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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)

ICS: 77.040.10

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

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Contents

Page

Foreword

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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. 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. 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 WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword - Supplementary information

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 148-2:2008), 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 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.

This standard describes both the original direct verification as well as the indirect verification procedures.

Metallic materials — Charpy pendulum impact test —

Part 2:
Verification of testing machines

1 Scope

This part of ISO 148 covers the verification of pendulum-type impact testing machines, in terms of their constructional elements, their overall performance and the accuracy of the results they produce. 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 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.

1) 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.

2) 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 describes how to assess the different components of the total energy absorbed in fracturing a test piece. This total absorbed energy consists of

— the energy needed to fracture 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*

ISO 7500-1:2004, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

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 1 to entry: 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 thickness (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 to entry: Industrial machines are not used to establish reference values, unless they also meet the requirements of a reference pendulum (see ISO 148-3).

Note 2 to entry: 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

Note 1 to entry: Reference machines are verified using the procedures described in ISO 148-3.

3.1.7
striker
portion of the pendulum that contacts the test piece

Note 1 to entry: 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 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 (see 6.3).

3.2.2
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

Note 1 to entry: 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 as defined in 6.4.5.

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 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 and air resistance to determine the absorbed energy, K

3.2.7
reference absorbed energy

K_R

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

3.3   Definitions pertaining to test pieces

3.3.1
width
distance between the notched face and the opposite face

3.3.2
thickness
dimension perpendicular to the width and 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 1 to entry: 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 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[8]
h	m	Height of fall of pendulum
H_1	m	Height of rise of pendulum
ISO	—	International Organization for Standardization
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_T	J	Total absorbed energy
K_S	J	Indicated absorbed energy
K_{calc}	J	Calculated energy
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_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 strike) 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 $F \cdot l_2$
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 rise 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	—	Standard uncertainty
$u(\overline{KV}_V)$	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
$u(F_{ftd})$	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
v_B	—	Degrees of freedom corresponding to $u(B_V)$
v_V	—	Degrees of freedom corresponding to u_V
v_{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 items a)-e) listed in Clause 5.

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:

1) 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;

2) 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 during an impact test 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:

1) free position of the pendulum;

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

3) transverse and radial play of the pendulum bearings;

4) clearance between the hammer and the framework.

Machines manufactured after 1998 shall have a reference plane from which measurements can be made.

Annex C is provided for information.