
**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

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 4, *Toughness testing — Fracture (F), Pendulum (P), Tear (T)*.

This third edition cancels and replaces the second edition (ISO 148-1:2009), 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*

Metallic materials — Charpy pendulum impact test —

Part 1: Test method

1 Scope

This part of ISO 148 specifies the Charpy (V-notch and U-notch) pendulum impact test method for determining the energy absorbed in an impact test of metallic materials. This part of ISO 148 does not cover instrumented impact testing, which is specified in ISO 14556.

[Annexes B](#) and [C](#) are based on ASTM E23 and are used with the permission of ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, USA.

2 Normative references

The following referenced documents, in whole or in part, are normatively referenced in this document and 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, *Metallic materials — Charpy pendulum impact test — Part 2: Verification of testing machines*

ISO 286-1, *Geometrical product specifications (GPS) — ISO code system for tolerances on 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 Definitions pertaining to energy

3.1.1

initial potential energy

potential energy

K_p

potential energy of the pendulum hammer prior to its release for the impact test, as determined by direct verification

3.1.2

absorbed energy

K

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

Note 1 to entry: 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 the radius of the striker, for example KV_2 .

3.1.3

nominal initial potential energy

nominal energy

K_N

energy assigned by the manufacturer of the pendulum impact testing machine

3.2 Definitions pertaining to test piece

3.2.1

width

W

distance between the notched face and the opposite face

Note 1 to entry: See Figure 1.

Note 2 to entry: In previous versions of the ISO 148 series (prior to 2016), the distance between the notched face and the opposite face was specified as “height”. Changing this dimension to “width” makes this part of ISO 148 consistent with the terminology used in other ISO fracture standards.

3.2.2

thickness

B

dimension perpendicular to the width and parallel to the notch

Note 1 to entry: See Figure 1.

Note 2 to entry: In previous versions of the ISO 148 series (prior to 2016), the dimension perpendicular to the width that is parallel to the notch was specified as “width”. Changing this dimension to “thickness” makes this part of ISO 148 consistent with the terminology used in other ISO fracture standards.

3.2.3

length

L

largest dimension perpendicular to the notch

Note 1 to entry: See Figure 1.

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
B	mm	thickness of test piece
α	°	angle of fall of the pendulum
β_1	J or °	angle of rise when the machine is operated in the normal manner without a test piece in position
β_2	J or °	angle of rise when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
L	mm	length of test piece
LE	mm	lateral expansion
K	J	absorbed energy (expressed as KV_2 , KV_8 , KU_2 , KU_8 , to identify specific notch geometries and the radius of the striking edge)
K_1	J or °	indicated absorbed energy when the machine is operated in the normal manner without a test piece in position
K_2	J or °	indicated absorbed energy when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
K_N	J or °	nominal initial potential energy
K_p	J	initial potential energy (potential energy)
KV_2	J	absorbed energy for a V-notch test piece using a 2 mm striker

Table 1 (continued)

Symbol	Unit	Designation
KV_8	J	absorbed energy for a V-notch test piece using a 8 mm striker
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
M	N·m	moment equal to the product $F \cdot l_2$
p	J	absorbed energy loss caused by pointer friction
p'	J	absorbed energy loss caused by bearing friction and air resistance
p_β	J	correction of absorbed energy losses for an angle of rise β
SFA	%	shear fracture appearance
T_t	°C	transition temperature
W	mm	width of test piece
T_{t27}	°C	transition temperature defined at a specific value of absorbed energy; for example, 27 J
$T_{t50 \%US}$	°C	transition temperature defined at a particular percentage of the absorbed energy of the upper shelf; for example, 50 %
$T_{t50 \%SFA}$	°C	transition temperature defined at a particular proportion of shear fracture; for example, 50 %
$T_{t0,9}$	°C	transition temperature defined at a particular amount of lateral expansion; for example, 0,9 mm

5 Principles of the test

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 a specified geometry and is located in the middle between two supports, opposite to the location which is impacted in the test. The energy absorbed in the impact test, the lateral expansion and the shear fracture appearance are normally 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.

The Charpy pendulum impact test is often used in routine, high-throughput pass/fail acceptance tests in industrial settings. For these tests, it may not be important whether the test sample is completely broken, partially broken, or simply plastically deformed and dragged through the anvils. In research, design, or academic settings, the measured energy values are studied in more detail, in which case it can be highly relevant whether the sample is broken or not.

It is important to note that not all Charpy pendulum impact test results can be directly compared. For example, the test can be performed with hammers having strikers with different radii, or with different test piece shapes. Tests performed with different strikers can give different results,[\[2\]](#) and test results obtained with differently shaped test pieces can as well. This is why not only the adherence to ISO 148 but also a clear and complete reporting of the type of instrument, the test piece and the details of the post-test test pieces are crucial for comparability of results.

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 subsize test pieces, having a thickness of 7,5 mm, 5 mm or 2,5 mm (see [Figure 2](#) and [Table 2](#)), shall be used, if not otherwise specified.

NOTE 1 Direct comparison of results is only of significance when made between test pieces of the same form and dimensions.

NOTE 2 For low energies, the use of shims to better position subsize test pieces relative to the centre of strike is important to avoid excess energy absorption by the pendulum. For high energies, this might not be as important. Shims can be placed on or under the test piece supports, with the result that the mid-thickness of the specimen is 5 mm above the 10 mm supports. Shims can be temporarily fixed to the supports using tape or another means.

When a heat-treated material is being evaluated, the test piece shall be finish-machined and notched after the final heat treatment, unless it can be demonstrated that machining before heat treatment does not affect test results.

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 executed 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 where plastic deformation and surface discontinuities caused by marking do not affect the absorbed energy (see [8.8](#)).

7 Test equipment

7.1 General

The measurements of the instrument and test piece details shall be traceable to national or international standards. Equipment used for measurements 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 radius on the striker be shown as a subscript as follows: KV_2 or KV_8 and KU_2 or KU_8 .

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

NOTE Tests carried out with 2 mm and 8 mm strikers can give different results.^[7]

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 mid-plane 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 Friction measurement

The energy absorbed by friction shall be checked on every testing day prior to the first test. The friction losses may be estimated as explained below, but other methods may also be applied.

NOTE The energy absorbed by friction includes, but is not limited to, air resistance, bearing friction and the friction of the indicating pointer. Increases in friction on a machine can influence the measure of absorbed energy.

8.2.1 To determine the loss caused by pointer friction the machine is operated in the normal manner, but without a test piece in position, and the angle of rise, β_1 , or energy reading, K_1 , is noted. A second test is then carried out without resetting the indication pointer and the new angle of rise, β_2 , or energy reading, K_2 , is noted. Thus, the loss due to friction in the indicating pointer during the rise is equal to

$$p = M(\cos \beta_1 - \cos \beta_2) \quad (1)$$

when the scale is graduated in degrees, or

$$p = K_1 - K_2 \quad (2)$$

when the scale is graduated in energy units.

NOTE For machines without a pointer, this friction measurement is not necessary.

8.2.2 The procedure to determine the losses caused by bearing friction and air resistance for one half swing is as follows.

After determining β_2 or K_2 , the pendulum is returned to its initial position. Without resetting the indicating mechanism, release the pendulum without shock and vibration and permit it to swing 10 half swings. After the pendulum starts its 11th half swing, move the indicating mechanism to about