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Metallic materials — Charpy pendulum impact test —

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

Matériaux métalliques — Essai de flexion par choc sur éprouvette Charpy

Partie 3: Préparation et caractérisation des éprouvettes Charpy à entaille en V pour la vérification indirecte des machines d'essai mouton-pendule

Reference number
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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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).

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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 148-3:2008), 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*

Introduction

The suitability of a pendulum impact testing machine for acceptance testing of metallic materials has usually 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 test piece. 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 that could 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 pendulum impact testing machines used for acceptance testing of material sold to them should 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 should be performed using reference test pieces in addition to direct verification. Other standards and codes also require indirect verification using reference test pieces; for example, EN 10045-2[1] (now obsolete) and ASTM E23[2] require the use of reference test pieces. The purpose of this part of ISO 148 is to specify the requirements, preparation and methods for qualifying test pieces used for the indirect verification of pendulum impact testing machines.

Metallic materials — Charpy pendulum impact test —

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

1 Scope

This part of ISO 148 specifies the requirements, preparation and methods for qualifying test pieces used for the indirect verification of pendulum impact testing machines in accordance with ISO 148-2.

It specifies notched test pieces with nominal dimensions identical to those specified in ISO 148-1; however, the tolerances are more stringent.

NOTE 1 The chemical composition or heat treatment, or both, are varied according to the energy level desired.

NOTE 2 Reference test pieces are qualified on reference pendulum impact testing machines which are also described in this part of ISO 148.

2 Normative references

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

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

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

3 Terms and definitions

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

3.1 Definitions pertaining to the machine

3.1.1
industrial machine
pendulum impact testing machine used for industrial, general or most research-laboratory testing of metallic materials

Note 1 to entry: These machines are not used to establish reference values.

3.1.2
reference machine
pendulum impact testing machine used to determine certified values for batches of reference test pieces

3.2 Definitions pertaining to energy

3.2.1
total absorbed energy
K_T
total absorbed energy required to break a test piece with a pendulum impact testing machine, which is not corrected for any losses of energy

Note 1 to entry: 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.

3.2.2
absorbed energy
K
energy required to break a test piece with a pendulum impact testing machine, after correction for energy losses

Note 1 to entry: The letter V or U is used to indicate the notch geometry, i.e. *KV* or *KU*. The number 2 or 8 is used as a subscript to indicate the radius of the striking edge of the striker, for example KV_2.

3.2.3
reference absorbed energy
K_R
certified value of absorbed energy assigned to the test pieces used to verify the performance of pendulum impact testing machines

3.3 Definitions related to groups of test pieces

3.3.1
batch
definite quantity of reference test pieces manufactured under identical conditions of production, with a common certified absorbed energy

3.3.2
set
group of test pieces chosen at random from a batch

3.3.2.1
characterization set
set of test pieces taken from a batch and used to determine the reference energy of the batch

3.3.2.2
reference set
set of test pieces used to verify a pendulum impact testing machine

3.4 Definitions pertaining to test pieces

3.4.1
width
W
distance between the notched face and the opposite face

Note 1 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 ISO 148-1 consistent with the terminology used in other ISO fracture standards.

3.4.2
thickness
B
dimension perpendicular to the width and parallel to the notch

Note 1 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 ISO 148-1 consistent with the terminology used in other ISO fracture standards.

3.4.3
length
L
largest dimension perpendicular to the notch

3.4.4
reference test piece
impact test piece used to verify the suitability of a pendulum impact testing machine by comparing the indicated absorbed energy measured by that machine to the reference absorbed energy associated with the test pieces

3.4.5
certified reference test piece
impact test piece accompanied by a certificate providing the certified absorbed energy value, K_R, and its uncertainty at a stated level of confidence

Note 1 to entry: The certified reference value is the value determined by a certified national or international body, or by an organization accredited for the production of certified Charpy reference test pieces in accordance with ISO Guide 34[3], following the procedures described in this part of ISO 148.

4 Symbols and abbreviated terms

Table 1 — Symbols/abbreviated terms and their designations and units

Symbol/ abbreviated term	Unit	Designation
CRM	—	certified reference material
GUM	—	guide to the expression of uncertainty in measurement
k	—	coverage factor
K	J	absorbed energy
K_T	J	total absorbed energy
K_R	J	reference absorbed energy of a set of Charpy reference test pieces
KV	J	absorbed energy as measured in accordance with ISO 148-1 on a V-notched sample
KV_{char}	J	KV value as determined for a batch of V-notched Charpy reference materials in a batch certification characterization exercise
KV_{PB}	J	certified KV value of a PB reference material
KV_R	J	certified KV value of a Charpy reference material
KV_{SB}	J	certified KV value of an SB reference material
n_{hom}	—	number of samples tested for the homogeneity assessment
n_{PB}	—	number of PB specimens used to compare SB with PB
n_{SB}	—	number of SB specimens used to compare SB with PB
n_V	—	number of reference samples tested for the indirect verification of a pendulum impact testing machine
p	—	number of laboratories/instruments participating in a laboratory comparison

Table 1 *(continued)*

Symbol/ abbreviated term	Unit	Designation
PB	—	primary batch
REMCO	—	ISO Committee on Reference Materials
RM	—	reference material
SB	—	secondary batch
s_p	J	standard deviation of the mean K_V values obtained at p laboratories
s_{PB}	J	standard deviation of results obtained on n_{PB} PB samples when comparing them with n_{SB} SB samples
s_{RM}	J	standard deviation of the K_V values obtained on n_{hom} samples in the homogeneity assessment of the batch of reference material
u_{char}	J	standard uncertainty of KV_{char}
$u_{char,PB}$	J	standard uncertainty of KV_{char} for a PB
$u_{char,SB}$	J	standard uncertainty of KV_{char} for an SB
u_{hom}	J	standard uncertainty of the homogeneity assessment of the reference material
u_{lts}	J	standard uncertainty of the long-term-stability assessment of the reference material
u_{RM}	J	standard uncertainty of the certified value of a reference material used for indirect verification
U_{RM}	J	expanded uncertainty of the certified value of a reference material at a confidence level of about 95 %
u_{sts}	J	standard uncertainty of the short-term-stability assessment of a reference material
$u_{\bar{X}PB}$	J	standard uncertainty of $\bar{X}_{PB}$
$u_{\bar{X}SB}$	J	standard uncertainty of $\bar{X}_{SB}$
$\bar{X}_{PB}$	J	mean of n_{PB} specimens used to compare SB with PB
$\bar{X}_{SB}$	J	mean of n_{SB} specimens used to compare SB with PB
δKV_{hom}	J	part of the error of the measured KV value due to batch heterogeneity
δKV_{lts}	J	part of the error of the measured KV value due to long-term instability
δKV_{sts}	J	part of the error of the measured KV value due to short-term instability
v_{char}	—	degrees of freedom corresponding to u_{char}
v_{hom}	—	degrees of freedom corresponding to u_{hom}
v_{RM}	—	degrees of freedom corresponding to u_{RM}

5 Reference testing machine

5.1 Characteristics

5.1.1 General

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.

5.1.2 Geometrical characteristics (see Table 2 and Figures 1 and 2)

The following geometrical characteristics apply:

a) the radius of the anvils shall be $\left(1^{+0,10}_{0,00}\right)$ mm ;

b) the distance between the anvils shall be $\left(40^{+0,10}_{0,00}\right)$ mm ;

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

Table 2 — Geometrical characteristics

Reference number[a]	Designation	Value	Tolerance	Units
1	Length of test piece	55,00	+0,00 −0,30 *	mm
2	Half-length of test piece	27,5	±0,2 *	mm
3	Width of test piece	10,00	±0,06	mm
4	Thickness of test piece	10,00	±0,07 *	mm
5	Ligament length	8,00	±0,06	mm
6	Angle of notch	45,0	±1,0 *	°
7	Radius at base of notch	0,250	±0,025	mm
8	Angle between adjacent faces	90,00	±0,15 *	°
9	Angle between plane of symmetry of notch and longitudinal axis	90	±2	°
10	Radius of anvils	1,00	+0,10 −0,00 *	mm
11	Angle of taper of anvils	11	±1,0	°
12	Distance between anvils	40,00	+0,10 −0,00 *	mm
13	Distance of striking edge from plane of symmetry of anvils	—	±0,25 *	mm
14	Angle of striker	30	±1	°
15A	Radius of striking edge of 2 mm striker	2,00	+0,20 −0,00 *	mm
15B	Radius of striking edge of 8 mm striker	8,00	±0.05	mm
15C	Radius of shoulder of 8 mm striker	0,25	+0,50 −0,05	mm
15D	Width of striking edge of 8 mm striker	4,00	±0,20	mm

NOTE 1 Tolerances followed by an asterisk * are tighter than those in ISO 148-1 or ISO 148-2.

NOTE 2 See Figures 1 and 2.

[a] See Figure 1.

5.1.3 Capacity

The capacity of a reference machine (nominal initial potential energy) shall be appropriate for the specimens to be tested and certified with it. Certified energies shall not exceed 80 % of the machine capacity.

5.1.4 Hardness

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