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AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
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Standard Test Method for Determining the Izod Impact Strength of Plastics[1]

This standard is issued under the fixed designation D 5941; 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 a procedure for determining the Izod impact strength of plastics under defined conditions. A number of different types of specimen and test configurations are defined. Different test parameters are specified according to the type of material, type of test specimen, and type of notch.

1.2 The procedure is used for investigating the behavior of specified types of specimens under the impact conditions defined and for estimating the brittleness or toughness of specimens within the limitations inherent in the test conditions.

1.3 The procedure is suitable for use with the following range of materials:

1.3.1 Rigid thermoplastics molding and extrusion materials, including filled and reinforced compounds in addition to unfilled types; rigid thermoplastics sheet;

1.3.2 Rigid thermosetting molding materials, including filled and reinforced compounds; rigid thermosetting sheet, including laminates;

1.3.3 Fiber-reinforced thermoset and thermoplastics composites incorporating unidirectional or nonunidirectional reinforcements such as mat, woven fabrics, woven rovings, chopped strands, combination and hybrid reinforcements, rovings and milled fibers; sheet made from pre-impregnated materials (prepregs).

1.3.4 Thermotropic liquid-crystal polymers.

1.4 The procedure is not normally suitable for use with rigid cellular materials and sandwich structures containing cellular material. Also, notched specimens are not normally used for long-fiber-reinforced composites or for thermotropic liquid-crystal polymers.

1.5 The procedure is adapted to the use of specimens that may be either molded to the chosen dimensions, machined from the central portion of a standard multipurpose test specimen (see ISO 3167 (Specification D 5936)), or machined from finished and semifinished products such as moldings, laminates, and extruded or cast sheet.

1.6 The procedure specifies preferred dimensions for the test specimen. Tests that are conducted on specimens of different dimensions and notches, or on specimens that are prepared under different conditions, may produce results that are not comparable. Other factors, such as the energy capacity of the pendulum, its impact velocity, and the conditioning of the specimens, can also influence the results. Consequently, when comparative data are required, these factors must be controlled and recorded carefully.

1.7 The procedure should not be used as a source of data for design calculations of components. Information on the typical behavior of a material can be obtained, however, by testing at different temperatures, by varying the notch radius or the thickness, or both, and by testing specimens prepared under different conditions.

1.8 This test method is identical to ISO 180. This test method is comparable to Test Method D 256, but neither test method should be substituted for the other. The two test methods may differ with respect to test specimen dimensions, test specimen conditioning, test equipment, testing conditions, etc. The two test methods may not give the same results.

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

1.10 *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 256 Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics[2]

D 5936 Specification for Multipurpose Test Specimens Used for Testing Plastics[3]

D 5939 Practice for Preparing Multipurpose Test Specimens and Bars of Thermoplastics by Injection Moulding[3]

D 5940 Practice for Preparing Small Plate Test Specimens of Thermoplastics by Injection Moulding[3]

2.2 *ISO Standards:*[4]

ISO 180 Determination of Izod Impact Strength

ISO 291:1977 Plastics—Standard Atmospheres for Conditioning and Testing

ISO 293:1986 Plastics—Compression Moulding Test Specimens of Thermoplastic Materials

[1] This test method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.61 on USA Technical Advisory Group for ISO/TC 61 on Plastics.

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[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 08.03.

[4] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

ISO 294 Plastics—Injection Moulding of Test Specimens of Thermoplastic Materials
ISO 295:1991 Plastics—Compression Moulding of Test Specimens of Thermosetting Materials
ISO 1268:1974 Plastics—Preparation of Glass Fibre Reinforced, Resin Bonded, Low-Pressure Laminated Plates or Panels for Test Purposes
ISO 2557-1:1989 Plastics—Amorphous Thermoplastics—Preparation of Test Specimens with a Specified Maximum Reversion—Part 1: Bars
ISO 2557-2:1986 Plastics—Amorphous Thermoplastics—Preparation of Test Specimens with a Specified Reversion—Part 2: Plates
ISO 2602:1980 Statistical Interpretation of Test Results—Estimation of the Mean—Confidence Interval
ISO 2818 Plastics—Preparation of Test Specimens by Machining
ISO 3167 Plastics—Multipurpose Test Specimens

3. Terminology

3.1 *Definitions*—For the purposes of this test method, the following definitions apply:

3.1.1 *Izod impact strength of notched specimens, a_{iN}*—impact energy absorbed in breaking a notched specimen, referred to the original cross-sectional area of the specimen at the notch, with the pendulum striking the face containing the notch.

3.1.1.1 *Discussion*—It is expressed in kilojoules per square metre.

3.1.2 *Izod impact strength of reversed-notch specimens, a_{iR}*—impact energy absorbed in breaking a reversed-notch specimen, referred to the original cross-sectional area of the specimen at the notch, with the pendulum striking the face opposite the notch.

3.1.2.1 *Discussion*—It is expressed in kilojoules per square metre.

3.1.3 *Izod impact strength of unnotched specimens, a_{iU}*—impact energy absorbed in breaking an unnotched specimen, referred to the original cross-sectional area of the specimen.

3.1.3.1 *Discussion*—It is expressed in kilojoules per square metre.

3.1.4 *normal impact (n) (for laminar reinforced plastics)*—the direction of blow normal to the laminate plane of sheet materials (see Fig. 1, edgewise normal).

3.1.4.1 *Discussion*—This kind of impact is not used with the Izod test, but is indicated only for clarifying the designation system.

3.1.5 *parallel impact (p) (for laminar reinforced plastics)*—the direction of blow parallel to the laminate plane of sheet materials. The blow direction in the Izod test is edgewise (e) (see Fig. 1, edgewise parallel).

4. Principle

4.1 The test specimen, supported as a vertical cantilever beam, is broken by a single swing of a pendulum, with the line of impact at a fixed distance from the specimen clamp and, in the case of notched specimens, from the centerline of the notch (see Fig. 2).

5.

6. Apparatus

6.1 *Testing Machine*:

6.1.1 The testing machine shall be of the pendulum type and shall be of rigid construction. It shall be capable of measuring the impact energy, *W*, absorbed in breaking a test specimen. The value of this energy is defined as the difference between the initial energy, *E*, of the pendulum and the energy remaining in the pendulum after breaking the test specimen. The energy shall be corrected for losses due to friction and air resistance (see Table 1 and 8.4).

6.1.2 The machine shall have the characteristics indicated in Table 1.

6.1.2.1 In order to apply the test to the full range of materials specified in 1.3, it is necessary to use a set of interchangeable pendulums (see 8.3). It is not advisable to compare the results obtained with different pendulums. The frictional losses shall be checked periodically.

NOTE 1—Pendulums with energies other than those given in Table 1 are permitted, but it is planned to withdraw this option at the next revision.

6.1.3 The machine shall be fixed securely to a foundation having a mass at least 40 times that of the heaviest pendulum in use. The foundation shall be capable of being adjusted so that the orientations of the pendulum and vice are as specified in 6.1.4 and 6.1.6.

6.1.4 The striking edge of the pendulum shall be hardened steel with a cylindrical surface having a radius of curvature of $R_1 = 0.8 \pm 0.2$ mm, with its axis horizontal and perpendicular to the plane of motion of the pendulum. It shall be aligned so that it contacts the full width or thickness of rectangular test specimens. The line of contact shall be perpendicular within $\pm 2°$ to the longitudinal axis of the test specimen.

6.1.5 The distance between the axis of rotation and the point of impact shall be within ± 1 % of the pendulum length, L_p.

NOTE 2—The pendulum length, L_p, in metres, may be determined experimentally from the period of small amplitude oscillations of the pendulum by means of the following equation:

$$L_p = \frac{g_n}{4\pi^2} \times T^2 \quad (1)$$

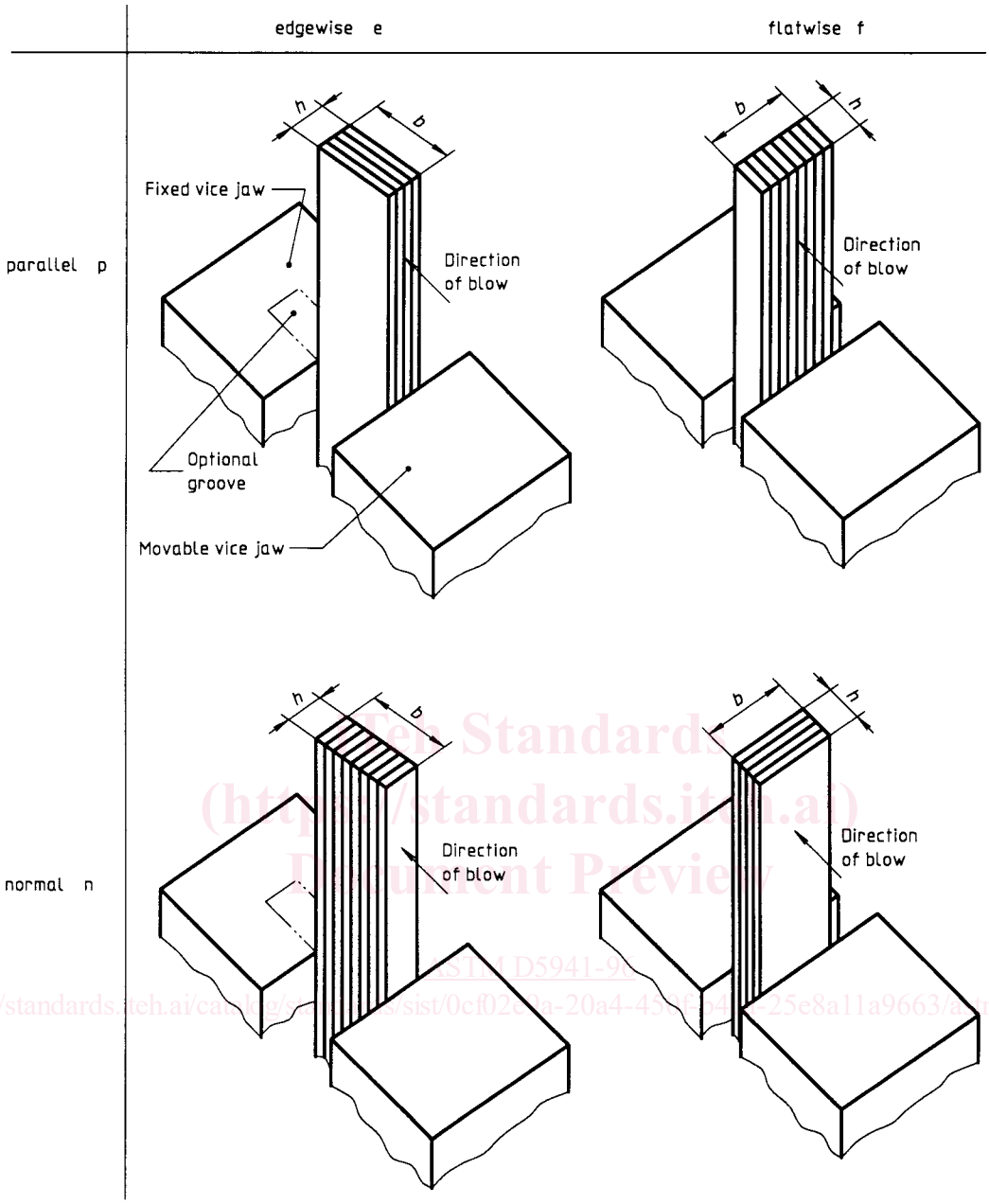
where:

g_n = the standard acceleration of free fall, in m/s^2(9.81 m/s^2), and
T = the period, in s, of a single complete swing (to and from) determined from at least 50 consecutive and uninterrupted swings (known to an accuracy of one part in two thousand). The angle of swing shall be less than 5° to each side of the center.

6.1.6 The test specimen support shall comprise a vice consisting of a fixed and a moveable jaw. The clamping surfaces of the jaws shall be parallel to within 0.025 mm. The vice shall be arranged to hold the test specimen vertically with respect to its long axis and at right angles to the top plane of the vice (see Fig. 2). The top edges of the vice jaws shall have radii $R_2 = 0.2 \pm 0.1$ mm.

6.1.6.1 Means shall be provided to ensure that when a notched test specimen is clamped in the vice, the top plane of the vice is within 0.2 mm of the plane bisecting the angle of the notch.

6.1.6.2 The vice shall be positioned so that the test specimen



NOTE 1—Direction of blow with respect to specimen thickness, *h*, and specimen width, *b*: edgewise (e) and flatwise (f); with respect to the laminate plane: parallel (p) and normal (n).

NOTE 2—The usual Izod test is edgewise parallel. When $h = b$, then parallel as well as normal can be tested.

FIG. 1 Scheme of Designations Describing the Direction of Blow

is central, to within ±0.05 mm, of the striking edge so that the center of the striking edge is 22.0 ± 0.2 mm above the top plane of the vice (see Fig. 2). The vice shall be designed to prevent the clamped portion of the test specimen from moving during the clamping or testing operations.

NOTE 3—The fixed vice jaw may be provided with a groove to improve the positioning and handling of the test specimen (see Fig. 1).

6.1.7 Some plastics are sensitive to clamping pressure. When testing such materials, a means of standardizing the clamping force shall be used and the brated torque wrench or a pneumatic or hydraulic device on the vice clamping screw.

6.2 *Micrometers and Gages*—Micrometers and gages suitable for measuring the essential dimensions of the test specimens to an accuracy of 0.02 mm are required. For measuring the dimension b_N of notched specimens, the micrometer shall be fitted with an anvil of 2 to 3-mm width and of suitable profile to fit the shape of the notch.

7. Test Specimens

7.1 *Preparation*:

7.1.1 *Molding or Extrusion Compounds*—Specimens shall be prepared in accordance with the relevant material specification. When none exists, or unless otherwise specified,