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Plastics — Verification of pendulum impact-testing machines — Charpy, Izod and tensile impact-testing

Plastiques — Vérification des machines d'essai de choc pendulaire — Essais de choc Charpy, Izod et de choc-traction

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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).

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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 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 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

This second edition cancels and replaces the first edition (ISO 13802:1999), which has been technically revised. It also incorporates the Technical Corrigendum ISO 13802:1999/Cor.1:2000.

This corrected version of ISO 13802:2015 incorporates the following correction:

— in Table 4, the pendulum length, L_P, in m, has been changed from “0,225 to 0,390” to “0,221 to 0,417”.

Plastics — Verification of pendulum impact-testing machines — Charpy, Izod and tensile impact-testing

1 Scope

This International Standard specifies frequency and methods for the verification of pendulum impact-testing machines used for the Charpy impact test, Izod impact test, and tensile impact test described in ISO 179-1, ISO 180, and ISO 8256, respectively. Verification of instrumented impact machines is covered insofar as the geometrical and physical properties of instrumented machines are identical to non instrumented machines. The force/work verification of instrumented machines is not covered in this International Standard.

This International Standard is applicable to pendulum-type impact-testing machines, of different capacities and/or designs, with the geometrical and physical properties defined in Clause 5.

Methods are described for verification of the geometrical and physical properties of the different parts of the test machine. The verification of some geometrical properties is difficult to perform on the assembled instrument. It is, therefore, assumed that the manufacturer is responsible for the verification of such properties and for providing reference planes on the instrument that enable proper verification in accordance with this International Standard.

These methods are for use when the machine is being installed, has been repaired, has been moved, or is undergoing periodic checking.

A pendulum impact-testing machine verified in accordance with this International Standard, and assessed as satisfactory, is considered suitable for impact testing with unnotched and notched test specimens of different types.

Annex A details design requirements for Charpy testing machines.

Annex B details design requirements for Izod testing machines.

Annex C details design requirements for tensile impact machines.

Annex D explains how to calculate the ratio of frame mass to pendulum mass required to avoid errors in the impact energy.

Annex E explains deceleration of pendulum during impact.

Annex F details design requirements for one type of gauge used to verify striker and anvil/support alignment for Charpy testing machine.

2 Normative references

The following 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 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

ISO 179-2, *Plastics — Determination of Charpy impact properties — Part 2: Instrumented impact test*

ISO 180, *Plastics — Determination of Izod impact strength*

ISO 8256, *Plastics — Determination of tensile-impact strength*

3 Terms and definitions

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

3.1
verification
proof, with the use of calibrated standards or standard reference materials, that the calibration of an instrument is acceptable

3.2
calibration
set of operations that establish, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system and values corresponding to appropriate standards or known values derived from standards

3.3
period of oscillation of the pendulum
T_P
period, expressed in seconds, *s*, of a single complete oscillation of the pendulum, oscillating at angles of oscillation of less than 5°, on average, to each side of the vertical

3.4
centre of percussion
point on a pendulum at which a perpendicular impact in the plane of swing does not cause reaction forces at the axis of rotation of the pendulum

3.5
pendulum length
L_P
distance, expressed in metres, between the axis of rotation of the pendulum and the *centre of percussion* (3.4) and it is the distance from the axis of rotation where the mass of a pendulum would have to be concentrated to have the same period of swing, T_P, as the actual pendulum

3.6
gravity length
Lm
distance, expressed in metres, between the axis of rotation of the pendulum and the centre of gravity of the pendulum

3.7
gyration length
L_G
distance, expressed in metres, between the axis of rotation of the pendulum and the point at which the pendulum mass, m_P, would have to be concentrated to give the same moment of inertia as the pendulum

3.8
impact length
L_I
distance, expressed in metres, between the axis of the rotation of the pendulum and the point of impact of the striking edge at the centre of the specimen face

3.9
release angle
α_0
angle, expressed in degrees, relative to the vertical, from which the pendulum is released

Note 1 to entry: Usually, the test specimen is impacted at the lowest point of the pendulum swing (α_0 = 0°). In this case, the release angle will also be the angle of fall [see Figure 1b)].

3.10
impact velocity
v_I
velocity, expressed in metres per second, of the pendulum at the moment of impact

3.11
potential energy
E
potential energy, expressed in joules, of the pendulum in its starting position, relative to its position at impact

3.12
impact energy
W
energy, expressed in joules, required to deform, break, and push away the test specimen

3.13
frame
part of the machine carrying the pendulum bearings, the supports, the vice and/or clamps, the measurement instruments, and the mechanism for holding and releasing the pendulum

Note 1 to entry: The mass of the frame, m_F, is expressed in kilograms.

3.14
base
part of the framework of the machine located below the horizontal plane of the supports

3.15
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

3.16
test specimen supports
portion of the machine that serves to properly position the test specimen for impact, with respect to the centre of percussion of the pendulum, the striker, and the anvils

3.17
striker
portion of the pendulum that contacts the test piece

3.18
period of oscillation of the frame
T_F
period, expressed in seconds, of the freely decaying, horizontal oscillation of the frame and it characterizes the oscillation of the frame vibrating against the stiffness of the (resilient) mounting, e.g. a test bench and/or its foundation (which may include damping material for instance) (see Annex D)

3.19
mass of the pendulum
$m_{P,max}$
mass, expressed in kilograms, of the heaviest pendulum used

3.20
Izod/Charpy impact reference specimen
specimen made from stainless steel 80 mm ± 0,05 mm in length and of rectangular section, 10 mm ± 0,02 mm in height, and 10 mm ± 0,02 mm in width

3.21
half-height Charpy impact reference specimen
specimen made from stainless steel 80 mm ± 0,05 mm in length and of rectangular section, 5 mm ± 0,02 mm in height, and 10 mm ± 0,02 mm in width

3.22
tensile impact reference specimen
specimen made from stainless steel 80 mm ± 0,05 mm in length and of rectangular section, 10 mm ± 0,02 mm in height, and 4 mm ± 0,02 mm in width

4 Measurement instruments

The verification methods described in this International Standard call for the use of straight edges, vernier calipers, set squares, levels and dynamometers, load cells or scales, and timing devices to check if the geometrical and physical properties of the components of the test machine conform to the requirements given in this International Standard.

These measurement instruments shall be accurate enough to measure the parameters within the tolerance limits given in Clause 6 (Table 4).

5 Description of a pendulum impact-testing machine

5.1 Types of pendulum impact-testing machines

Three different types of test machines are covered by this International Standard. Annex A contains details of construction and performance of a machine configured for Charpy testing. Figure A.1 shows a typical example of a Charpy test machine. Important values to be verified are listed in Table A.1. Test conditions are found in ISO 179.

Annex B contains details of construction and performance of a machine configured for Izod testing. Figure B.1 shows a typical example of an Izod test machine. Important values to be verified are listed in Table B.1. Test conditions are found in ISO 180.

Annex C contains details of construction and performance of a machine configured for tensile impact testing. Figures C.1 and C.2 show typical examples of tensile impact-testing machines. Important values to be verified are listed in Table C.1. Test conditions are found in ISO 8256.

5.2 Testing machine components

A pendulum impact testing machine consists of the following parts:

5.2.1 Machine frame — The base of the machine and the structure supporting the pendulum

5.2.1.1 Bearings.

5.2.1.2 Mechanism for holding and releasing the pendulum.

5.2.1.3 Base.

5.2.2 Pendulum

5.2.2.1 Pendulum rod or compound (bifurcated) design.

5.2.2.2 Striker, with striking edge for Charpy or Izod impact tests or with striking surfaces or clamps for tensile impact testing (see ISO 8256, test methods A and B respectively).

5.2.2.3 Add-on weights (optional), for increasing potential energy capacity of pendulum.

NOTE There are several pendulum designs available, and they are acceptable if they meet the requirements of this International Standard.

5.2.3 Test specimen anvils, supports, clamps and/or holders

5.2.3.1 Anvils and test specimen supports, for Charpy impact testing.

The Charpy test supports and anvils shall be located one on each side of the plane of swing of the pendulum. The anvils shall be installed perpendicular to the supports and normal to the plane of swing of the pendulum. Essentially, the specimen rests on the supports and the anvil takes the reaction from the impact on the specimen.

NOTE Recesses in the supports to accommodate flash on specimens are permitted.

5.2.3.2 Vice, for Izod impact testing.

5.2.3.3 Clamps or stops, for tensile impact testing (see ISO 8256, methods A and B).

5.2.3.4 Crossheads, for tensile impact testing (see ISO 8256, methods A and B).

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

6 Procedure for verification and inspection of a pendulum impact-testing machine

6.1 Certification of machine design and manufacturer

There are several aspects of the design and manufacture of an impact machine that are critical to its performance and can only be certified at the time of manufacture by the manufacturer, including the following (see Table 1).

6.1.1 Centre of percussion.

6.1.2 Axis of rotation.

6.1.3 Pendulum plane of swing.

6.1.4 Mass of frame.

Unless the ratio, $m_F/m_{P,max}$, of the mass of the frame to the mass of the heaviest pendulum used is at least 40, the frame shall be bolted to a rigid test bench.

Since many machines may not have been supplied with manufacturer's certificates detailing the ratio of the mass of the frame to the mass of the pendulum, bolting the machine to the test bench and levelling with shims is strongly recommended.

Table 1 — Components of impact machine to be certified only at the time of manufacture

Parameter	Unit	Value
Centre of percussion	mm	At the centre of strike ±2,5
Axis of rotation of pendulum[a]	—	Parallel within ±2/1 000 relative to the reference plane
Plane of swing relative to axis of rotation	—	90° ± 0,1° to the axis of rotation
Mass of frame	kg	At least 40 times the weight of the heaviest pendulum used or bolted to a heavy secure bench

[a] The reference plane of a particular machine will vary by manufacturer.

6.2 Field verification of the machine frame shall consist of determining the following items (see Table 4)

6.2.1 Installation

The pendulum impact-testing machine shall be installed on a sturdy bench or table in an area that is free from vibration. If the machine is equipped with levelling adjustment screws, the adjustment screws shall be fixed after levelling in order to maintain the frame in position and the stiffness of the mounting. During an impact test, there shall be no visible displacement of the frame on its support. Verify that there is no movement of either the machine or the test bench by configuring the machine with the highest energy capacity pendulum available on the machine. Latch the pendulum and place a level on the base. Release the pendulum and observe the level for any movement of the bubble. Any bubble movement observed requires that the machine be mounted in a more secure manner.

6.2.2 Levelness

Determine the levelness of the reference plane in the direction of the swing and perpendicular to the swing. The machine shall be installed so that the reference plane is horizontal to within 2/1 000.

6.2.3 Axial play of the pendulum bearings

The endplay in the bearings of the pendulum spindle in the axial direction shall not exceed 0,25 mm.

6.2.4 Radial play of the pendulum bearings

Determine the radial play of the shaft in the pendulum bearings when a torque of 2 ± 0,2 N is applied in alternate directions perpendicular to the plane of swing of the pendulum. The total play in the radial direction should not exceed 0,05 mm.

6.2.5 Mechanism for holding and releasing the pendulum

The mechanism for releasing the pendulum from its initial position shall be visually inspected. A properly functioning release mechanism operates freely and permits the release of the pendulum without initial impulse, retardation or side vibration, or any other interference that would result in energy loss.

6.2.6 Free hanging position

When hanging free, the pendulum shall hang so that the striking edge is within 6,35 mm of the position where it would just touch the reference specimen.

6.2.7 Contact between specimen and striking edge (Izod/Charpy)

For Izod and Charpy machines, the striker shall make contact over the full width of the Izod/Charpy impact reference specimen defined in 3.20.

One method of verifying this is as follows. A Izod/Charpy impact reference specimen is tightly wrapped in thin paper (e.g. by means of adhesive tape), and is placed in the specimen supports or clamp. 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 Izod/Charpy impact reference specimen, and prevented from contacting the test piece a second time. The mark made by the carbon paper on the paper covering the Izod/Charpy impact reference specimen 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 Izod/Charpy impact reference specimen.

6.2.8 Potential energy, *E*

Table 2 shows the nominal potential energy values of pendulums typically used in Charpy, Izod, and tensile impact machines. The potential energy, E, shall not differ by more than 1 % of the nominal value given in Table 2. It shall be determined as follows:

a) Support the pendulum at an arbitrary length, L_H, from the axis of rotation, on a balance or dynamometer. Ensure that the line from the axis of rotation to the centre of gravity of the pendulum is horizontal [see Figure 1a)].

b) Measure the vertical force, F_H, in newtons, at L_H and the length, L_H, in metres, to a precision of ±1,0 %.

c) Calculate the horizontal moment, M_H, of the pendulum about the axis of rotation, in newton metres, using the formula:

$$M_H = F_H L_H \quad (1)$$

d) Measure the release angle, α_0 [see Figure 1b)], to a precision $\Delta\alpha_0$, which corresponds to a relative precision of 1/400th of the potential energy, E, and, if applicable, the impact angle, α_I, to within 0,25°. Thus, for starting angles of 140°, 150°, and 160°, $\Delta\alpha_0$ is 0,39°, 0,54°, and 0,81°, respectively.

e) Calculate the potential energy, E, of the pendulum from the following formula:

$$E = M_H (\cos\alpha_I - \cos\alpha_0) \quad (2)$$

where

E is the potential energy of the pendulum, in joules;

M_H is the horizontal moment of the pendulum [see Formula (2)], in newton metres;

α_0 is the release angle, in degrees;

α_I is the impact angle, in degrees.

NOTE 1 Most pendulum impact-testing machines use an impact angle of 0°, for which $\cos\alpha_I = 1$.

NOTE 2 In certain cases, it may be necessary to remove the pendulum from the machine to determine its moment, M_H, by the method described.

