Designation: E23 – 18

An American National Standard

Standard Test Methods for Notched Bar Impact Testing of Metallic Materials[1]

This standard is issued under the fixed designation E23; 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.

1. Scope*

1.1 These test methods describe notched-bar impact testing of metallic materials by the Charpy (simple-beam) test and the Izod (cantilever-beam) test. They give the requirements for: test specimens, test procedures, test reports, test machines (see Annex A1) verifying Charpy impact machines (see Annex A2), optional test specimen configurations (see Annex A3), designation of test specimen orientation (see Terminology E1823), and determining the shear fracture appearance (see Annex A4). In addition, information is provided on the significance of notched-bar impact testing (see Appendix X1), and methods of measuring the center of strike (see Appendix X2).

1.2 These test methods do not address the problems associated with impact testing at temperatures below –196 °C (77 K).

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3.1 *Exception*—Section 9 and Annex A4 provide inch-pound units for information only.

1.4 *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.* Specific precautionary statements are given in Section 6.

1.5 *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]

B925 Practices for Production and Preparation of Powder Metallurgy (PM) Test Specimens

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

E1823 Terminology Relating to Fatigue and Fracture Testing

E2298 Test Method for Instrumented Impact Testing of Metallic Materials

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *absorbed energy, [FL], n*—work spent to fracture a specimen in a single pendulum swing, as measured by a compenstated indicating device.

3.1.2 *direct verification, n*—process that ensures all parts that may affect measured absorbed energy are within specified dimensional tolerances.

3.1.3 *indirect verification, n*—process that ensures the average absorbed energy from testing a set of verification specimens corresponds to the certified absorbed energy within a specified tolerance (see A2.4.1).

3.1.4 *lateral expansion [L], n*—the maximum increase in the thickness of the specimen as a result of the impact test, expressed in mm.

3.1.4.1 *Discussion*—Lateral expansion is used as a measure of ductility.

3.1.5 *range capacity, n*—maximum available energy for a specific pendulum setting.

3.1.5.1 *Discussion*—On single range machines this corresponds to the machine capacity.

3.1.6 *shear fracture appearance, SFA, n*—the amount of fracture surface in the specimen that failed in a shear (stable) mode, expressed in percent.

[1] These test methods are under the jurisdiction of ASTM Committee E28 on Mechanical Testing and are the direct responsibility of Subcommittee E28.07 on Impact Testing.

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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

4. Summary of Test Method

4.1 The essential features of an impact test are: a suitable specimen (specimens of several different types are recognized), a set of anvils, and specimen supports on which the test specimen is placed to receive the blow of the moving mass, a moving mass that has sufficient energy to break the specimen placed in its path, and an indicating device for measuring the absorbed energy of the broken specimen.

5. Significance and Use

5.1 These test methods of impact testing relate specifically to the behavior of metal when subjected to a single application of a force resulting in multi-axial stresses associated with a notch, coupled with high rates of loading and in some cases with high or low temperatures. For some materials and temperatures the results of impact tests on notched specimens, when correlated with service experience, have been found to predict the likelihood of brittle fracture accurately. Further information on significance appears in Appendix X1.

6. Precautions in Operation of Machine

6.1 Safety precautions should be taken to protect personnel from the swinging pendulum, flying broken specimens, and hazards associated with specimen warming and cooling media.

7. Apparatus

7.1 *General Requirements:*

7.1.1 The testing machine shall be a pendulum type of rigid construction.

7.1.2 The testing machine shall be designed and built to conform with the requirements given in Annex A1.

7.2 *Inspection and Verification:*

7.2.1 Procedures for direct verification of impact machines are provided in A2.2 and A2.3. The items listed in A2.2 require direct verification annually.

7.2.2 Procedures for indirect verification of Charpy machines, using verification specimens, are given in A2.4. Charpy impact machines require direct and indirect verification annually.

8. Test Specimens

8.1 *Configuration and Orientation:*

8.1.1 Specimens shall be taken from the material as specified by the applicable specification.

8.1.2 The type of specimen chosen depends largely upon the characteristics of the material to be tested. A given specimen may not be equally satisfactory for soft nonferrous metals and hardened steels; therefore, many types of specimens are recognized. In general, sharper and deeper notches are required to distinguish differences in very ductile materials or when using low testing velocities.

8.1.3 The specimens shown in Fig. 1 and Fig. 2 are those most widely used and most generally satisfactory. They are particularly suitable for ferrous metals, excepting cast iron.[3] The Charpy specimen designations are V-notch and U-notch.

[3] Report of Subcommittee XV on Impact Testing of Committee A03 on Cast Iron, Proceedings, ASTM, Vol 33 Part 1, 1933.

NOTE 1—Keyhole notch specimen is similar to U-notch, except the notch width is 1.6 mm or less.

8.1.4 The specimens commonly found suitable for powder metallurgy materials are shown in Fig. 3 and Fig. 4. Powder metallurgy impact test specimens shall be produced following the procedure in Practices B925. The impact test results of these materials are affected by specimen orientation. Therefore, unless otherwise specified, the position of the specimen in the machine shall be such that the pendulum will strike a surface that is parallel to the compacting direction. For powder metallurgy materials the impact test results are reported as unnotched absorbed energy.

8.1.5 Sub-size and supplementary specimen recommendations are given in Annex A3.

8.2 *Specimen Machining:*

8.2.1 When heat-treated materials are being evaluated, the specimen shall be finish machined, including notching, after the final heat treatment, unless it can be demonstrated that the impact properties of specimens machined before heat treatment are identical to those machined after heat treatment.

8.2.2 Notches shall be smoothly machined, but polishing has proven generally unnecessary.

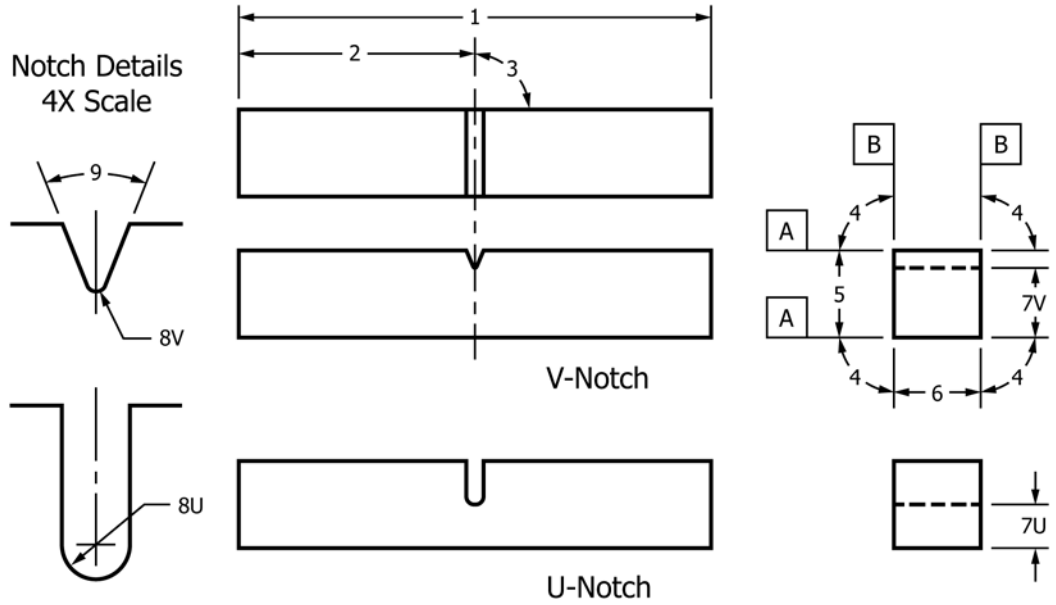
NOTE 2—Variations in notch dimensions will affect the results of the tests. Appendix X1.2 illustrates the effects from varying notch dimensions on V-notch specimens.

NOTE 3—In keyhole notch specimens, carefully drill the round hole with a slow feed rate. Exercise care in cutting the slot to ensure that the surface of the drilled hole opposite the slot is not damaged.

8.2.3 Identification marks shall only be placed in the following locations on specimens: either of the 10-mm square ends; the side of the specimen that faces up when the specimen is positioned in the anvils (see Note 4); or the side of the specimen opposite the notch. No markings, on any side of the specimen, shall be within 10 mm of the center line of the notch. Permanent markers, laser engraving, scribes, electrostatic pencils, and other reasonable marking methods may be used for identification purposes. However, some marking methods can result in damage to the specimens if not used correctly. For example, excessive heat from electrostatic pencils or deformation to the specimen from stamping can change the mechanical properties of the specimen. Therefore, care shall always be taken to avoid damage to the specimen. Stamping and other marking processes that result in deformation of the specimen should only be used on the ends of the specimens, prior to notching.

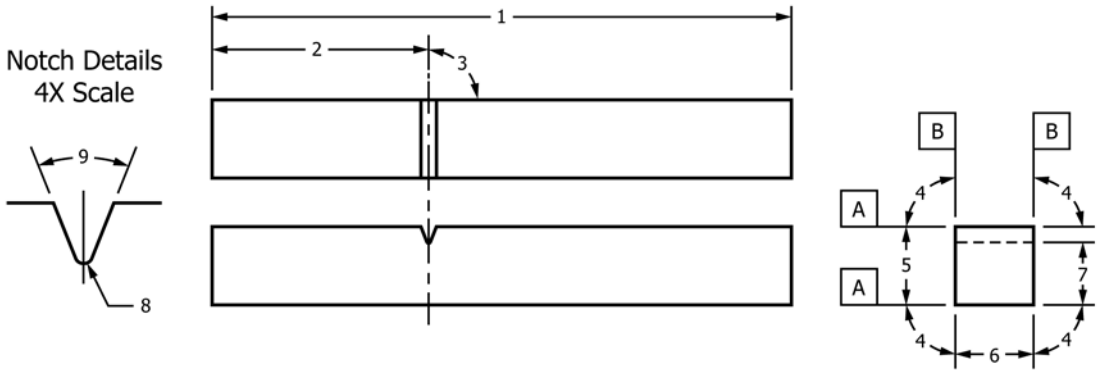
NOTE 4—Careful consideration should be given before placing identification marks on the side of the specimen to be placed up when positioned in the anvils. If the test operator is not careful, the specimen can be placed in the machine with the identification marking resting on the specimen supports (that is, facing down). Under these circumstances, the absorbed energy value obtained may be unreliable.

8.2.4 Test specimens shall conform to the dimensions and tolerances shown in Fig. 1 or any other applicable figure in this test method.



ID Number	Description	Dimension	Tolerance
1	Length of specimen	55 mm	+0/-2.5 mm
2	Centering of notch		±1 mm
3	Notch length to edge	90°	±2°
4	Adjacent sides angle	90°	±0.17°
5	Width	10 mm	±0.075 mm
6	Thickness	10 mm	±0.075 mm
7V	Ligament length, Type V	8 mm	±0.025 mm
7U	Ligament length, Type U	5 mm	±0.075 mm
8V	Radius of notch, Type V	0.25 mm	±0.025 mm
8U	Radius of notch, Type U	1 mm	±0.025 mm
9	Angle of notch	45°	±1°
A	Surface finish requirements	2 µm (Ra)	≤
B	Surface finish requirements	4 µm (Ra)	≤

FIG. 1 Charpy (Simple-Beam) Impact Test Specimens, V-Notch and U-Notch



ID Number	Description	Dimension	Tolerance
1	Length of specimen	75 mm	+0/-2.5 mm
2	Notch to top	28 mm	
3	Notch length to edge	90°	±2°
4	Adjacent sides angle	90°	±0.17°
5	Width	10 mm	±0.025 mm
6	Thickness	10 mm	±0.025 mm
7	Ligament length	8 mm	±0.025 mm
8	Radius of notch	0.25 mm	±0.025 mm
9	Angle of notch	45°	±1°
A	Surface finish requirement	2 µm (Ra)	≤
B	Surface finish requirement	4 µm (Ra)	≤

FIG. 2 Izod (Cantilever-Beam) Impact Test Specimen