INTERNATIONAL STANDARD

ISO 148-2

Second edition
2008-12-15

Metallic materials — Charpy pendulum impact test —

Part 2:
Verification of testing machines

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

Partie 2: Vérification des machines d'essai (mouton-pendule)

Reference number
ISO 148-2:2008(E)

Contents

Page

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 148-2 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 148-2:1998), 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 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 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 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.

Metallic materials — Charpy pendulum impact test —

Part 2:
Verification of testing machines

1 Scope

This part of ISO 148 covers the verification of the constructional elements of pendulum-type impact testing machines. It is applicable to machines with 2 mm or 8 mm strikers used for pendulum impact tests carried out, for instance, in accordance with ISO 148-1.

It can analogously be applied to pendulum impact testing machines of various capacities and of different design.

Impact machines used for industrial, general or research laboratory testing of metallic materials in accordance with this part of ISO 148 are referred to as industrial machines. Those with more stringent requirements are referred to as reference machines. Specifications for the verification of reference machines are found in ISO 148-3.

This part of ISO 148 describes two methods of verification.

a) The direct method, which is static in nature, involves measurement of the critical parts of the machine to ensure that it meets the requirements of this part of ISO 148. Instruments used for the verification and calibration are traceable to national standards. Direct methods are used when a machine is being installed or repaired, or if the indirect method gives a non-conforming result.

b) The indirect method, which is dynamic in nature, uses reference test pieces to verify points on the measuring scale.

A pendulum impact testing machine is not in compliance with this part of ISO 148 until it has been verified by both the direct and indirect methods and meets the requirements of Clauses 6 and 7.

The requirements for the reference test pieces are found in ISO 148-3.

This part of ISO 148 takes into account the total energy absorbed in fracturing the test piece using an indirect method. This total absorbed energy consists of

— the energy needed to break the test piece itself, and

— the internal energy losses of the pendulum impact testing machine performing the first half-cycle swing from the initial position.

NOTE Internal energy losses are due to

— air resistance, friction of the bearings of the rotation axis and of the indicating pointer of the pendulum which can be determined by the direct method (see 6.4.5), and

— shock of the foundation, vibration of the frame and pendulum for which no suitable measuring methods and apparatus have been developed.

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

ISO 148-3, *Metallic materials — Charpy pendulum impact test — Part 3: Preparation and characterization of Charpy V-notch test pieces for indirect verification of pendulum impact 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
anvil
portion of the machine that serves to properly position the test piece for impact with respect to the striker and the test piece supports, and supports the test piece under the force of the strike

3.1.2
base
that part of the framework of the machine located below the horizontal plane of the supports

3.1.3
centre of percussion
that point in a body at which, on striking a blow, the percussive action is the same as if the whole mass of the body were concentrated at the point

NOTE When a simple pendulum delivers a blow along a horizontal line passing through the centre of percussion, there is no resulting horizontal reaction at the axis of rotation.

See Figure 4.

3.1.4
centre of strike
that point on the striking edge of the pendulum at which, in the free hanging position of the pendulum, the vertical edge of the striker meets the upper horizontal plane of a test piece of half standard height (i.e. 5 mm) or equivalent gauge bar resting on the test piece supports

See Figure 4.

3.1.5
industrial machine
pendulum impact machine used for industrial, general, or most research-laboratory testing of metallic materials

NOTE 1 These machines are not used to establish reference values.

NOTE 2 Industrial machines are verified using the procedures described in this part of ISO 148.

3.1.6
reference machine
pendulum impact testing machine used to determine certified values for batches of reference test pieces

3.1.7
striker
portion of the pendulum that contacts the test piece

NOTE The edge that actually contacts the test piece has a radius of 2 mm (the 2 mm striker) or a radius of 8 mm (the 8 mm striker).

See Figure 2.

3.1.8
test piece supports
portion of the machine that serves to properly position the test piece for impact with respect to the centre of percussion of the pendulum, the striker and the anvils

See Figures 2 and 3.

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 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 (see 6.3).

3.2.2
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

NOTE See 6.4.2.

3.2.3
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.

3.2.4
calculated energy
K_{calc}
energy calculated from values of angle, length, and force measured during direct verification

3.2.5
nominal initial potential energy
nominal energy
K_N
energy assigned by the manufacturer of the pendulum impact testing machine

3.2.6
indicated absorbed energy
K_S
energy indicated by the display/dial of the testing machine, which may or may not need to be corrected for friction to determine absorbed energy, K

3.2.7
reference absorbed energy
K_R
certified value of absorbed energy assigned to the test pieces used to verify the performance of pendulum impact machines

3.3 Definitions pertaining to test pieces

3.3.1
height
distance between the notched face and the opposite face

3.3.2
width
dimension perpendicular to the height that is parallel to the notch

3.3.3
length
largest dimension perpendicular to the notch

3.3.4
reference test piece
impact test piece used to verify the suitability of pendulum impact testing machines by comparing the indicated absorbed energy measured by that machine to the reference absorbed energy associated with the test pieces

NOTE Reference test pieces are prepared in accordance with ISO 148-3.

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in Table 1 are applicable.

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

Symbol/ abbreviated term [a]	Unit	Designation
B_V	J	Bias of the pendulum impact machine as determined through indirect verification
b	J	Repeatability
F	N	Force exerted by the pendulum when measured at a distance of l_2
F_g	N	Force exerted by the pendulum due to gravity
g	m/s^2	Acceleration due to gravity
GUM	—	Guide to the expression of uncertainty in measurement
h	m	Height of fall of pendulum
H_1	m	Height of rise of pendulum
ISO	—	International Organization for Standardization
KV	J	Absorbed energy as measured in accordance with ISO 148 on a V-notched sample
KV_R	J	Certified KV value of the reference material used in the indirect verification
$\overline{KV}_V$	J	Mean KV value of the reference test pieces tested for indirect verification
K_N	J	Nominal initial potential energy (nominal energy)
K_P	J	Initial potential energy (potential energy)
K_R	J	Reference absorbed energy of a set of Charpy reference test pieces

Table 1 (*continued*)

Symbol/ abbreviated term [a]	Unit	Designation
K	J	Absorbed energy (expressed as KV_2, KV_8, KU_2, KU_8, to identify specific notch geometries and striker radii)
K_T	J	Total absorbed energy
K_S	J	Indicated absorbed energy
K_{calc}	J	Calculated energy
K_1 or β_1	J or degree	Indicated absorbed energy or angle of rise when the machine is operated in the normal manner without a test piece in position
K_2 or β_2	J or degree	Indicated absorbed energy 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
K_3 or β_3	J or degree	Indicated absorbed energy or angle of rise after 11 half swings when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
l	m	Distance to centre of test piece (centre of striker) from the axis of rotation (length of pendulum)
l_1	m	Distance to the centre of percussion from the axis of rotation
l_2	m	Distance to the point of application of the force F from the axis of rotation
M	N·m	Moment equal to the product Fl_2
n_V	—	Number of reference samples tested for the indirect verification of a pendulum impact testing machine
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 swing β
r	J	Resolution of the pendulum scale
RM	—	Reference material
s_V	J	Standard deviation of the KV values obtained on n_V reference samples
S	J	Bias in the scale mechanism
t	s	Period of the pendulum
T	s	Total time for 100 swings of the pendulum
T_{max}	s	Maximum value of T
T_{min}	s	Minimum value of T
$u(\overline{KV}_V)$	J	Standard uncertainty of $\overline{KV}_V$
$u(B_V)$	J	Standard uncertainty contribution from bias
$u(F)$	J	Standard uncertainty of the measured force, F
$u(F_{std})$	J	Standard uncertainty of the force transducer
$u(r)$	J	Standard uncertainty contribution from resolution
u_{RM}	J	Standard uncertainty of the certified value of the reference material used for the indirect verification
u_V	J	Standard uncertainty of the indirect verification result
α	degree	Angle of fall of the pendulum
β	degree	Angle of rise of the pendulum
ν_B	—	Degrees of freedom corresponding to $u(B_V)$
ν_V	—	Degrees of freedom corresponding to u_V
ν_{RM}	—	Degrees of freedom corresponding to u_{RM}

[a] See Figure 4.

5 Testing machine

A pendulum impact testing machine consists of the following parts (see Figures 1 to 3):

a) foundation/installation;

b) machine framework — the structure supporting the pendulum, excluding the foundation;

c) pendulum, including the hammer;

d) anvils and supports (see Figures 2 and 3);

e) indicating equipment for the absorbed energy (e.g. scale and friction pointer or electronic readout device).

6 Direct verification

6.1 General

Direct verification of the machine involves the inspection of the following items:

a) foundation/installation;

b) machine framework;

c) pendulum, including the hammer and the striker;

d) anvils and supports;

e) indicating equipment.

6.2 Foundation/installation

6.2.1 The foundation to which the machine is fixed and the method(s) of fixing the machine to the foundation are of utmost importance.

6.2.2 Inspection of the machine foundation can usually not be made once the machine has been installed; thus, documentation made at the time of installation shall be produced to provide assurance that the mass of the foundation is not less than 40 times that of the pendulum.

6.2.3 Inspection of the installed machine shall consist of the following:

a) ensuring that the bolts are torqued to the value specified by the machine manufacturer. The torque value shall be noted in the document provided by the manufacturer of the machine (see 6.2.1). If other mounting arrangements are used or selected by an end user, equivalency shall be demonstrated;

b) ensuring that the machine is not subject to external vibrations transmitted through the foundation at the time of the impact test.

NOTE This can be accomplished, for example, by placing a small container of water on any convenient location on the machine framework. The absence of ripples on the water surface indicates that this requirement has been met.

6.3 Machine framework

6.3.1 Inspection of the machine framework (see Figure 1) shall consist of determining the following items:

a) free position of the pendulum;

b) location of the pendulum in relation to the supports;

c) transverse and radial play of the pendulum bearings;

d) clearance between the hammer and the framework.

Machines manufactured after the original publication date of this part of ISO 148 shall have a reference plane from which measurements can be made. Annex C, based on EN 10045-2, is provided for information.

6.3.2 The axis of rotation of the pendulum shall be parallel to the reference plane to within 2/1 000. This shall be certified by the manufacturer.

6.3.3 The machine shall be installed so that the reference plane is horizontal to within 2/1 000.

For pendulum impact testing machines without a reference plane, the axis of rotation shall be established to be horizontal to within 4/1 000 directly or a reference plane shall be established from which the horizontality of the axis of rotation can be verified as described above.

6.3.4 When hanging free, the pendulum shall hang so that the striking edge is within 0,5 mm of the position where it would just touch the test specimen.

NOTE This condition can be determined using a gauge in the form of a bar, approximately 55 mm in length and of rectangular section, 9,5 mm in height and approximately 10 mm in width (see Figure 3). The distance between the striker and the bar is then measured.

6.3.5 The plane of the swing of the pendulum shall be 90° ± 0,1° to the axis of rotation.

6.3.6 The striker shall make contact over the full width of the test piece.

NOTE One method of verifying this is as follows.

A test piece having dimensions of 55 mm × 10 mm × 10 mm is tightly wrapped in thin paper (e.g. by means of adhesive tape), and the test piece is placed in the test-piece supports. Similarly, the striker edge is tightly wrapped in carbon paper with the carbon side outermost (i.e. not facing the striker). From its position of equilibrium, the pendulum is raised a few degrees, released so that it contacts the test piece, and prevented from contacting the test piece a second time. The mark made by the carbon paper on the paper covering the test piece should extend completely across the paper. This test may be performed concurrently with that of checking the angle of contact between the striker and the test piece (see 6.4.8).

6.3.7 The pendulum shall be located so that the centre of the striker and the centre of the gap between the anvils are coincident to within 0,5 mm.

6.3.8 Axial play in the pendulum bearings shall not exceed 0,25 mm measured at the striker under a transverse force of approximately 4 % of the effective weight of the pendulum, F_g [see Figure 4 b)], applied at the centre of strike.

6.3.9 Radial play of the shaft in the pendulum bearings shall not exceed 0,08 mm when a force of 150 ± 10 N is applied at a distance l perpendicular to the plane of swing of the pendulum.

NOTE The radial play can be measured, for example, by a dial gauge mounted on the machine frame at the bearing housing in order to indicate movement at the end of the shaft (in the bearings) when a force of about 150 N is applied to the pendulum perpendicularly to the plane of the swing.

6.3.10 For new machines, it is recommended that the mass of the base of the machine framework be at least 12 times that of the pendulum.

NOTE The base of the machine is that portion of the framework located below the plane(s) of the supports.

6.4 Pendulum

6.4.1 The verification of the pendulum (including striker) shall consist of determining the following quantities:

a) potential energy, K_P;

b) error in the indicated absorbed energy, K_S;

c) velocity of the pendulum at instant of impact;

d) energy absorbed by friction;