Designation: D 1822 – 99

Standard Test Method for Tensile-Impact Energy to Break Plastics and Electrical Insulating Materials[1]

This standard is issued under the fixed designation D 1822; 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 the determination of the energy required to rupture standard tension-impact specimens of plastic or electrical insulating materials. Materials that can be tested by this test method are those too flexible or too thin to be tested in accordance with Test Methods D 256, as well as more rigid materials.

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

NOTE 1—This test method is not equivalent to ISO 8256, and results cannot be directly compared between the two methods.

1.3 *This standard does not purport to address all of the safety problems, 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 Methods for Impact Resistance of Plastics and Electrical Insulating Materials[2]
D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[2]
D 638 Test Method for Tensile Properties of Plastics[2]
D 883 Terminology Relating to Plastics[2]
D 1898 Practice for Sampling of Plastics[2]
D 4000 Classification System for Specifying Plastic Materials[3]
D 4066 Specification for Nylon Injection and Extrusion Materials[3]
E 23 Test Methods for Notched Bar Impact Testing of Metallic Materials[4]

3. Terminology

3.1 *Definitions*—Definitions of terms applying to this test method appear in Terminology D 883.

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 by shock in tension is determined by the kinetic energy extracted from the pendulum of an 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 (Note 2). In order to compensate for the minor differences in cross-sectional area of the specimens as they will occur in the preparation of the specimens, the energy to break can be 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 11. For a perfectly elastic material the impact energy might be reported per unit volume of material undergoing deformation. However, since much of the energy to break the plastic 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. The test method permits two specimen geometries so that the effect of elongation or rate of extension, or both, upon the result can be observed. 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

---

[1] This test method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.10 on Mechanical Properties.

Current edition approved April 10, 1999. Published July 1999. Originally published as D 1822 – 61 T. Last previous edition D 1822 – 93.

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

[3] *Annual Book of ASTM Standards*, Vol 08.02.

[4] *Annual Book of ASTM Standards*, Vol 03.01.

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

greater occurrence of brittle fracture) gives greater reproducibility, but less differentiation among materials. Results obtained with different capacity machines may not be comparable.

NOTE 2—Friction losses are largely eliminated by careful design and proper operation of the testing machine. Attention is drawn to Test Methods E 23 for a general discussion of impact equipment and procedures.

5.2 The scatter of data may be due to different failure mechanisms within a group of specimens. Some materials may 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. Some materials retract at failure with insignificant permanent set. With such materials it may not be possible to determine the type of failure, ductile, or brittle, by examining the broken pieces. A set of specimens may sometimes be sorted 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 D 256 and the low rate of usual tension testing in accordance with Test Method D 638.

5.3 The energy for fracture is a function of the force times the distance through which the force operates. Thus, two materials may have properties that result in equal tensile-impact energies on the same specimen geometry, arising in one case from a large force associated with a small elongation and in the other from a small force associated with a large elongation. It cannot 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 can 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 Slippage of specimens results in erroneously high values. The tabs of broken specimens should be examined for an undistorted image of the jaw faces optically, preferably under magnification, and compared against a specimen which has been similarly clamped but not tested. Because slippage has been shown to be present in many cases and suspected in

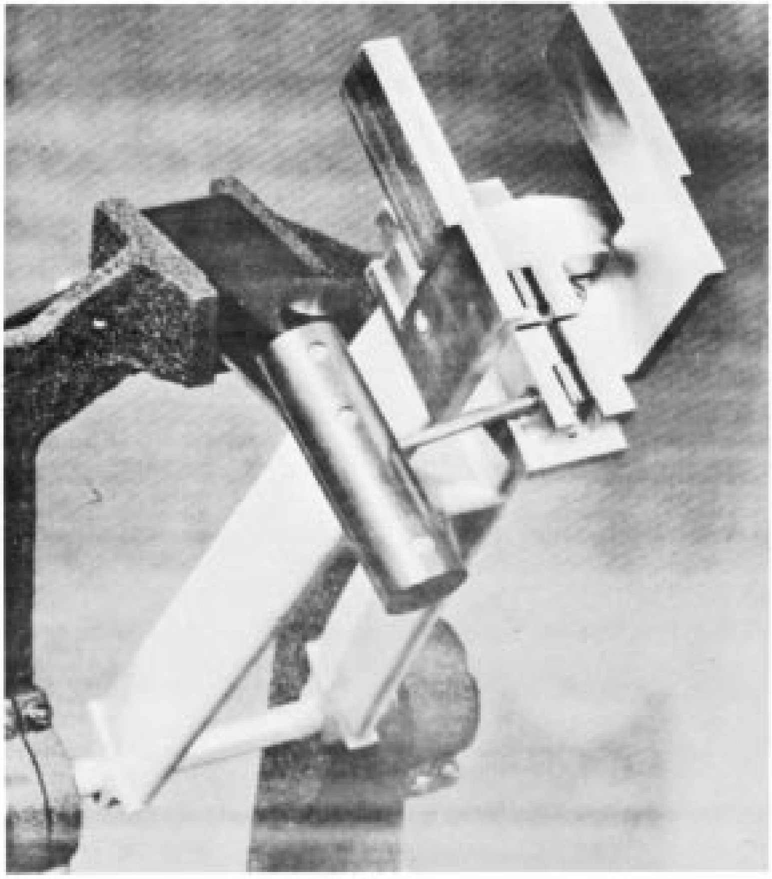

FIG. 1 Specimen-in-Head Tension-Impact Machine

others, the use of bolted specimens is mandatory. The function of the bolt is to assure good alignment and to improve the tightening of the jaw face plates.

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

5.8 For many materials, there may be a specification that requires 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 D 4000 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 pendulum should be released from such a position that the linear velocity of the center of impact (center of percussion) at the instant of impact shall be approximately 3.444 m/s (11.3 ft/s), which corresponds to an initial elevation of this point of 610 mm (2.00 ft).

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 can be demonstrated to be coincident within ±2.54 mm (±0.100 in.) and that the point of contact occur 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 may be determined experimentally from the period of small amplitude oscillations of the pendulum by means of the following equation:

$$L = (g/4\pi^2)\, p^2 \tag{1}$$

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/s^2(ft/s^2),
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 should 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 serrated jaws to prevent slipping. Jaws should have file-like serrations and the size of serrations should be selected according to experience with hard and tough materials and with the thickness of the specimen. The edge of the serrated jaws in close proximity to the test region shall have a 0.40 mm (1⁄64-in.) radius to break the edge of the first serrations.

6.4 A means shall be provided for measuring the energy absorbed from the pendulum by measuring on a suitable scale the height of the pendulum swing after the break.

6.5 Accurate means shall be available to determine and minimize energy losses due to windage and friction.

6.6 Setup and calibration procedures for tension-impact machines shall be followed as described in Appendix X2.

6.7 A ball-type micrometer shall be used for measuring the width of the restricted area of the Type S specimen. Either a ball-type or ordinary machinist's micrometer may be used to measure the thickness of the Type S specimen and the thickness and width of the Type L specimen. These measurements shall be made to an accuracy of 0.013 mm (0.0005 in.).

7. Sampling

7.1 Unless otherwise agreed upon between interested parties, the material shall be sampled in accordance with the sections on General Sampling Procedure in Practice D 1898.

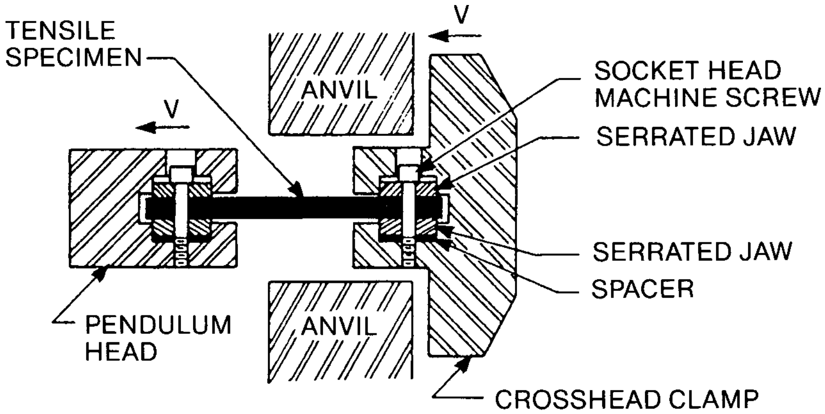

FIG. 2 Specimen-in-Head Tension-Impact Machine (Schematic)

8. Test Specimen

8.1 At least five and preferably ten specimens from each sample shall be prepared for testing. For sheet materials that are suspected of anisotropy, duplicate sets of test specimens shall be prepared having their long axis respectively parallel with, and normal to, the suspected directions of anisotropy.

8.2 The test specimen shall be sanded, machined, or die cut to the dimensions of one of the specimen geometries shown in Fig. 3, or molded in a mold whose cavity has these dimensions. Fig. 4A shows bolt holes and bolt hole location and Fig. 4B shows a slot as an alternative method of bolting for easy insertion of the specimens into the grips. The No. 8-32 bolt size

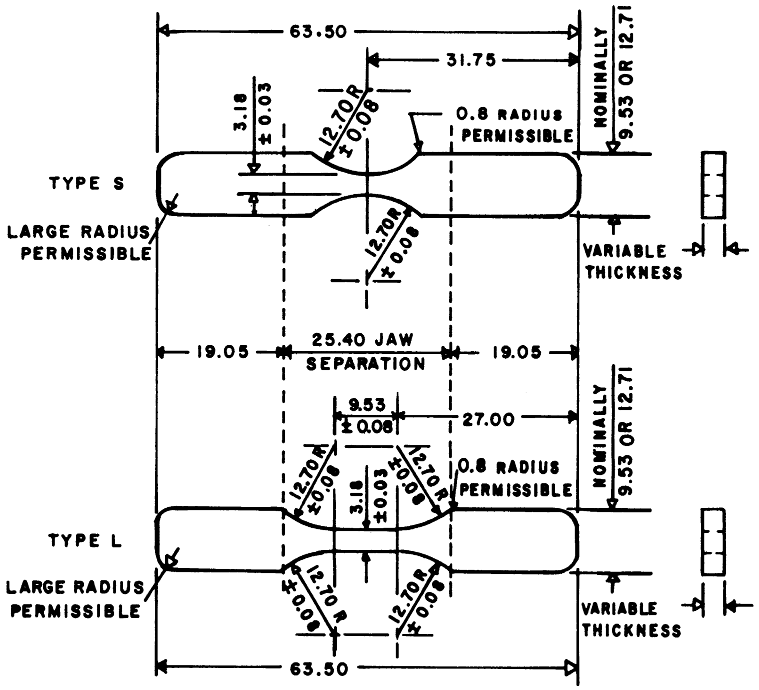

FIG. 3A Mold Dimensions of Types S and L Tension-Impact Specimens (Dimensioned in Millimetres)

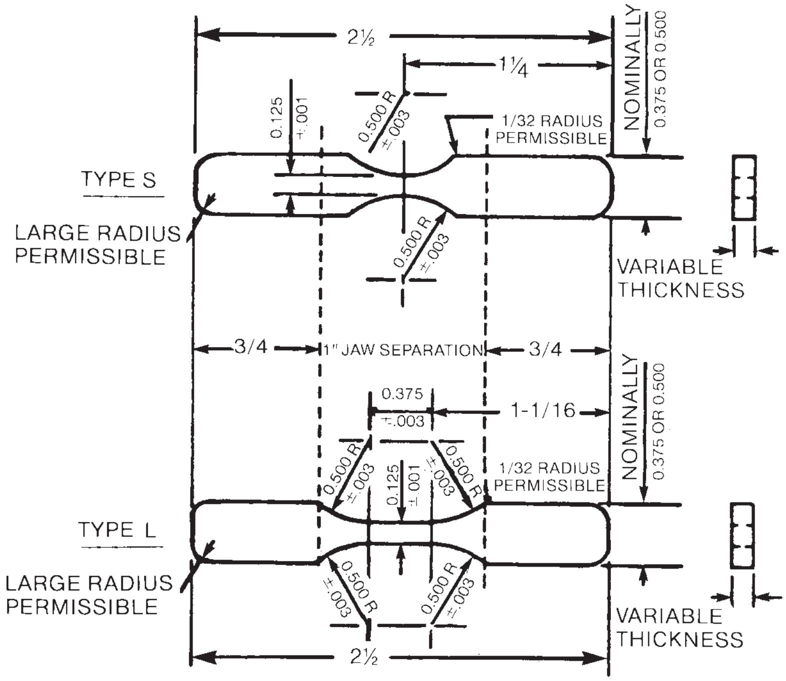

FIG. 3B Mold Dimensions of Types S and L Tension-Impact Specimens (Dimensioned in Inches)

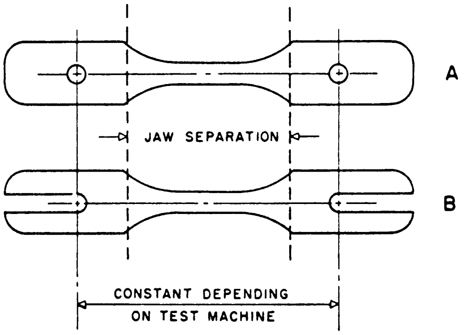

FIG. 4 Bolt Hole Location

is recommended for the 9.53-mm (0.375-in.) wide tab and No. 8-32 or No. 10-32 bolt size is suggested for the 12.70-mm (0.500-in.) wide tabs. Final machined, cut, or molded specimen dimensions cannot be precisely maintained because of shrinkage and other variables in sample preparation.

8.3 A nominal thickness of 3.2 mm (⅛ in.) is optimum for most materials being considered and for commercially available machines. Thicknesses other than 3.2 mm (⅛ in.) are nonstandard and they should be reported with the tension-impact value.

NOTE 4—Cooperating laboratories should agree upon standard molds and upon specimen preparation procedures and conditions.

9. Conditioning

9.1 *Conditioning*—Condition the test specimens at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D 618, for those tests where conditioning is required. In cases of disagreement, the tolerances shall be± 1°C (±1.8°F) and ±2 % relative humidity.

9.1.1 Note that for some hygroscopic materials, such as nylons, the material specifications (for example, Specification D 4066) call for testing "dry as-molded specimens." Such requirements take precedence over the above routine preconditioning to 50 % relative humidity and require sealing the specimens in water vapor-impermeable containers as soon as molded and not removing them until ready for testing.

9.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity, unless otherwise specified in the test methods or in this test method. In cases of disagreement, the tolerances shall be ±1°C (±1.8°F) and ±2 % relative humidity.

10. Procedure

10.1 Measure the thickness and width of each specimen with a micrometer. Record these measurements along with the identifying markings of the respective specimens.

10.2 Bolt the specimen securely with a torque wrench in accordance with 5.3. Clamp the specimen to the crosshead while the crosshead is out of the pendulum. A jig may be necessary for some machines to position the specimen properly with respect to the crosshead during the bolting operation. With the crosshead properly positioned in the elevated pendulum, bolt the specimen at its other end to the pendulum itself, as shown in Fig. 1.

10.3 Use the lowest capacity pendulum available, unless the impact values go beyond the 85 % scale reading. If this occurs, use a higher capacity pendulum.

NOTE 5—In changing pendulums, the tensile-impact energy will decrease as the mass of the pendulum is increased.

10.4 Measure the tension-impact energy of each specimen and record its value, and comment on the appearance of the specimen regarding permanent set or necking, and the location of the fracture.

11. Calculation

11.1 Calculate the corrected impact energy to break as follows:

$$X = E - Y + e \quad (2)$$

where:
X = corrected impact energy to break, in J (ft·lbf),
E = scale reading of energy of break, in J (ft·lbf),
Y = friction and windage correction in J (ft·lbf), and
e = bounce correction factor, in J (ft·lbf) (Fig. 5).

NOTE 6—Fig. 5 is a sample curve. A curve must be calculated in accordance with Appendix X1 for the crosshead and pendulum used before applying any bounce correction factors.

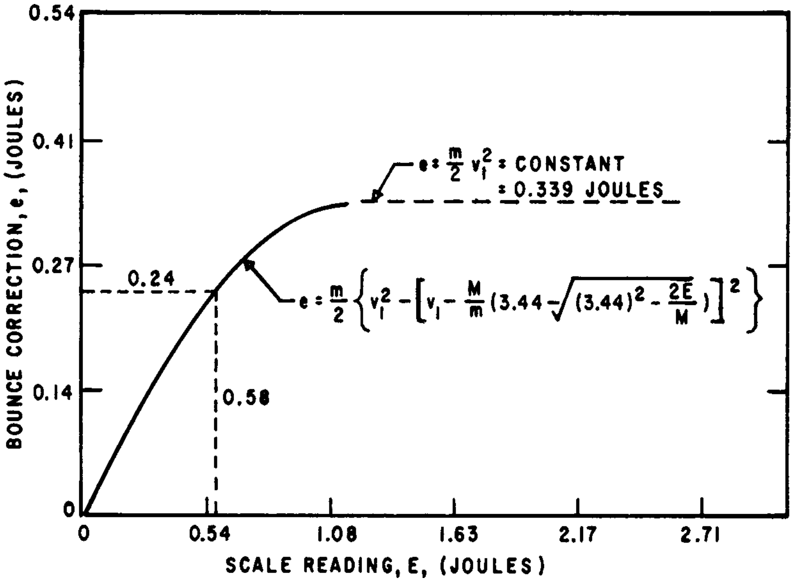

FIG. 5 Typical Correction Factor Curve for Single Bounce of Crosshead for Specimen-in-Head Tension-Impact Machine, 6.8-J Hammer, 0.428-lb Steel Crosshead (see Appendix X1)

TABLE 1 Round-Robin Calibration Tests[5]

Kind of Specimen	Tensile-Impact Strength		Approximate Standard Deviation	
	kJ/m^2	ft·lbf/in.^{2}	kJ/m^2	ft·lbf/in.^{2}
Poly(methyl methacrylate) 9.5 by 3.2 mm (3⁄8-in. tab, 1⁄8-in. neck)	42	20	5.0	2.4
Poly(methyl methacrylate) 12.7 by 6.4 mm (1⁄2-in. tab, 1⁄4-in. neck)[A]	46	22	2.7	1.3

[A] Nonstandard geometry.

NOTE 7—*Examples*:

Case A—*Low-Energy Specimen:*	
Scale reading of energy to break	0.58 J (0.43 ft·lbf)
Friction and windage correction −0.03 J (−0.02 ft·lbf)	
Bounce correction factor, e (from Fig. 5 in Appendix X1) +0.25 J (+0.18 ft·lbf) = +0.22 (+0.16 ft·lbf)	+0.22 J (0.16 ft·lbf)
Corrected impact energy to break	0.80 J (0.59 ft·lbf)
Case B—*High-Energy Specimen*:	
Scale reading of energy to break	2.33 J (1.72 ft·lbf)
Friction and windage correction −0.01 J (−0.01 ft·lbf)	
Bounce correction factor,e (from Fig. 5 in Appendix X1) +0.34 J (+0.25 ft·lbf) = +0.33 J (+0.24 ft·lbf)	+0.33 J (0.24 ft·lbf)
Corrected impact energy to break	2.66 J (1.96 ft·lbf)

NOTE 8—Corrections for a slight variation in specimen dimensions due to specimen preparation or mold shrinkage can be made as follows:

$$X = \frac{E - Y + e}{\left(\frac{w}{a}\right)\left(\frac{t}{a}\right)} \tag{3}$$

where:

X, E, Y, and e are as described in 10.1,
a = 3.2 mm (0.125 in.),
w = specimen width, mm (in.), and
t = specimen thickness, mm (in.).

This would normalize the value of tensile impact energy to a standard specimen whose cross section is 3.2 mm (0.125 in.) by 3.2 mm (0.125 in.).

11.2 Calculate the standard deviation (estimated) as follows and report to two significant figures:

$$s = \sqrt{\Sigma X^2 - n\bar{X}^2/n - 1} \tag{4}$$

where:

s = estimated standard deviation,
X = value of single observation,
n = number of observations, and
$\bar{X}$ = arithmetic mean of the set of observations.

12. Report

12.1 Report the following information:

12.1.1 Complete identification of the material tested, including type, source, manufacturer's code number, form, principal dimensions, and previous history.

12.1.2 Specimen type (S or L), and tab width.

12.1.3 A statement of how the specimens were prepared, the testing conditions, including the size of the bolts and torque used, thickness range, and direction of testing with respect to anisotropy, if any.

12.1.4 The capacity of the pendulum in kilo-joules (or foot-pounds-force or inch-pounds-force).

12.1.5 The average and the standard deviation of the tensile-impact energy of specimens in the sample. If the ratio of the minimum value to maximum value is less than 0.75, report average and maximum and minimum values. If there is an apparent difference in the residual elongation observed due to some of the sample necking, report the number of specimens displaying necking.

12.1.6 Number of specimens tested per sample or lot of material (that is, five or ten or more).

13. Precision and Bias [5]

13.1 In round-robin tests of triplicate bolted specimens, the nine participating laboratories averaged the standard deviations shown in Table 1.

APPENDIXES

(Nonmandatory Information)

X1. DETERMINATION OF BOUNCE VELOCITY AND CORRECTION FACTOR

X1.1 General

X1.1.1 Upon contacting the anvil at the bottom of the swing of the pendulum, the crosshead bounces away with an initial velocity dependent upon the degree of elasticity of the contacting surface. The elastic compression and expansion of the metallic crosshead, both of which take place prior to the separation of the crosshead from the anvil, occur in a time interval given approximately by twice the crosshead thickness divided by the speed of sound in the metal of which the crosshead is made. This is usually of the order of 25 mm (1 in.) divided by 5080 m/s (200 000 in./s), or about 5×10^{-6}s. During this time the crosshead, moving at about 3.4 m/s (135 in./s) moves along about 17 μm (7×10^{-4} in.). For a test specimen with a modulus of 3.4 GPa (500 000 psi) and a specific gravity of 1.0 the sound speed in the sample would be only 1778 m/s (70 000 in./s) and a stress wave would move only about 10 mm (0.4 in.) in 5×10^{-6}s. Thus in this short time a stress wave would not have traveled through the plastic specimen to the end of the specimen clamped to the pendulum, and so the specimen would exert no retarding force on the crosshead at the instant it bounced away. Since this is the case, one can assume that the initial rebound velocity of the crosshead, v_1, is the same as that which is measured with no specimen in the pendulum.

X1.2 Determination of Bounce Velocity

X1.2.1 The determination of bounce velocity, v_1, of the free crosshead can be made by photographic analysis (high-speed movies or stroboscopic techniques) or by the coefficient of restitution method.

X1.2.2 It has been observed that in several cases the rebound velocity of the crosshead is about 1.88 m/s (6.2 ft/s). It has also been noted that under certain geometrical conditions, the coefficient of restitution of steel on steel is about 0.55 (Eshbach's *Handbook of Engineering Fundamentals*). Since 0.55 × 11.3 ft (3.44 m)/s = 6.2 ft (1.88 m)/s, it appears that an approximate value of the rebound velocity might be taken as 6.2 ft/s for steel crossheads, if the use of high speed moving pictures is impractical. However, the preferred method of determining crosshead rebound velocity is by photographic analysis.

X1.3 Determination of Correction Factor

X1.3.1 After impact and rebound of the crosshead, the specimen is pulled by two moving bodies, the pendulum with an energy of $MV^2/2$, and the crosshead with an energy of $mv^2/2$. When the specimen breaks, only that energy is recorded on the pendulum dial which is lost by the pendulum. Therefore, one must add the incremental energy contributed by the crosshead to determine the true energy used to break the specimen. Consider once again the moving crosshead before the specimen breaks. As the crosshead moves away from the anvil it is slowed down by the specimen, which is being stretched. If the specimen does not break very quickly, the crosshead velocity will diminish to zero and theoretically the crosshead could be brought back against the anvil and rebound again. This second bounce has not been observed in several high speed moving pictures taken of tensile-impact breaks, but if it does occur one can no longer assume that the specimen exerts no retarding force, and the determination of the crosshead velocity on the second bounce becomes relatively complex.

X1.3.2 If only a single bounce occurs, one can calculate the correction (that is, the incremental energy contributed by the crosshead) as follows:

By definition

$$E = (M/2)(V^2 - V^2) \qquad \text{(X1.1)}$$

and by definition:

$$e = (m/2)(v_1^2 - v_2^2) \qquad \text{(X1.2)}$$

where:

M = mass of pendulum, N·s^2/m (lbf·s^2/ft),
m = mass of crosshead, N·s^2/m (lbf·s^2/ft),
V = maximum velocity of center of percussion of crosshead of pendulum, m/s (ft/s),
V_2 = velocity of center of percussion of pendulum at time when specimen breaks, m/s (ft/s),
v_1 = crosshead velocity immediately after bounce, m/s (ft/s),
v_2 = crosshead velocity at time when specimen breaks, m/s (ft/s),
E = energy read on pendulum dial, J (ft·lbf), and

---

[5] Supporting data are available from ASTM Headquarters. Request RR: D20 – 1034.

e = energy contribution of crosshead, that is, bounce correction factor to be added to pendulum reading, J (ft·lbf).

Once the rebound of the crosshead has occurred, the momentum of the system (in a horizontal direction) must remain constant. Neglecting vertical components of the momentum one can write:

$$MV - mv_1 = MV_2 - mv_2 \qquad \text{(X1.3)}$$

Eq X1.1-X1.3 can be combined to give:

$$e = m/2\,\{v_1^2 - [v_1 - M/m)\,(V - \sqrt{(V)^2 - (2E/M)}))]^2 \qquad \text{(X1.4)}$$

If e is plotted as a function of E (for fixed values of V, M, m, and v_1), e will increase from zero, pass through a maximum (equal to $mv_1^2/2$), and decrease, passing again through zero and becoming negative. The only part of this curve for which a reasonably accurate analysis has been made is the initial portion where the curve lies between values of zero and $mv_1^2/2$. Once the crosshead reverses the direction of its travel, the correction becomes less clearly defined, and after a second contact with the anvil has been made, the correction becomes much more difficult to evaluate. It is assumed, therefore, for the sake of simplicity, that once e has reached its maximum value, the correction factor will remain constant at a value of $mv_1^2/2$. It should be clearly realized that the use of that portion of the curve in Fig. 5 where e is constant does not give an accurate correction. However, as E grows larger, the correction factor becomes relatively less important and no great sacrifice of over-all accuracy results from the assumption that the maximum correction is $mv_1^2/2$.

X2. SET-UP AND CALIBRATION PROCEDURE FOR LOW CAPACITY 1.4 TO 22 J (1 TO 16 FT·LBF), TENSION-IMPACT MACHINES FOR USE WITH PLASTIC SPECIMENS

X2.1 Locate impact machine on a sturdy bench. It shall not "walk" on the bench and the bench shall not vibrate appreciably. Loss on energy from vibrations will give high readings. It is recommended that the impact tester be bolted to a bench weighing at least 23 kg (50 lb) if it is used at capacities higher than 2.7 J (2 ft·lbf).

X2.2 Check the levelness of the machine in both directions in the plane of the base with spirit levels mounted in the base, by a machinist's level if a satisfactory reference surface is available, or with a plumb bob. The machine should be level to within $\tan^{-1}$ 0.001 in the plane of swing and to within $\tan^{-1}$ 0.002 in the plane perpendicular to the swing.

X2.3 Check for signs of rubbing or interference between the pendulum head and the anvil and check the side clearance between the pendulum head and anvil while the pendulum hangs freely. Unequal side clearances may indicate a bent pendulum arm, bent shaft, or faulty bearings. Excessive side play may also indicate faulty bearings. If free-hanging side clearances are equal, but there are signs of interference, the pendulum may not have sufficient rigidity. Readjust the shaft bearings, relocate the anvil, or straighten the pendulum shaft as necessary to attain the proper relationship between the pendulum head and the anvil.

X2.4 Check the pendulum arm for straightness within 1.2 mm (0.05 in.) with a straightedge or by sighting down the shaft. This arm is sometimes bent by allowing the pendulum to slam against the catch when high-capacity weights are on the pendulum.

X2.5 Swing the pendulum to a horizontal position and support it by a string clamped in the vise of the pendulum head so that the string is positioned exactly on the longitudinal centerline of the specimen. Attach the other end of the string to a suitable load-measuring device. The pendulum weight should be within 0.4 % of the required weight for that pendulum capacity. If weight must be added or removed, take care to balance the added or removed weight about the center of percussion. It is not advisable to add weight to the opposite side of the bearing axis from the head to increase the effective length of the pendulum since the distributed mass will lead to large energy losses from vibration of the pendulum.

X2.6 Calculate the effective length of the pendulum arm, or the distance to the center of percussion from the axis of rotation, by the procedure of Note 3. The effective length must be within 1 % of the distance from the center of rotation to the striking edge.

X2.7 Measure the vertical distance of fall of the pendulum center of percussion from the trip height to its lowest point. The distance should be 610 ± 2 mm (24 ± 0.1 in.). The vertical falling distance may be adjusted by varying the position of the pendulum latch.

X2.8 When the pendulum is in the position where the

TABLE X2.1 Round-Robin Calibration Tests[5]

Thickness of 5052 Aluminum, in.	Machine Capacity		Tensile-Impact Strength		Approximate Standard Deviation	
	J	ft·lbf	kJ/m^2	ft·lbf/in.^{2}	kJ/m^2	ft·lbf/in.^{2}
0.020	5.4 (1)[A]	4 (1)	622	296	55	26
	6.8 (4)	5 (4)	559	266	55	26
	20 (2)	15 (2)	542	258	110	52
0.050	5.4 (1)	4 (1)	748	356	72	34
	6.8 (4)	5 (4)	732	348	53	25
	20 (2)	15 (2)	666	317	44	21

[A] Numbers in parentheses show the number of machines used in obtaining the average values.

TABLE X2.2 Converting Tensile-Impact Units

Multiply	by	To Obtain
Inch-pounds-force	0.113	Joules
Foot-pounds-force	1.356	Joules
Joules	8.85	Inch-pounds-force
Joules	0.738	Foot-pounds-force
Foot-pounds-force/inch^2	2.101	Kilojoules/metre^2
Kilojoules/metre^2	0.476	Foot-pounds-force/inch^2

crosshead just touches the anvil the pointer should be at the full scale index within 0.2 % of scale.

X2.9 The pointer friction should be adjusted so that the pointer will just maintain its position anywhere on the scale. The striking pin of the pointer should be securely fastened to the pointer. The friction device should be adjusted in accordance with the recommendations of the manufacturer.

X2.10 The free swing reading of a 2.7-J (2-ft·lbf) pendulum (without specimen) from the tripping height should be less than 2.5 % of scale on the first swing. If the reading is higher than this then the pointer friction is excessive or the bearings are dirty. To clean the bearings dip them in grease solvent and spin dry in an air jet. Clean the bearings until they spin freely, or replace them. Oil very lightly with instrument oil before replacing. A reproducible method of starting the pendulum from the proper height must be devised.

X2.11 The position of the pointer after three swings of the pendulum, each from the starting position, without manual readjustment of the pointer should be between ½ and 1 % of the scale. If the readings differ from this, then the machine is not level, the calibration dial is out of alignment, or the pendulum finger is out of calibration position.

X2.12 The shaft about which the pendulum rotates shall have no detectable radial play (less than 0.05 mm (0.002 in.)). An end play of 0.25 mm (0.010 in.) is permissible when a 1-kg (2.2-lb) axial force is applied in alternate directions. This shaft shall be horizontal within $\tan^{-1}$ 0.003 as checked with a level.

X2.13 The center of the anvil faces shall lie in a plane parallel to the shaft axis of the pendulum within $\tan^{-1}$ 0.001. The anvil faces shall be parallel to the transverse and vertical axis of the pendulum within $\tan^{-1}$ 0.001. One side of the crosshead shall not make contact with the anvil later than 0.05 mm (0.002 in.) after the other side has made contact. This measurement can be made by holding the crosshead in place in the pendulum head with the hand and feeling click of the sides of the crosshead against the anvil while thin shims are inserted between the side of the crosshead and the anvil. If the crosshead is not being contacted evenly check the crosshead for nicks and burrs and then the pendulum for twisting.

X2.14 The top of the machine base and the approach to the anvil should be surfaced with a soft rubber or plastic material having a low coefficient of friction with the crosshead so that the crosshead can slide or bounce free of the anvil after impact. This is to ensure that the crosshead does not come in contact with the pendulum on the backswing. Otherwise considerable damage to the crosshead and pendulum may result.

X2.15 The machine should not be used to indicate more than 85 % of the energy capacity of the pendulum.

X2.16 A jig shall be provided for locating the specimen so that it will be parallel to the base of the machine at the instant of strike within $\tan^{-1}$ 0.01 and coincident with the center of strike within 0.25 mm (0.01 in.).

X2.17 For checking the accuracy and reliability of the tension-impact machines use standard specimens made from 5052 H-32 aluminum. For low-capacity tension-impact machines 0.458-mm (0.020-in.) thick specimens may be used and for high-capacity tension-impact machines 1.27-mm (0.050-in.) specimens are recommended. In round-robin calibration tests on ten standard "L" specimens the six participating laboratories averaged the standard deviations shown in Table X2.1. Standard specimens may be obtained from Koehler Instrument Co., Inc., 1595 Sycamore Ave., Bohemia, L. I., NY 11716.

X2.18 In converting tension-impact units use Table X2.2 to multiply the quantity in the units on the left by the number in the center to convert to the units on the right.

SUMMARY OF CHANGES

This section identifies the location of selected changes to this test method. For the convenience of the user, Committee D-20 has highlighted those changes that may impact the use of this test method. This section may also include descriptions of the changes or reasons for the changes, or both.

D 1822 – 99:

(*1*) Revision to Note 1 and deletion of reference to Test Method D 1822M.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).