horizontal when the other part is held vertically (less than 90° included angle).
P =	*Partial Break*—An incomplete break that does not meet the definition for a hinge break but has fractured at least 90 % of the distance between the vertex of the notch and the opposite side.
NB =	*Non-Break*—An incomplete break where the fracture extends less than 90 % of the distance between the vertex of the notch and the opposite side.