INTERNATIONAL STANDARD

ISO 148-1

Second edition
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Metallic materials — Charpy pendulum impact test —

Part 1: Test method

Matériaux métalliques — Essai de flexion par choc sur éprouvette Charpy —

Partie 1: Méthode d'essai

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 148-1 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 4, *Toughness testing — Fracture (F), Pendulum (P), Tear (T)*.

This second edition cancels and replaces the first edition (ISO 148-1:2006), which has been technically revised.

ISO 148 consists of the following parts, under the general title *Metallic materials — Charpy pendulum impact test*:

— *Part 1: Test method*

— *Part 2: Verification of testing machines*

— *Part 3: Preparation and characterization of Charpy V-notch test pieces for indirect verification of pendulum impact machines*

Annexes B and C are based on ASTM E23 (*Standard Test Methods for Notched Bar Impact Testing of Metallic Materials)*, copyright ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, USA.

Metallic materials — Charpy pendulum impact test —

Part 1: Test method

1 Scope

This part of ISO 148 specifies the Charpy pendulum impact (V-notch and U-notch) test method for determining the energy absorbed in an impact test of metallic materials.

This part of ISO 148 does not apply to instrumented impact testing, which is specified in ISO 14556.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 148-2:2008, *Metallic materials — Charpy pendulum impact test — Part 2: Verification of testing machines*

ISO 286-1, *Geometrical product specifications (GPS) — ISO code system for tolerances of linear sizes — Part 1: Basis of tolerances, deviations and fits*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Energy

3.1.1
initial potential energy
potential energy
K_p
difference between the potential energy of the pendulum hammer prior to its release for the impact test, and the potential energy of the pendulum hammer at the position of impact, as determined by direct verification

[ISO 148-2:2008, definition 3.2.2]

3.1.2
absorbed energy
K
energy required to break a test piece with a pendulum impact testing machine, after correction for friction

NOTE The letter V or U is used to indicate the notch geometry, that is: KV or KU. The number 2 or 8 is used as a subscript to indicate striker radius, for example KV_2.

3.2 Test piece

With the test piece placed in the test position on the supports of the machine, the following nomenclature shall apply (see Figure 1).

3.2.1
height
h
distance between the notched face and the opposite face

3.2.2
width
w
dimension perpendicular to the height that is parallel to the notch

3.2.3
length
l
the largest dimension at right angles to the notch

4 Symbols and abbreviated terms

The symbols and designations applicable to this part of ISO 148 are indicated in Tables 1 and 2, and are illustrated in Figure 2.

Table 1 — Symbols and their unit and designation

Symbol	Unit	Designation
K_p	J	Initial potential energy (potential energy)
FA	%	Shear-fracture appearance
h	mm	Height of test piece
KU_2	J	Absorbed energy for a U-notch test piece using a 2 mm striker
KU_8	J	Absorbed energy for a U-notch test piece using an 8 mm striker
KV_2	J	Absorbed energy for a V-notch test piece using a 2 mm striker
KV_8	J	Absorbed energy for a V-notch test piece using a 8 mm striker
LE	mm	Lateral expansion
l	mm	Length of test piece
T_t	°C	Transition temperature
w	mm	Width of test piece

5 Principle

This test consists of breaking a notched test piece with a single blow from a swinging pendulum, under the conditions defined in Clauses 6, 7 and 8. The notch in the test piece has specified geometry and is located in the middle between two supports, opposite to the location which is struck in the test. The energy absorbed in the impact test is determined.

Because the impact values of many metallic materials vary with temperature, tests shall be carried out at a specified temperature. When this temperature is other than ambient, the test piece shall be heated or cooled to that temperature, under controlled conditions.

6 Test pieces

6.1 General

The standard test piece shall be 55 mm long and of square section, with 10 mm sides. In the centre of the length, there shall be either a V-notch or a U-notch, as described in 6.2.1 and 6.2.2, respectively.

If the standard test piece cannot be obtained from the material, one of the subsidiary test pieces, having a width of 7,5 mm, 5 mm or 2,5 mm (see Figure 2 and Table 2), shall be used.

NOTE For low energies, the use of shims is important, as excess energy is absorbed by the pendulum. For high energies, this might not be important. Shims can be placed on or under the test piece supports, with the result that the mid-height of the specimen is 5 mm above the 10 mm specimen-support surface.

The test pieces shall have a surface roughness of better than Ra 5 µm except for the ends.

When a heat-treated material is being evaluated, the test piece shall be finish-machined, including notching, after the final heat treatment, unless it can be demonstrated that there is no difference when machined prior to heat treatment.

6.2 Notch geometry

The notch shall be carefully prepared so that the root radius of the notch is free of machining marks which could affect the absorbed energy.

The plane of symmetry of the notch shall be perpendicular to the longitudinal axis of the test piece (see Figure 2).

6.2.1 V-notch

The V-notch shall have an included angle of 45°, a depth of 2 mm, and a root radius of 0,25 mm [see Figure 2 a) and Table 2].

6.2.2 U-notch

The U-notch shall have a depth of 5 mm (unless otherwise specified) and a root radius of 1 mm [see Figure 2 b) and Table 2].

6.3 Tolerance of the test pieces

The tolerances on the specified test piece and notch dimensions are shown in Figure 2 and Table 2.

6.4 Preparation of the test pieces

Preparation shall be carried out in such a way that any alteration of the test piece, for example due to heating or cold working, is minimized.

6.5 Marking of the test pieces

The test piece may be marked on any face not in contact with supports, anvils or striker and at a position which avoids the effects of plastic deformation and surface discontinuities on the absorbed energy measured in the test (see 8.7).

7 Test equipment

7.1 General

The equipment used for all measurements shall be traceable to national or International Standards. They shall be calibrated within suitable intervals.

7.2 Installation and verification

The testing machine shall be installed and verified in accordance with ISO 148-2.

7.3 Striker

The striker geometry shall be specified as being either the 2 mm striker or the 8 mm striker. It is recommended that the striker radius be shown as a subscript as follows: KV_2 or KV_8.

Reference shall be made to the product specification for striker geometry guidance.

NOTE Some materials can yield significantly varying results (per cent difference) at low energy levels and the 2 mm results can be higher than the 8 mm results.

8 Test procedure

8.1 General

The test piece shall lie squarely against the anvils of the testing machine, with the plane of symmetry of the notch within 0,5 mm of the midplane between the anvils. It shall be struck by the striker in the plane of symmetry of the notch and on the side opposite the notch (see Figure 1).

8.2 Test temperature

8.2.1 Unless otherwise specified, tests shall be carried out at (23 ± 5) °C. If a temperature is specified, the test piece shall be conditioned to that temperature to within ± 2 °C.

8.2.2 For conditioning, either heating or cooling, using a liquid medium, the test piece shall be positioned in a container on a grid that is at least 25 mm above the bottom of the container and covered by at least 25 mm of liquid and be at least 10 mm from the sides of the container. The medium shall be constantly agitated and brought to the specified temperature by any convenient method. The device used to measure the temperature of the medium should be placed in the centre of the group of test pieces. The temperature of the medium shall be held at the specified temperature to within ± 1 °C for at least 5 min.

NOTE When a liquid medium is near its boiling point, evaporative cooling can dramatically lower the temperature of the test piece during the interval between removal from the liquid and fracture (see ASTM STP 1072 [5]).

8.2.3 For conditioning, either heating or cooling, using a gaseous medium, the test piece shall be positioned in a chamber at least 50 mm from the nearest surface. Individual test pieces shall be separated by at least 10 mm. The medium shall be constantly circulated and brought to the specified temperature by any convenient method. The device used to measure the temperature of the medium should be placed in the centre of the group of test pieces. The temperature of the gaseous medium shall be held at the specified temperature within ± 1 °C for at least 30 min.

8.3 Specimen transfer

When testing is performed at other than ambient temperature, not more than 5 s shall pass between the time the test piece is removed from the heating or cooling medium and the time it is struck by the striker.

The transfer device shall be designed and used in such a way that the temperature of the test piece is maintained within the permitted temperature range.

The parts of the device in contact with the specimen during transfer from the medium to the machine shall be conditioned with the specimens.

Care should be taken to ensure that the device used to centre the test piece on the anvils does not cause the fractured ends of low-energy, high-strength test pieces to rebound off this device into the pendulum and cause erroneously-high indicated energy. It has been shown that clearance between the end of a test piece in the test position and the centring device, or a fixed portion of the machine, shall be greater than approximately 13 mm or else, as part of the fracture process, the ends can rebound into the pendulum.

NOTE Self-centring tongs, similar to those for V-notched test pieces in Annex A, are often used to transfer the test piece from the temperature-conditioning medium to the proper test position. Tongs of this nature eliminate potential clearance problems due to interference between the fractured specimen halves and a fixed centring device.

8.4 Exceeding machine capacity

The absorbed energy, K, should not exceed 80 % of the initial potential energy, K_p. If the absorbed energy exceeds this value, the absorbed energy shall be reported as approximate and it shall be noted in the test report that it exceeded 80 % of the machine capacity.

NOTE Ideally, an impact test would be conducted at a constant impact velocity. In a pendulum-type test, the velocity decreases as the fracture progresses. For specimens with impact energies approaching the capacity of the pendulum, the velocity of the pendulum decreases during fracture to the point that accurate impact energies are no longer obtained.

8.5 Incomplete fracture

If a test piece is not completely broken in a test, the impact energy may be reported or averaged with the results of the completely broken test pieces.

8.6 Test piece jamming

If any test piece jams in the machine, the results shall be disregarded and the machine thoroughly checked for damage that would affect its calibration.

NOTE Jamming occurs when a broken test piece is caught between moving and non-moving parts of the testing machine. It can result in significant energy absorption. Jamming can be differentiated from secondary strike marks, because a jam is associated with a pair of opposing marks on the specimen.

8.7 Post-fracture inspection

If post-fracture inspection shows that any portion of the marking is in a portion of the test piece which is visibly deformed, the test result might not be representative of the material and this shall be noted in the test report.

9 Test report

9.1 Mandatory information

The test report shall include the following information:

a) a reference to this part of ISO 148, i.e. ISO 148-1:2009;

b) identification of the test piece (e.g. type of steel and cast number);

c) the type of notch;

d) the size of the test piece, if other than full size;

e) the conditioning temperature of the test piece;

f) the absorbed energy, KV_2, KV_8, KU_2 or KU_8, as appropriate;

g) any abnormalities that can affect the test.

9.2 Optional information

The test report may optionally include, in addition to the information in 9.1:

a) the test-piece orientation (see ISO 3785);

b) the nominal energy of the testing machine, in joules;

c) the lateral expansion (see Annex B);

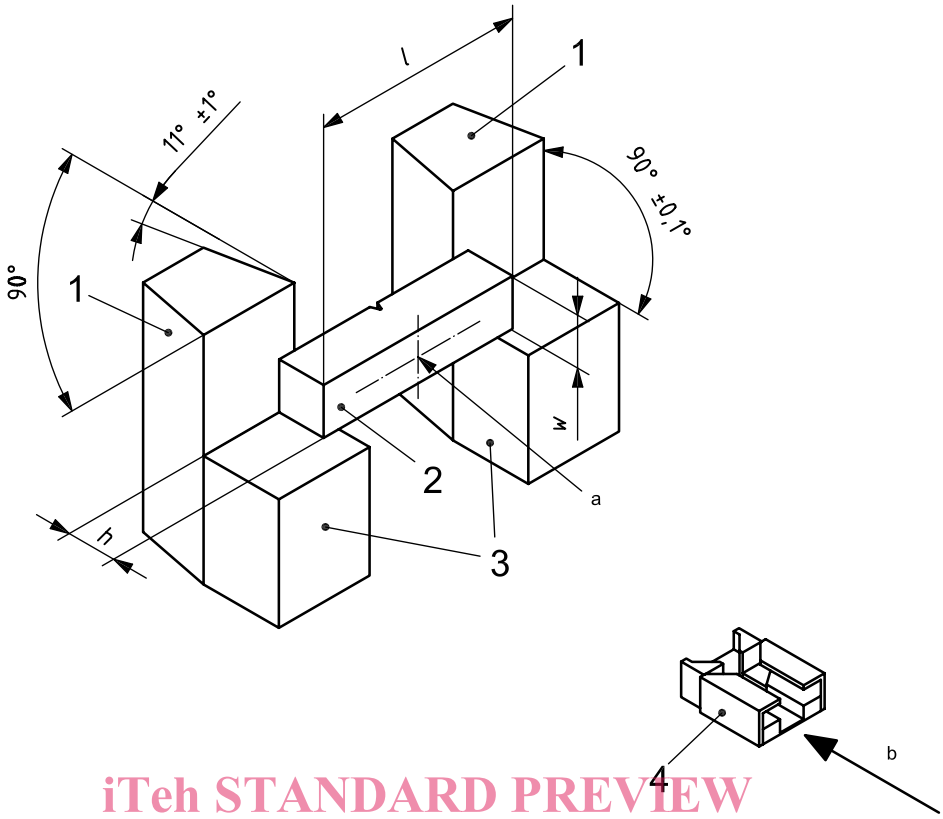
d) the fracture appearance, per cent shear (see Annex C);

e) the absorbed energy/temperature curve (see D.1);

f) the transition temperature and the criteria used (see D.2);

g) the number of test pieces which were not completely broken in the test;

h) the measurement uncertainty (see Annex E).

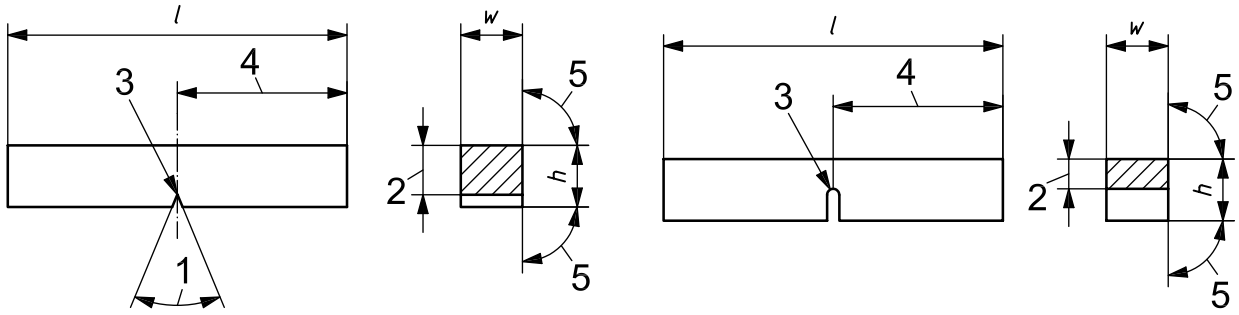


Key

1 anvil
2 standard-sized test piece
3 test piece supports
4 shroud

h height of test piece
l length of test piece
w width of test piece
a Centre of strike.
b Direction of pendulum swing.

Figure 1 — Test piece terminology showing configuration of test piece supports and anvils of a pendulum impact-testing machine



a) V-notch geometry

b) U-notch geometry

NOTE The symbols l, h, w and the numbers 1 to 5 refer to Table 2.

Figure 2 — Charpy pendulum impact test piece

Table 2 — Tolerances on specified test piece dimensions

Designation	Symbol and No.	V-notch test piece			U-notch test piece		
		Nominal dimension	Machining tolerance	Tolerance class [a]	Nominal dimension	Machining tolerance	Tolerance class [a]
Length	l	55 mm	± 0,60 mm	js15	55 mm	± 0,60 mm	js15
Height [b]	h	10 mm	± 0,075 mm	js12	10 mm	± 0,11 mm	js13
Width [b]:	w						
— standard test piece		10 mm	± 0,11 mm	js13	10 mm	± 0,11 mm	js13
— reduced-section test piece		7,5 mm	± 0,11 mm	js13	—	—	—
— reduced-section test piece		5 mm	± 0,06 mm	js12	—	—	—
— reduced-section test piece		2,5 mm	± 0,05 mm	js12	—	—	—
Angle of notch	1	45°	± 2°	—	—	—	—
Height below notch (height of test piece minus depth of notch)	2	8 mm	± 0,075 mm	js12	5 mm [c]	± 0,09 mm	js13
Radius of curvature at base of notch	3	0,25 mm	± 0,025 mm	—	1 mm	± 0,07 mm	js12
Distance of plane of symmetry of notch from ends of test piece [b]	4	27,5 mm	± 0,42 mm [d]	js15	27,5 mm	± 0,42 mm [d]	js15
Angle between plane of symmetry of notch and longitudinal axis of test piece		90°	± 2°	—	90°	± 2°	—
Angle between adjacent longitudinal faces of test piece	5	90°	± 2°	—	90°	± 2°	—

[a] In accordance with ISO 286-1.

[b] The test pieces shall have a surface roughness better than Ra 5 µm except for the ends.

[c] If another height (2 mm or 3 mm) is specified, the corresponding tolerances shall also be specified.

[d] For machines with automatic positioning of the test piece, it is recommended that the tolerance be taken as ± 0,165 mm instead of ± 0,42 mm.