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Plastics — Determination of tensile-impact strength

Plastiques — Détermination de la résistance au 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 document 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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For an explanation of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical behaviour,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 249, *Plastics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 8256:2004), which has been technically revised.

The main changes are as follows:

— the reference to ISO 3167 has been replaced with ISO 20753;

— Table 2 has been modified clarified;

— additional description on preparation methods for the specimen types in 6.2.1 has been given.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Plastics — Determination of tensile-impact strength

1 Scope

1.1 This document specifies two methods (method A and method B) for the determination of the tensile-impact strength of plastics under defined conditions. The tests can be described as tensile tests at relatively high strain rates. These methods can be used for rigid materials (as defined in ISO 472), but are especially useful for materials too flexible or too thin to be tested with impact tests conforming to the ISO 179 series or ISO 180.

1.2 These methods are used for investigating the behaviour of specified specimens under specified impact velocities, and for estimating the brittleness or the toughness of specimens within the limitations inherent in the test conditions.

1.3 These methods are applicable both to specimens prepared from moulding materials and to specimens taken from finished or semi-finished products (for example mouldings, laminates, or extruded or cast sheets).

1.4 Results obtained by testing moulded specimens of different dimensions are not necessarily the same. Equally, it is possible that specimens cut from moulded products will not give the same results as specimens of the same dimensions moulded directly from the material. Test results obtained from specimens prepared from moulding compounds cannot be applied directly to mouldings of any given shape, because values may depend on the design of the moulding and the moulding conditions. Results obtained by method A and method B can or can not be comparable.

1.5 These methods are not suitable for use as a source of data for design calculations on components. Information on the typical behaviour of a material can be obtained, however, by testing different types of test specimen prepared under different conditions, and by testing at different temperatures. The two different methods are suitable for production control as well as for quality control.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 179 (all parts), *Plastics — Determination of Charpy impact properties*

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

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 293, *Plastics — Compression moulding of test specimens of thermoplastic materials*

ISO 294-1, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar test specimens*

ISO 294-2, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 2: Small tensile bars*

ISO 295, *Plastics — Compression moulding of test specimens of thermosetting materials*

ISO 472, *Plastics — Vocabulary*

ISO 1268 (all parts), *Fibre-reinforced plastics — Methods of producing test plates*

ISO 2602, *Statistical interpretation of test results — Estimation of the mean — Confidence interval*

ISO 2818, *Plastics — Preparation of test specimens by machining*

ISO 13802, *Plastics — Verification of pendulum impact-testing machines — Charpy, Izod and tensile impact-testing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
tensile-impact strength of unnotched specimens
a_{tU}
energy absorbed in breaking an unnotched specimen under specified conditions, referred to the original cross-sectional area of the specimen

Note 1 to entry: It is expressed in kilojoules per square metre (kJ/m^2).

3.2
tensile-impact strength of notched specimens
a_{tN}
energy absorbed in breaking a notched specimen under specified conditions, referred to the original cross-sectional area of the specimen at the notch

Note 1 to entry: It is expressed in kilojoules per square metre (kJ/m^2).

4 Principle

A specimen is broken by a single impact at the bottom of the swing of the pendulum of a tensile-impact machine. The specimen is horizontal at the moment of rupture. One end of the specimen, at impact, is held either by the frame or the pendulum and the other end by the crosshead. The two methods described are based on two different ways of positioning the specimen held by the crosshead: the specimen may be either mounted stationary on the support frame (method A) or carried downward together with the pendulum (method B).

The energy to fracture is determined by the kinetic energy extracted from the pendulum in the process of breaking the specimen. Corrections are made for the energy to toss (method A) or bounce (method B) the crosshead.

5 Apparatus

5.1 Test machine

The principles, characteristics and verification of suitable test machines are detailed in ISO 13802.

5.2 Pendulum and striker

5.2.1 The pendulum shall be constructed of a single- or multiple-membered arm holding the head, in which the greatest mass is concentrated. A rigid pendulum is essential to maintain the proper

clearances and geometric relationships between related parts and to minimize energy losses, which are always included in the measured impact-energy value.

5.2.2 The strikers for method A and method B are described in detail in ISO 13802.

5.3 Crosshead

5.3.1 As pointed out in ISO 13802, in order to reduce bouncing due to the impact of the metal striker on the metal crosshead, the material used for the crosshead shall be one which gives an essentially inelastic impact (e.g. aluminium). The mass of the crosshead, both for method A and for method B, shall be selected from the values given in Table 1.

5.3.2 A jig or other device shall be used to assist in clamping the crosshead in the specified position, at right angles to the longitudinal axis of the specimen.

Table 1 — Crosshead masses

Potential energy J	Crosshead mass g	
	Method A	Method B
2,0	15 ± 1 or 30 ± 1	15 ± 1
4,0	15 ± 1 or 30 ± 1	15 ± 1
7,5	30 ± 1 or 60 ± 1	30 ± 1
15,0	30 ± 1 or 60 ± 1	120 ± 1
25,0	60 ± 1 or 120 ± 1	120 ± 1
50,0	60 ± 1 or 120 ± 1	120 ± 1
NOTE For method A, use the lighter crosshead whenever possible.		

5.4 Clamping devices/jaws

Clamps and jaws for tensile-impact testing are described in ISO 13802.

5.5 Micrometers and gauges

Micrometers and gauges suitable for measuring the dimensions of test specimens to an accuracy of 0,01 mm are required. In measuring the thickness of the specimen, the measuring face shall apply a load of 0,01 MPa to 0,05 MPa. For notched specimens, see the requirements of 7.4.

6 Test specimens

6.1 Shape and dimensions

Five types of test specimen, as specified in Table 2 and shown in Figure 1, may be used. In general, all types can be used with either of the two methods.

Method A: the preferred specimen types are type 1 and type 4.

Method B: the preferred specimen types are type 2 and type 4.

The test result depends on the type of specimen used and its preparation and thickness. For reproducible results, or in cases of dispute, the type of test specimen and its preparation and thickness shall be agreed upon.

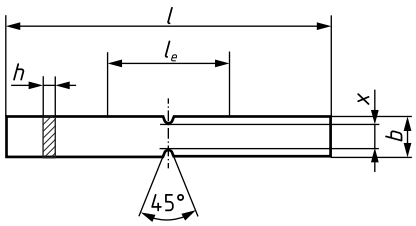
Specimens are tested at their original thickness up to and including 4 mm. The preferred specimen thickness is 4 mm ± 0,2 mm for type 1 specimens and 3 mm ± 0,2 mm for type 4 specimens. Within the gauge area, the thickness shall be maintained to within a tolerance of ±5 %. Above 4 mm, the test methods described in this document are inapplicable, and ISO 179 or ISO 180 shall be used to determine the impact properties of specimens.

Table 2 — Specimen types and dimensions

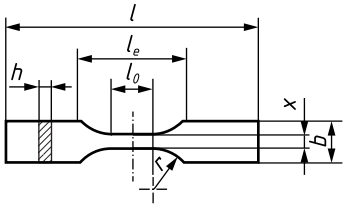
Dimensions in millimetres

Specimen type	1	2	3	4	5
Length l	80,0 ± 2,0	60,0 ± 2,0	80,0 ± 2,0	60,0 ± 2,0	80,0 ± 2,0
Free length between grips l_e [a]	30,0 ± 2,0	25,0 ± 2,0	30,0 ± 2,0	25,0 ± 2,0	50,0 ± 2,0
Preferred value of dimension l_0	—	10,0 ± 0,2	10,0 ± 0,2	—	10,0 ± 0,2
Radius of curvature r	—	10,0 ± 1,0	20,0 ± 1,0	15,0 ± 1,0	20,0 ± 1,0
Width b	10,0 ± 0,2	10,0 ± 0,2	15,0 ± 0,2	10,0 ± 0,2	15,0 ± 0,2
Preferred value of dimension x	6,0 ± 0,2	3,0 ± 0,2	10,0 ± 0,2	3,0 ± 0,2	5,0 ± 0,2
b'	—	—	—	—	23,0 ± 2,0
r'	—	—	—	—	4,0 ± 0,5
l'	—	—	—	—	11,0 ± 1,0
Thickness h (Preferred value)	≤ 4 (4,0 ± 0,2)	≤ 4	≤ 4	≤ 4 (3,0 ± 0,2)	≤ 4
All tolerances for l, l_0, r, b, x, b', r', l', h identical with tolerances given in ISO 20753. a Free length between grips l_e is not a sample dimension but a test dimension.					

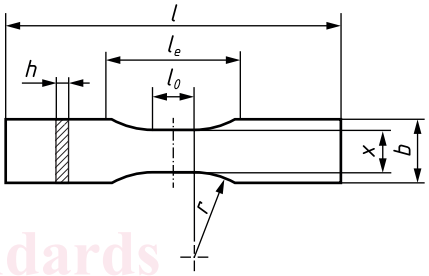
Type 1



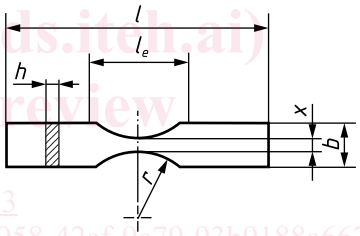
Type 2



Type 3



Type 4



Type 5

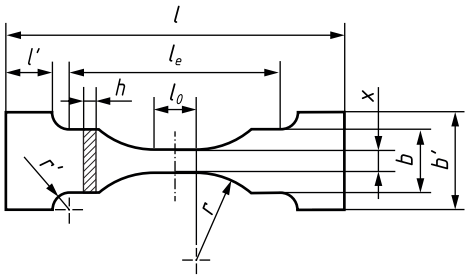


Figure 1 — Types of test specimen

6.2 Preparation

6.2.1 Moulding and extrusion compounds

Specimens shall be prepared in accordance with the relevant material specification. When none exists or when otherwise specified, specimens shall be directly extruded or compression or injection moulded from the material in accordance with ISO 293, ISO 294-1, ISO 294-2 or ISO 295, or machined in accordance with ISO 2818 from sheets or plates compression or injection moulded from the compound.

Type 1 specimen can be prepared from type A1 or B1 test specimen described in ISO 20753.

Type 2 specimen can be prepared from type D1 test specimen described in ISO 20753.

Type 3 specimen is identical with type CP described in ISO 20753 and can be prepared from type F1 test specimen described in ISO 20753.

Type 4 specimen is identical with type CW described in ISO 20753 and can be moulded directly in accordance with ISO 294-2 or machined from plates moulded in accordance with ISO 294-3.

Type 5 specimen can be prepared from type F1 test specimen described in ISO 20753.

Other preparation methods than those described above are also permitted if no standard or specification is available.

6.2.2 Sheets

Specimens shall be machined from sheets in accordance with ISO 2818.

6.2.3 Fibre-reinforced resins

A panel shall be prepared from the compound in accordance with the relevant part of the ISO 1268 (series), and specimens shall be machined in accordance with ISO 2818.

6.3 Notching of specimens

6.3.1 Notches (for type 1 specimens) shall be machined in accordance with ISO 2818 on unnotched specimens prepared in accordance with 6.2.

6.3.2 The radius of the notch base shall be 1,0 mm ± 0,05 mm and its angle 45° ± 1° (see Figure 1). The profile of the cutting tooth shall be such as to produce in the specimen, at right angles to its principal axis, two notches of the contour and depth shown in Figure 1. The two lines drawn perpendicular to the length direction of the specimen through the apex of each notch shall be within 0,2 mm of each other. Particular attention shall be given to the accuracy of the dimension *x* (see Table 2). Close tolerances shall be imposed on the contour and the radius of the notch for most materials because these factors largely determine the degree of stress concentration at the base of the notch during the test. The maintenance of a sharp, clean-edged cutting tool is particularly important since minor defects at the base of the notch can cause large deviations in the test results. The profile of the notch being produced by a particular cutting tool shall be checked at regular intervals.

6.3.3 Specimens with moulded-in notches may be used if specified for the material being tested. Specimens with moulded-in notches generally do not give the same results as specimens with machined notches, and allowance should be made for this difference in interpreting the results. Specimens with machined notches are generally preferred because skin effects and/or localized anisotropy are minimized. The profile of the notch being produced shall be checked at regular intervals.

6.3.4 For specimens prepared by cutting them out with a puncher, the notch shall not be punched out but shall be machined in a second step.

6.4 Number of test specimens

Unless otherwise specified in the standard for the material being tested, a set consisting of ten specimens shall be tested. When the coefficient of variation (see ISO 2602) has a value of less than 5 %, a minimum number of five test specimens is sufficient.

6.5 Anisotropy

The impact properties of certain types of sheet material may differ depending on the direction of measurement in the plane of the sheet. In such cases, it is customary to prepare two groups of test