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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Determining Charpy Impact Strength of Plastics[1]

This standard is issued under the fixed designation D 5942; 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 Charpy 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 This test method is used for investigating the behavior of specified types of specimen under the impact conditions defined and for estimating the brittleness or toughness of specimens within the limitations inherent in the test conditions.

1.3 This test method has a greater range of applicability than that given in Test Method D 5941 and is more suitable for the testing of materials showing interlaminar shear fracture or of materials exhibiting surface effects due to environmental factors.

1.4 This test method is suitable for use with the following range of materials:

1.4.1 Rigid thermoplastics molding and extrusion materials, including filled and reinforced compounds in addition to unfilled types; rigid thermoplastic sheets;

1.4.2 Rigid thermosetting molding materials, including filled and reinforced compounds; rigid thermosetting sheets, including laminates;

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

1.4.4 Thermotropic liquid-crystal polymers.

1.5 This test method 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.

1.6 This test method 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.

1.7 This test method 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.

1.8 This test method 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.

1.9 This test method is identical to ISO 179. 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.

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

1.11 *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]

D 5941 Test Method for Determining the Izod Impact Strength of Plastics[3]

[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.

2.2 *ISO Standards:*[4]

ISO 179 Determination of Charpy Impact Strength

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

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

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 Fiber 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 3167:1993 Plastics—Multipurpose Test Specimens

3. Terminology

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

3.1.1 *Charpy impact strength of notched specimens, a_{cN}*—impact energy absorbed in breaking a notched specimen, referred to the original cross-sectional area of the specimen at the notch, where *N* = *A, B,* or *C,* depending on the notch type (see 7.3.1.1).

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

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

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

3.1.3 *edgewise impact (e)*—the direction of blow parallel to the dimension *b,* with impact on the narrow longitudinal surface, $h \times l$, of the specimen (see Fig. 1, left, and Fig. 2 and Fig. 3).

3.1.4 *flatwise impact (f)*—the direction of blow parallel to the dimension *h,* with impact on the broad longitudinal surface, $b \times l$, of the specimen (see Fig. 1, right, and Fig. 4 and Fig. 3).

3.1.5 *normal impact (n)*—the direction of blow normal to the plane of reinforcement (see Fig. 3).

3.1.5.1 *Discussion*—It is used for laminar-type reinforced plastics.

3.1.6 *parallel impact (p)*—the direction of blow parallel to the plane of reinforcement (see Fig. 3).

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

4. Principle

4.1 Supported as a horizontal beam, the test specimen is broken by a single swing of a pendulum, with the line of impact midway between the supports.

4.2 In the case of edgewise impact with notched specimens, the line of impact is directly opposite the single notch (see Fig. 1, left, and 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 accurately 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 1.4, it is necessary to use more than one machine or to use a set of interchangeable pendulums (see 8.3). It is not advisable to compare results obtained with different pendulums. The frictional losses shall be checked periodically.

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 striker and supports are as specified in 6.1.4 and 6.1.6.

6.1.4 The striking edge of the pendulum shall be hardened steel tapered to an included angle of 30 ± 1° and shall be rounded to a radius of $R_1 = 2 \pm 0.5$ mm. It shall pass midway, to within ±0.2 mm, between the test specimen supports and shall be aligned so that it contacts the full width or thickness of rectangular test specimens. The line of contact shall be perpendicular, within ±2°, to the longitudinal axis of the test specimen.

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

NOTE 1—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:

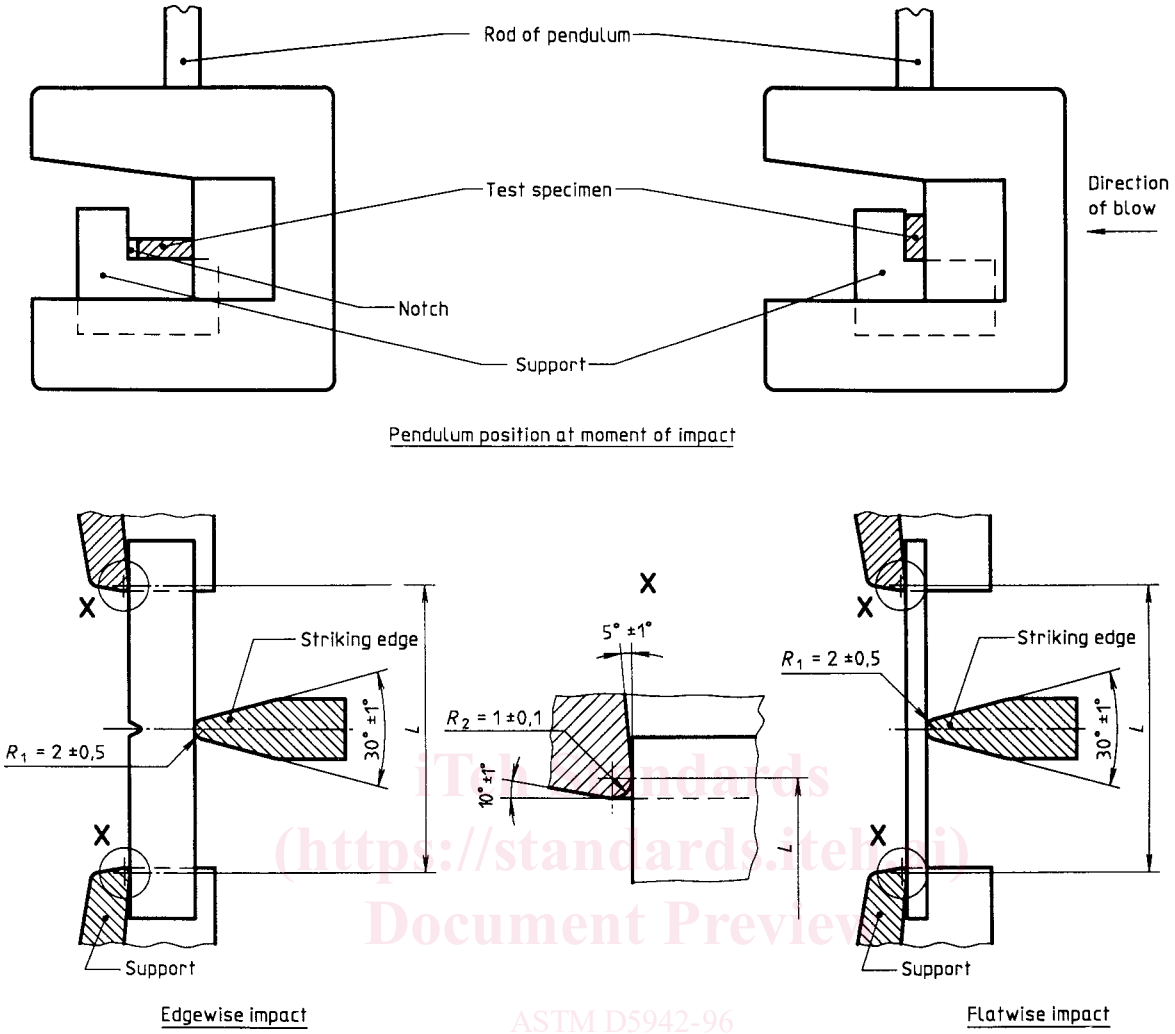
$$L_p = \frac{g_n}{4\pi^2} \times T^2 \quad (1)$$

where:

g_n = standard acceleration of free fall, 9.81 m/s^2, and

T = period, s, of a single complete swing (to and from) determined from at least 50 consecutive and uninterrupted swings (known to an accuracy of 1 part in 2000). The angle of swing shall be less than 5° to each side of the center.

6.1.6 The test specimen supports shall be two rigidly mounted smooth blocks, arranged so that the longitudinal axis of a perfectly rectangular test specimen is horizontal to within 1 part in 200 and the striking face of such a test specimen is



NOTE 1—Dimensions in millimetres.

FIG. 1 Striking Edge and Support Blocks for Type 1 Test Specimens

parallel to the striking edge of the pendulum to within 1 part in 200 at the moment of impact. The specimen supports shall not inhibit the movement of the specimen.

6.1.6.1 The shape of the supports shall be as shown in Fig. 1. The span, *L*, is the distance between the contact lines of the specimen on the supports and shall be as specified in Table 2. Means shall be provided to center the test specimens, in relation to the striker, to within ±0.5 mm. Separate support blocks may be required for each type of test specimen.

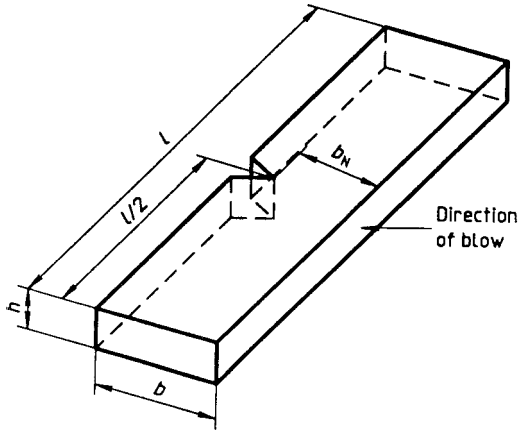


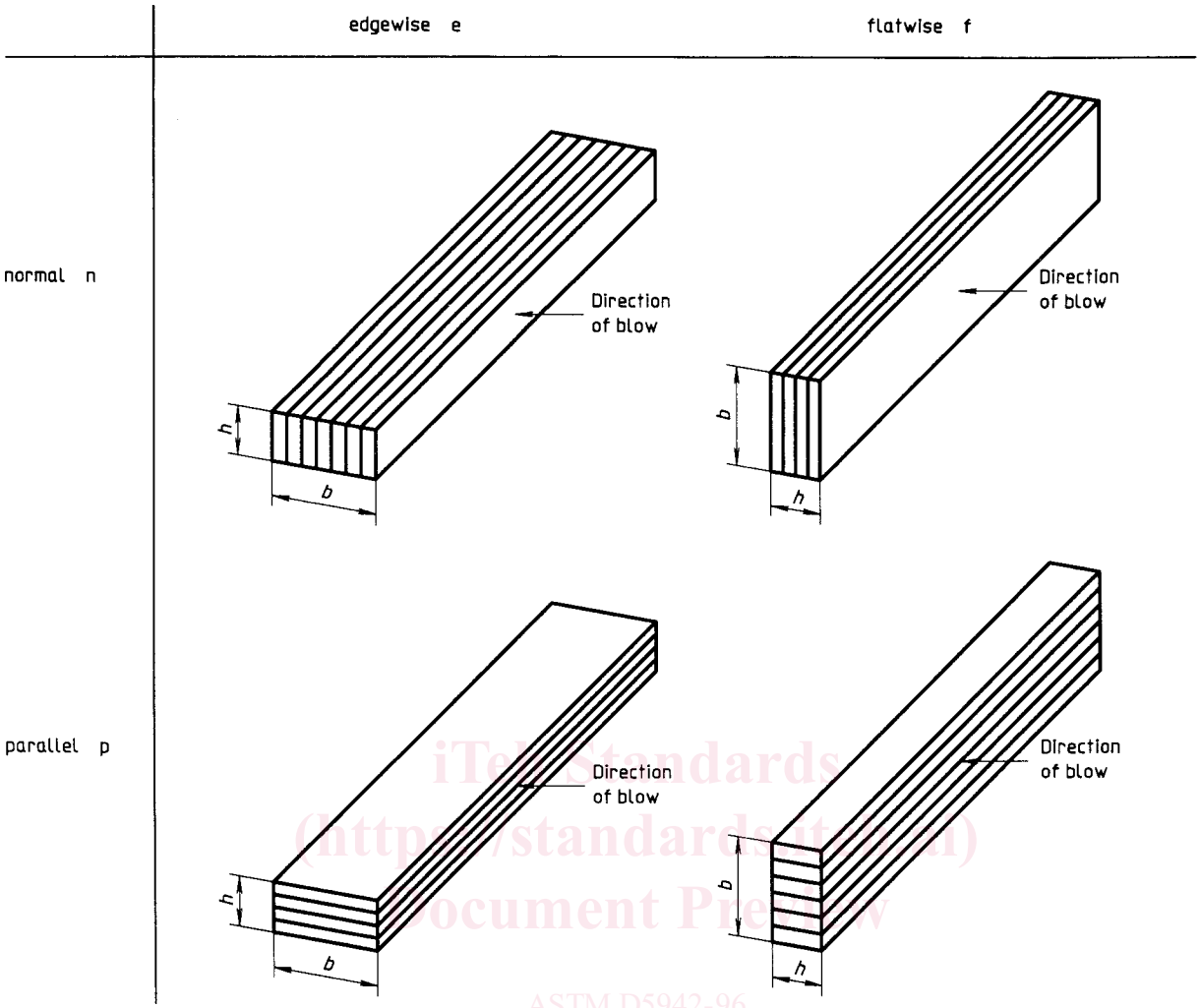
FIG. 2 Charpy Edgewise Impact (e), with Single-Notched Specimen

6.2 *Micrometers and Gages*—Micrometers and gages suitable for measuring the essential dimensions of 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 width 2 to 3 mm 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, specimens shall be either directly compression molded or injection molded from the material in accordance with ISO 293, 294 (Practices D 5939 and D 5940), 295, 2557-1, or 2557-2, as appropriate, or machined in accordance with ISO 2818 from sheet that has been compression or injection molded from the compound.



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: normal (n) and parallel (p).

NOTE 2—The Charpy fn and ep tests are used for laminates, and the Charpy e test is used for all other materials; the charpy *f*-test is used for testing surface effects.

FIG. 3 Scheme of Designations Describing the Direction of Blow

NOTE 2—Type 1 specimens may be cut from multipurpose test specimens complying with ISO 3167 (Specification D 5936), Type A.

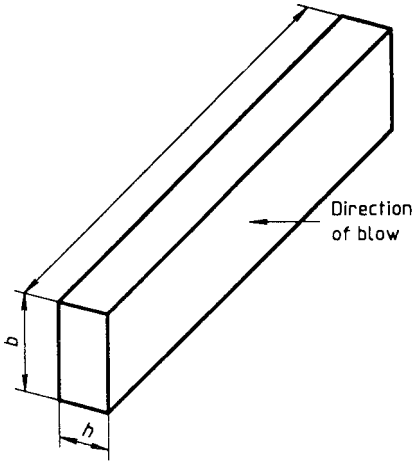


FIG. 4 Charpy Flatwise Impact (f)

7.1.2 *Sheets*—Specimens shall be machined from sheets in accordance with ISO 2818.

7.1.3 *Long-Fiber-Reinforced Polymers*—A panel shall be prepared in accordance with ISO 1268 or another specified or

TABLE 1 Characteristics of Pendulum Impact Testing Machines

Energy, *E* (Nominal), J	Velocity of Impact, v_0, m/s	Maximum Permissible Frictional Loss Without Specimen, J	Permissible Error[A] after Correction with Specimen, J
0.5			0.01
1.0			0.01
2.0	2.9	0.02	0.01
4.0	(±10 %)		0.02
5.0			0.02
7.5		0.04	0.05
15.0	3.8	0.05	0.05
25.0	(±10 %)	0.10	0.10
50.0		0.20	0.10

[A]The permissible error shall not be exceeded within the 10 to 80 % range of the pendulum capacity.