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Metallic materials — Charpy pendulum impact test —

Part 3:
Preparation and characterization of Charpy V reference test pieces for verification of test machines

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

Partie 3: Préparation et caractérisation des éprouvettes de référence Charpy V pour la vérification des machines d'essai (mouton-pendule)

Contents

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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.

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.

International Standard ISO 148-3 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 4, *Toughness testing.*

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 test machines*

— *Part 3: Preparation and characterization of Charpy V reference test pieces for verification of test machines*

Annex A of this part of ISO 148 is for information only.

Introduction

The suitability of a pendulum impact testing machine for acceptance testing of metallic materials usually has been based on a calibration of its scale and verification of compliance with specified dimensions, such as the shape and spacing of the anvils supporting the specimen. The scale calibration is commonly verified by measuring the mass of the pendulum and its elevation at various scale readings. This procedure for evaluation of machines had the distinct advantage of requiring only measurements of quantities which can be traced to national standards. The objective nature of these traceable measurements minimized the necessity for arbitration regarding the suitability of the machines for material acceptance tests.

However, sometimes two machines that had been evaluated by the direct-verification procedures described above, and which met all dimensional requirements, were found to give significantly different impact values when testing test pieces of the same material. This difference was commercially important when values obtained using one machine met the material specification, while the values obtained using the other machine did not.

To avoid such disagreements, some purchasers of materials added the requirement that all impact machines used for acceptance testing of material sold to them must be indirectly verified by testing reference test pieces supplied by them. A machine was considered acceptable only if the values obtained using the machine agreed, within specified limits, with the value furnished with the reference test pieces. Successful experience in the use of reference test pieces led to the requirement in ISO 148-2 that indirect verification must be performed using reference test pieces in addition to direct verification. Many national standards and codes also require indirect verification using reference test pieces: for example, EN 10045-2:1992, *Metallic materials — Charpy impact test — Part 2: Verification of the testing machine (pendulum impact)*, and ASTM E 23:1994b, *Test methods for notched bar impact testing of metallic materials*, require the use of notched test pieces. The purpose of this part of ISO 148 is to specify the requirements, preparation and methods of qualifying these reference test pieces by means of a reference machine. The indirect verification of the reference machine is carried out with reference test pieces which have been certified by a third party. As information, annex A shows this approach schematically.

Metallic materials — Charpy pendulum impact test —

Part 3:
Preparation and characterization of Charpy V reference test pieces for verification of test machines

1 Scope

This part of ISO 148 covers the requirements, preparation and methods of qualifying test pieces that are used to indirectly verify pendulum impact testing machines in accordance with ISO 148-2 and with the certificate for reference test pieces.

It describes notched test pieces with nominal dimensions identical to those specified in ISO 148-1. However, the tolerances are more stringent. The chemical composition or heat treatment or both are varied according to the energy level desired.

Reference test pieces are qualified on reference pendulum impact machines which are also described in this document.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 148. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 148 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 148-1:—[1)], *Metallic materials — Charpy pendulum impact test — Part 1: Test method.*

ISO 148-2:1998, *Metallic materials — Charpy pendulum impact test — Part 2: Verification of test machines.*

3 Definitions

For the purposes of this part of ISO 148, the following definitions apply.

3.1 industrial machine: Pendulum impact testing machine used for industrial and most research-laboratory testing of metallic materials. These machines are not used to establish reference values. Industrial machines are verified using direct verification and indirect verification with reference test pieces.

1) To be published. (Revision of ISO 83:1976 and ISO 148:1983)

3.2 reference machine: Pendulum impact testing machine used to determine the reference energy of a reference test piece. The verification requirements for this grade of machine are more stringent than those for industrial machines.

3.3 Definitions pertaining to energy

3.3.1 actual absorbed energy (absorbed energy), A_V**:** The total energy required to break a test piece when tested by a pendulum impact testing machine. It is equal to the difference in the potential energy from the starting position of the pendulum to the end of the first half-swing during which the test piece is broken.

3.3.2 indicated absorbed energy (**indicated energy),** A_S**:** The energy value indicated by the pointer or other readout device of a pendulum impact testing machine.

3.3.3 reference energy, A_R**:** The absorbed energy associated with reference test pieces, determined from tests made using reference machines. It is the mean value of the set tested (see also clause 6).

3.4 lot: A definite quantity of reference test pieces manufactured under identical conditions of production.

3.5 reference test piece: An impact test piece used to verify the suitability of an industrial pendulum impact testing machine by comparing the indicated energy measured by that machine to the reference energy associated with the test piece (see clause 8).

3.6 certified reference test piece: An impact test piece used to verify reference machines by comparing the impact energy measured by that machine to the certified reference value associated with the test piece.

NOTE — The certified reference value is the value determined by a national or international body following an inter-comparison exercise carried out on a group of reference machines within its jurisdiction.

3.7 set: A group of test pieces chosen at random from a lot.

3.7.1 characterization set: A set of test pieces taken from a lot in accordance with clause 6 and used to determine the reference energy of the lot.

3.7.2 reference set: A set of test pieces chosen in accordance with clauses 6 and 8 and used to verify a pendulum impact testing machine.

3.8 Definitions pertaining to the test piece (placed in the test position on the supports of the machine (see figures 1 and 2)

3.8.1 height: The distance between the notched face and the opposite face.

3.8.2 width: The dimension perpendicular to the height and parallel to the notch.

3.8.3 length: The largest dimension at right angles to the notch.

4 Symbols

The symbols used in this part of ISO 148 are as indicated in table 1.

Table 1 — Symbols and their meanings

Symbol	Unit	Meaning
A_V	J	Actual absorbed energy; absorbed energy
A_S	J	Indicated absorbed energy; indicated energy
A_R	J	Reference energy of a set of Charpy reference test pieces

5 Reference test machine

5.1 Characteristics

The characteristics of reference machines used to determine the reference energy of reference test pieces shall comply with the requirements of ISO 148-2 except as modified below:

5.1.1 Geometrical characteristics (see table 2 and figures 1 and 2)

a) The radius of curvature of the anvils shall be $\left(1^{+0,1}_{0}\right)$ mm.

b) The distance between the anvils shall be $\left(40^{+0,1}_{0}\right)$ mm.

c) The striking edge shall remain within 0,25 mm of the plane of symmetry of the anvils.

d) The striker shall conform to the geometry specified in ISO 148-2 for either the 2 mm or the 8 mm striker.

Table 2 — Geometrical characteristics (see figures 1 and 2)

Number	Designation	Size	Tolerance	Units
1	Length of test piece	55,00	$^{+0}_{-0,30}$ *	mm
2	Half-length of test piece	27,5	±0,20*	mm
3	Height of test piece	10,00	±0,06	mm
4	Width of test piece	10,00	±0,075*	mm
5	Ligament length	8,00	±0,06	mm
6	Angle of notch	45	±1*	deg
7	Radius of curvature of base of notch	0,250	±0,025	mm
8	Angle between adjacent faces	90	±0,15*	deg
9	Angle between plane of symmetry of notch and longitudinal axis	90	±2	deg
10	Radius of anvils	1	$^{+0,1}_{-0}$ *	mm
11	Angle of taper of anvils	11	±1	deg
12	Distance between anvils	40,0	$^{+0,1}_{-0}$ *	mm
13	Distance of striking edge from plane of symmetry of anvils	22	±0,25*	mm
14	Angle of striker	30	±1	deg
15A	Radius of curvature of striking edge of 2 mm striker	2 to 2,5		mm
15B	Radius of curvature of striking edge of 8 mm striker	8,0	±0,05	mm
15C	Radius of shoulder of 8mm striker	0,2 to 1,0		mm
15D	Width of striking edge of 8 mm striker	4,0	±0,05	mm
NOTE — Tolerances followed by an asterisk (*) are tighter than those in ISO 148-1 or ISO 148-2.				

The radius at the base of the notch shall be tangential to the notch angle.

The surface finish shall not exceed 1,6 µm on the notched surface or 3,2 µm on the other surfaces.

Identification marks shall not be placed in any area of the test piece that contacts the striker edge, anvils or test piece supports, or within 5 mm of the notch.

5.1.2 Capacity

The capacity of a reference machine shall be 300 J or greater.

5.1.3 Hardness

The portions of the striker and the anvils (see figure 1) which contact the specimen and apply or react to the impacting force shall have a minimum hardness of 56 HRC.

5.1.4 Vibration

Ensure that the reference machine is not subjected to external (random) vibrations induced by other equipment in close proximity, such as forging hammers, presses, moving vehicles.

NOTE — Such vibrations can be detected by placing a small container of water at any convenient location on the machine framework; the absence of ripples on the water surface indicates that this requirement is met. Excessive vibration in a machine firmly fastened to the floor indicates the need for a separate foundation and/or the use of vibration isolators.

5.1.5 Energy-indicating mechanism

The resolution shall be at least 1/400th of the nominal energy.

5.2 Qualification of reference test machine

Direct verification shall be carried out in accordance with ISO 148-2 and with the additional requirements of 5.1.

Indirect verification shall be carried out using certified reference test pieces. The repeatability and the error shall be as specified in table 3.

Table 3 — Repeatability and error of reference pendulum impact machines
(all values in joules)

Energy E	Repeatability	Error
< 40	⩽ 3	⩽ 2
⩾ 40	⩽ 7,5 % of A_R	⩽ 5 % of A_R

Repeatability is given by : $A_{V\,max} - A_{V\,min}$

Error is given by : $\overline{A}_V - A_R$

where

$$\overline{A}_V = \frac{A_{V1} + A_{V2} + A_{V3} + \ldots \quad A_{Vn}}{n}$$

5.3 Use of reference test machine

The procedure for the operation of the reference machine shall conform to the requirements of ISO 148 and to the following additional requirements:

5.3.1 The angular position of the pendulum at the extremes of its swing or the impact energy calculated therefrom shall be automatically recorded in digital or graphical form. These records shall be in permanent form suitable for evaluation at any time until one year after the entire batch of reference test pieces has been distributed.

5.3.2 The combined windage and friction loss during 11 successive half-swings shall be measured before and after testing each characterization set and the values recorded.