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ICS 83.080.01

Supersedes
DIN EN ISO 180:2013-08

Plastics –
Determination of Izod impact strength (ISO 180:2019);
English version EN ISO 180:2019,
English translation of DIN EN ISO 180:2020-03

Kunststoffe –
Bestimmung der Izod-Schlagzähigkeit (ISO 180:2019);
Englische Fassung EN ISO 180:2019,
Englische Übersetzung von DIN EN ISO 180:2020-03

Plastiques –
Détermination de la résistance au choc Izod (ISO 180:2019);
Version anglaise EN ISO 180:2019,
Traduction anglaise de DIN EN ISO 180:2020-03

Document comprises 21 pages

Translation by DIN-Sprachendienst.

In case of doubt, the German-language original shall be considered authoritative.

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A comma is used as the decimal marker.

National foreword

This document (EN ISO 180:2019) has been prepared by Technical Committee ISO/TC 61 “Plastics” in collaboration with Technical Committee CEN/TC 249 “Plastics” (Secretariat: NBN, Belgium).

The responsible German body involved in its preparation was *DIN-Normenausschuss Kunststoffe* (DIN Standards Committee Plastics), Working Committee NA 054-01-02 AA “Mechanical properties and preparation of test specimens”.

The DIN documents corresponding to the international documents referred to in this document are as follows:

ISO 291	DIN EN ISO 291
ISO 293	DIN EN ISO 293
ISO 294-1	DIN EN ISO 294-1
ISO 295	DIN EN ISO 295
ISO 2818	DIN EN ISO 2818
ISO 10724-1	DIN EN ISO 10724-1
ISO 13802	DIN EN ISO 13802
ISO 20753	DIN EN ISO 20753

Amendments

This standard differs from DIN EN ISO 180:2013-08 as follows:

a) Clause 2 “Normative references” has been updated;

b) in subclause 7.7, the definition of hinge break has been changed;

c) formulas in Clause 8 have been corrected;

d) the standard has been editorially revised.

Previous editions

DIN EN ISO 180: 1997-03, 2001-06, 2007-04, 2013-08

National Annex NA
(informative)

Bibliography

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

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

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

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

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

DIN EN ISO 10724-1, *Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) — Part 1: General principles and moulding of multipurpose test specimens*

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

DIN EN ISO 20753, *Plastics — Test specimens*

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 180

December 2019

ICS 83.080.01

Supersedes EN ISO 180:2000

English Version

Plastics - Determination of Izod impact strength (ISO 180:2019)

Plastiques - Détermination de la résistance au choc Izod (ISO 180:2019)

Kunststoffe - Bestimmung der Izod-Schlagzähigkeit (ISO 180:2019)

This European Standard was approved by CEN on 16 November 2019.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN ISO 180:2019 E

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European foreword

This document (EN ISO 180:2019) has been prepared by Technical Committee ISO/TC 61 "Plastics" in collaboration with Technical Committee CEN/TC 249 “Plastics” the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2020, and conflicting national standards shall be withdrawn at the latest by June 2020.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 180:2000.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 180:2019 has been approved by CEN as EN ISO 180:2019 without any modification.

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 properties*.

This fourth edition cancels and replaces the third edition (ISO 180:2000), of which it constitutes a minor revision. It also incorporates the Amendments ISO 180:2000/Amd.1:2006 and ISO 180:2000/Amd.2:2013.

The changes compared to the previous edition are as follows:

— Clause 2 has been updated;

— the following clauses have been revised:

  — Clause 5;

  — Clause 6;

  — Clause 7;

  — Clause 8;

  — Clause 9;

— a bibliography has been added.

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.

1 Scope

1.1 This document specifies a method for determining the Izod impact strength of plastics under defined conditions. A number of different types of specimen and test configurations are defined. Different test parameters are specified according to the type of material, the type of test specimen and the type of notch.

1.2 The method is used to investigate the behaviour of specified types of specimen under the impact conditions defined and for estimating the brittleness or toughness of specimens within the limitations inherent in the test conditions.

1.3 The method is suitable for use with the following range of materials:

— rigid thermoplastic moulding and extrusion materials, including filled and reinforced compounds in addition to unfilled types; rigid thermoplastics sheets;

— rigid thermosetting moulding materials, including filled and reinforced compounds; rigid thermosetting sheets, including laminates;

— fibre-reinforced thermosetting and thermoplastic composites incorporating unidirectional or non-unidirectional reinforcements such as mat, woven fabrics, woven rovings, chopped strands, combination and hybrid reinforcements, rovings and milled fibres and sheet made from pre-impregnated materials (prepregs);

— thermotropic liquid-crystal polymers.

1.4 The method is not normally suitable for use with rigid cellular materials and sandwich structures containing cellular material. Notched specimens are also not normally used for long-fibre-reinforced composites or thermotropic liquid-crystal polymers.

1.5 The method is suited to the use of specimens which can be either moulded to the chosen dimensions, machined from the central portion of a standard multipurpose test specimen (see ISO 20753) or machined from finished or semi-finished products such as mouldings, laminates and extruded or cast sheet.

1.6 The method specifies preferred dimensions for the test specimen. Tests which are carried out on specimens of different dimensions or with different notches, or specimens which are prepared under different conditions, may produce results which are not comparable. Other factors, such as the energy capacity of the apparatus, its impact velocity and the conditioning of the specimens can also influence the results. Consequently, when comparative data are required, these factors are to be carefully controlled and recorded.

1.7 The method is not intended to be used as a source of data for design calculations. Information on the typical behaviour of a material can be obtained, however, by testing at different temperatures, by varying the notch radius and/or the thickness and by testing specimens prepared under different conditions.

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

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 10724-1, *Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) — Part 1: General principles and moulding of multipurpose test specimens*

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

ISO 20753, *Plastics — Test specimens*

3 Terms and definitions

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

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

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

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

3.1
Izod unnotched impact strength
a_{iU}
impact energy absorbed in breaking an unnotched specimen, 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
Izod notched impact strength
a_{iN}
impact energy absorbed in breaking a notched specimen, referred to the original cross-sectional area of the specimen at the notch, with the pendulum striking the face containing the notch

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

3.3
parallel impact
p
<laminar-reinforced plastics> impact with the direction of blow parallel to the plane of reinforcement

Note 1 to entry: The direction of the blow in the Izod test is usually “edgewise parallel” (ep) (see Figure 1).

3.4
normal impact
n
<laminar-reinforced plastics> impact with the direction of blow normal to the plane of reinforcement

Note 1 to entry: This kind of impact is not usually used with the Izod test, but is indicated for the sake of completion (see also Figure 1).

4 Principle

The test specimen, supported as a vertical cantilever beam, is broken by a single impact of a striker, with the line of impact a fixed distance from the specimen clamp and, in the case of notched specimens, from the centreline of the notch (see Figure 2).

5 Apparatus

5.1 Test machine

5.1.1 The principles, characteristics and verification of suitable test machines are detailed in ISO 13802. ISO 13802 describes partial verification and full verification. In the case of full verification, some items are difficult to verify when the apparatus is assembled. Such verifications are assumed to be incumbent on the manufacturer.

5.1.2 Some plastics are sensitive to clamping pressure. When testing such materials, a means of standardizing the clamping force shall be used and the clamping force shall be recorded in the test report. The clamping force can be controlled by using a calibrated torque wrench or a pneumatic or hydraulic device on the vice clamping screw.

5.2 Micrometers and gauges

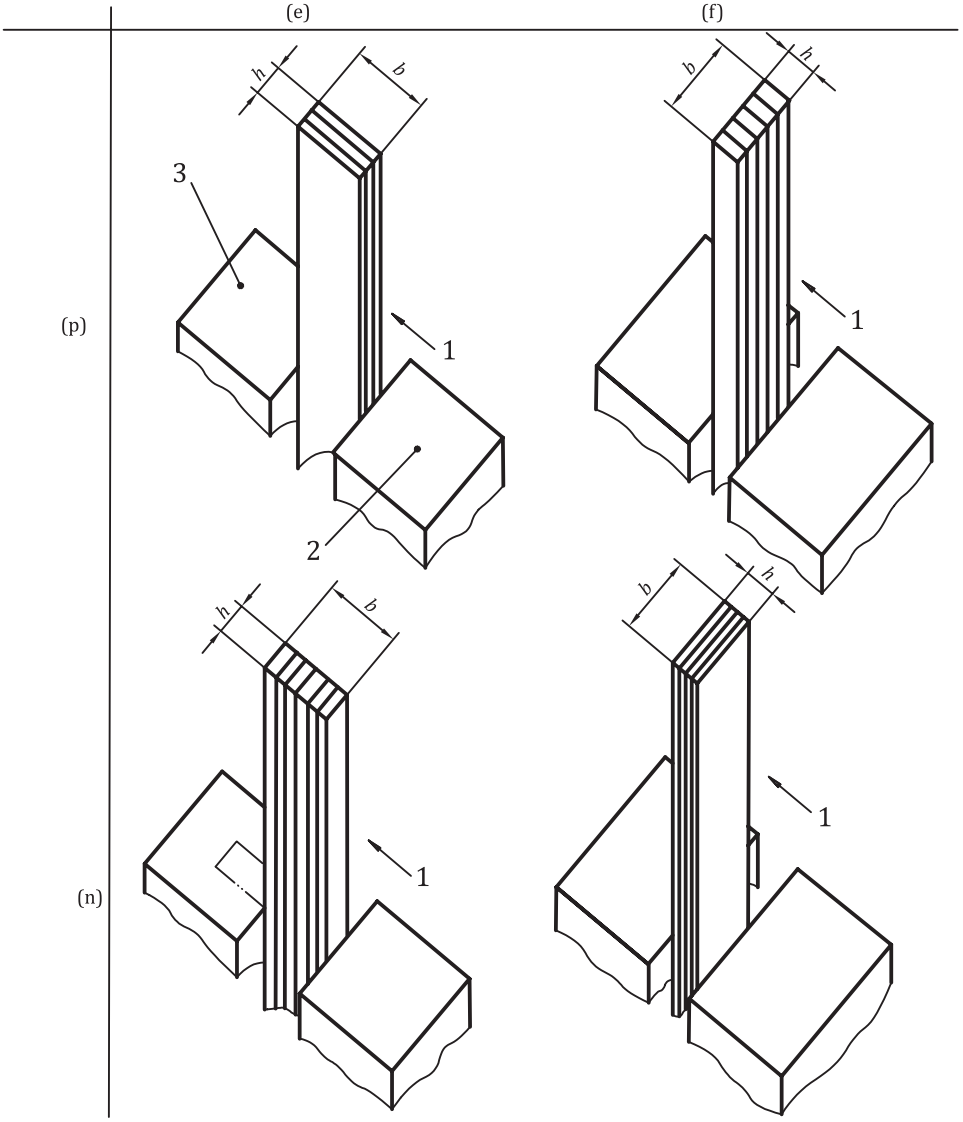
Micrometers and gauges capable of measuring the essential dimensions of test specimens to an accuracy of 0,02 mm are required. For measuring the dimension b_N of notched specimens, the micrometer shall be fitted with an anvil of width 2 mm to 3 mm and of suitable profile to fit the shape of the notch.

6 Test specimens

6.1 Preparation

6.1.1 Moulding and extrusion compounds

Specimens shall be prepared in accordance with the relevant material specification. When none exists, and unless otherwise specified, specimens shall be either directly compression-moulded or injection-moulded from the material in accordance with ISO 293, ISO 294-1, ISO 295 or ISO 10724-1 as appropriate, or machined in accordance with ISO 2818 from sheet that has been compression- or injection-moulded from the compound. Specimens may also be cut from multipurpose test specimens complying with ISO 20753, type A.



Key

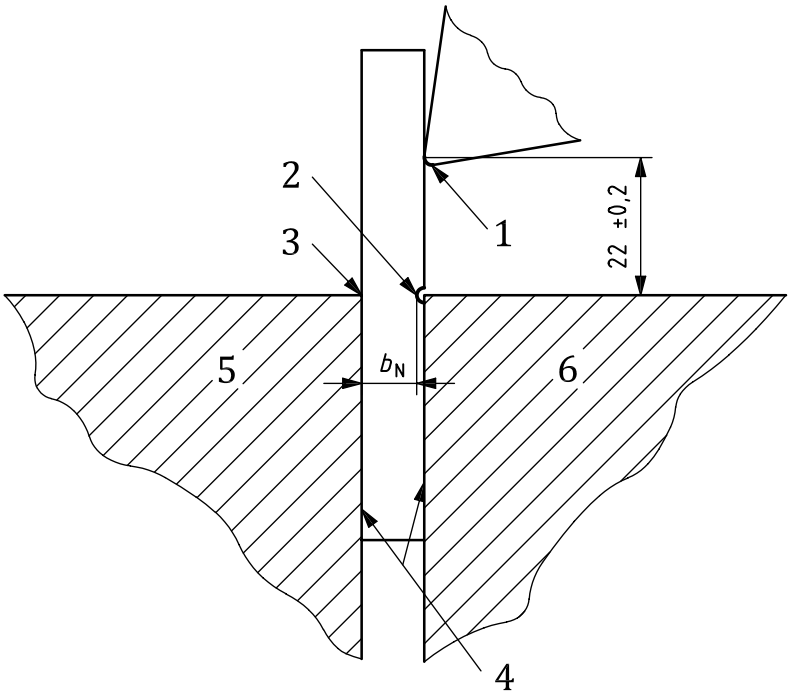
1	direction of blow	e	edgewise
2	movable vice jaw	f	flatwise
3	fixed vice jaw	n	normal
		p	parallel

NOTE 1 Edgewise (e) and flatwise (f) indicate the direction of the blow with respect to the specimen thickness *h* and specimen width *b*. Normal (n) and parallel (p) indicate the direction of the blow with respect to the laminate plane.

NOTE 2 The usual Izod test is "edgewise parallel". When $h = b$, parallel as well as normal impact testing is possible.

Figure 1 — Scheme of designations describing the direction of blow

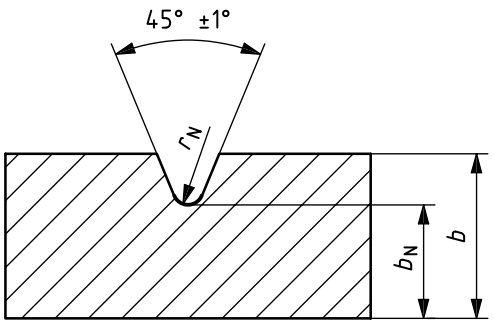
Dimensions in millimetres



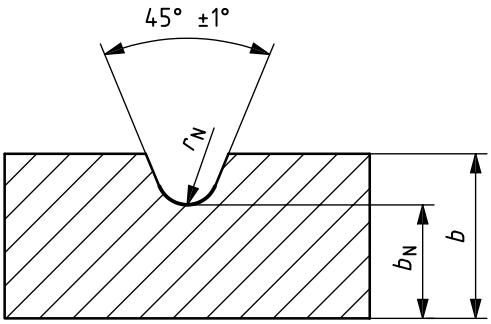
Key

1 striking edge (for radius, see ISO 13802)
2 notch
3 vice jaw edge about which bending takes place (for radius, see ISO 13802)
4 faces of jaws in contact with the specimen
5 fixed vice jaw
6 movable vice jaw
b_N remaining width at notch base (8 mm ± 0,2 mm)

Figure 2 — Vice jaws, test specimen (notched) and striking edge shown at impact



a) Type A
Radius r_N of notch base = 0,25 mm ± 0,05 mm



b) Type B
Radius r_N of notch base = 1 mm ± 0,05 mm

Key

b specimen width (10 mm ± 0,2 mm)
b_N remaining width at notch base (8 mm ± 0,2 mm)

Figure 3 — Notch types

6.1.2 Sheets

Specimens shall be machined from sheets in accordance with ISO 2818. Whenever possible, specimens with notch A shall be used. The machined surface of unnotched specimens shall not be tested under tension.

6.1.3 Long-fibre-reinforced materials

A panel shall be prepared in accordance with ISO 1268 or another specified or agreed upon preparation procedure. Specimens shall be machined in accordance with the relevant part of ISO 1268.

6.1.4 Checking

The specimens shall be free of twist and shall have mutually perpendicular parallel surfaces. The surfaces and edges shall be free from scratches, pits, sink marks and flash.

The specimens shall be checked for conformity with these requirements by visual observation against straightedges, squares and flat plates, and by measuring with micrometer callipers.

Specimens showing measurable or observable departure from one or more of these requirements shall be rejected or machined to proper size and shape before testing.

6.1.5 Notching

6.1.5.1 It is preferred that notches are machined into test specimens. Machined notches shall be prepared in accordance with ISO 2818. The profile of the cutting tooth shall be such as to produce in the specimen a notch of the contour and depth shown in Figure 3, at right angles to its principal axes. The notch profile shall be checked at regular intervals.

6.1.5.2 Specimens with moulded-in notches may be used if specified for the material being tested. Specimens with moulded-in notches do not give results comparable to those obtained from specimens with machined notches. The notch profile shall be checked at regular intervals.

6.2 Anisotropy

Certain types of sheet or panel material may show different impact properties depending on the direction in the plane of the sheet or panel. In such cases, it is customary to cut groups of test specimens with their major axes respectively parallel and perpendicular to the direction of some feature of the sheet or panel which is either visible or inferred from knowledge of the method of manufacture.

6.3 Shape and dimensions

6.3.1 General

For the dimensions of the test specimen, see Table 1.

Where necessary with certain types of apparatus, the length may be shortened symmetrically to 63,5 mm.

The longitudinal direction of the notch is always parallel to the thickness, *h*.

Table 1 — Method designations, specimen types, notch types and notch dimensions

Dimensions in millimetres

Method designation[a,b]	Specimen	Notch type[a]	Notch base radius, r_N	Remaining width, b_N, at notch base
ISO 180/U	Length l = 80 ± 2 Width b = 10,0 ± 0,2 Thickness h = 4,0 ± 0,2	Unnotched	—	—
ISO 180/A		A	0,25 ± 0,05	8,0 ± 0,2
ISO 180/B		B	1,00 ± 0,05	

[a] If specimens are taken from sheet or products, the thickness h of the sheet or product shall be added to the designation. Unreinforced specimens shall not be tested with their machined surface under tension.

[b] If the sheet thickness h equals the width b, the direction of the blow (normal n, or parallel p) shall be added to the designation.

6.3.2 Moulding and extrusion compounds

Test specimens with one of two different types of notch shall be used as specified in Table 1 and shown in Figure 3. The notch shall be located at the centre of the specimen.

The preferred type of notch is type A. If information on the notch sensitivity of the material is desired, specimens with notch types A and B shall be tested.

6.3.3 Sheet materials, including long-fibre-reinforced materials

The recommended thickness h is 4 mm. If the specimen is cut from a sheet or a piece taken from a structure, the thickness of the specimen, up to 10,2 mm, shall be the same as the thickness of the sheet or the structure.

Specimens taken from pieces thicker than 10,2 mm shall be machined to 10 mm ± 0,2 mm from one surface, providing that the sheet is homogeneous in its thickness and contains only one type of reinforcement uniformly distributed. If unnotched specimens are tested, the original surface shall be tested under tension, in order to avoid surface effects.

Specimens shall be tested edgewise parallel, with the exception of specimens with $h = b$ = 10 mm which can be tested parallel or normal to the laminate plane (see Figure 1 and Figure 2).

6.4 Number of test specimens

6.4.1 Unless otherwise specified in the standard for the material being tested, a set consisting of 10 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.

6.4.2 If laminates are tested in the normal and parallel directions, 10 specimens shall be used for each direction.

6.5 Conditioning

Unless otherwise specified in the standard for the material under test, the specimens shall be conditioned for at least 16 h at 23 °C and 50 % relative humidity in accordance with ISO 291, unless other conditions are agreed upon by the interested parties. In the case of notched specimens, the conditioning time is after notching.

7 Procedure

7.1 Conduct the test in the same atmosphere as that used for conditioning, unless otherwise agreed upon by the interested parties, e.g. for testing at high or low temperatures.

7.2 Measure the thickness h and width b of each test specimen, in the centre, to the nearest 0,02 mm. In the case of notched specimens, carefully measure the remaining width b_N to the nearest 0,02 mm.

In the case of injection-moulded specimens, it is not necessary to measure the dimensions of each specimen. It is sufficient to measure one specimen from a set to make sure that the dimensions correspond to those in Table 1. With multiple-cavity moulds, ensure that the dimensions of the specimens are the same for each cavity.

7.3 Check that the impact machine is able to perform the test with the specified velocity of impact and that it is in the correct range of absorbed energy W which shall be between 10 % and 80 % of the available energy at impact, E. If more than one of the pendulums conform to these requirements, the pendulum having the highest energy shall be used.

7.4 Determine the frictional losses and correct the absorbed energy in accordance with ISO 13802.

7.5 Lift the pendulum to the prescribed height and support it. Place the specimen in the vice and clamp it as shown in Figure 2, in accordance with 5.1.2. When determining the notched Izod impact strength, the notch shall be positioned on the side that is to be struck by the striking edge of the pendulum.

7.6 Release the pendulum. Record the impact energy absorbed by the specimen and apply any necessary corrections for frictional losses, etc. (see 7.4).

7.7 Four types of break designated by the following code-letters may occur:

C Complete break: a break in which the specimen separates into two or more pieces

H Hinge break: an incomplete break, such that one part of the specimen cannot support itself above the horizontal when the other part is held vertically, which means less than 90° included angle

P Partial break: an incomplete break that does not meet the definition for hinge break

N Non-break: there is no break and the specimen is only distorted, possibly combined with stress whitening

8 Calculation and expression of results

8.1 Unnotched specimens

Calculate the Izod impact strength of unnotched specimens, a_{iU}, expressed in kilojoules per square metre, using Formula (1):

$$a_{iU} = \frac{W_c}{h \times b} \times 10^3 \qquad (1)$$

where

W_c is the corrected energy, in joules, absorbed by breaking the test specimen;

h is the thickness, in millimetres, of the test specimen;

b is the width, in millimetres, of the test specimen.

8.2 Notched specimens

Calculate the Izod impact strength of notched specimens, a_{iN}, expressed in kilojoules per square metre, with notches A or B, using Formula (2):

$$a_{iN} = \frac{W_c}{h \times b_N} \times 10^3 \quad (2)$$

where

W_c is the corrected energy, in joules, absorbed by breaking the test specimen;

h is the thickness, in millimetres, of the test specimen;

b_N is the remaining width, in millimetres, of the test specimen.

8.3 Statistical parameters

Calculate the arithmetic mean of test results and the standard deviation of the mean value, if required, using the procedure given in ISO 2602. For different types of failure within one sample, the relevant numbers of specimens shall be given and mean values shall be calculated.

8.4 Significant figures

Report all calculated mean values to two significant figures.

9 Precision

See Annex A.

10 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 180:2019;

b) the method used, designated in accordance with Table 1, for example:

Izod Impact Test ISO 180/1 A
Specimen test (see Table 1)
Type of notch (see Figure 3)

c) all information necessary for identification of the material tested, including type, source, manufacturer's code, grade and history, where these are known;

d) a description of the nature and form of the material, i.e. whether a product, semi-finished product, test plate or specimen, including principal dimensions, shape, method of manufacture, etc., where these are known;

e) the velocity of impact;

f) the nominal pendulum energy;

g) the clamping pressure, if applicable (see 5.1.2);

h) the method of test specimen preparation,

i) if the material is in the form of a product or a semi-finished product, the orientation of the test specimen in relation to the product or semi-finished product from which it was cut;

j) the number of specimens tested;

k) the standard atmosphere used for conditioning and testing, plus any special conditioning treatment if required by the standard for the material or product;

l) the type(s) of failure observed;

m) the individual test results, presented as follows (see also Table 2):

1) group the results according to the three basic types of failure:

C complete break, including hinge break H

P partial break

N non-break

2) select the most frequent type and record the mean value *x* of the impact strength for this type of failure, followed by the letter C or P for the type of failure,

3) if the most frequent failure type is N, record the letter N only,

4) add (between brackets) the letter C, P or N for the second most frequent failure type, but only if its frequency is higher than 1/3 (if not relevant, insert an asterisk);

n) the standard deviations of the mean values, if required;

o) the date(s) of the test.

Table 2 — Presentation of results

Type of failure			Designation
C	**P**	**N**	
x	a	a	*x*C a
x	(P)	a	*x*C(P)
x	a	(N)	*x*C(N)
a	*X*	a	*x*P a
(C)	*X*	a	*x*P(C)
a	*X*	(N)	*x*P(N)
a	a	N	N a
(C)	a	N	N(C)
a	(P)	N	N(P)

x Mean value of impact strength for most frequent failure type, excluding type N.

C, P or N Most frequent failure type.

(C), (P) or (N) Second most frequent failure type, to be recorded only if its frequency is higher than 1/3.

a Not relevant.

Annex A
(informative)

Precision statement

A.1 Table A.1 is based on a round-robin test involving six laboratories and three materials. All of the test samples were prepared and distributed by one source, except for notching, which was the responsibility of the laboratories involved. Notches were then verified by the laboratory responsible for specimen distribution. Each "test result" was the average of 10 individual determinations. Each laboratory obtained and reported one test result for each material on two consecutive days. Test results are labelled according to laboratory and day (e.g. A1, A2, B1 and B2). Data from laboratory F were significantly different than data from the others; for this reason, they were excluded from the analysis and not reported.

A.2 Table A.2 contains statistical results output from ASTM E691.

CAUTION — Due to the limited number of laboratories and materials, the following explanations of *r* and *R* (see A.3) are only intended to present a meaningful way of considering the approximate precision of the test method. The data in Table A.2 should not be rigorously applied to the acceptance or rejection of material, as those data are specific to the round robin and might not be representative of other lots, conditions, materials or laboratories.

A.3 The concepts of "*r*" and "*R*" in Table A.2: if s_r and s_R have been calculated from a large enough body of data, and for test results that were from one test determination, then:

a) repeatability: two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the *r* value for that material. *r* is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment in the same laboratory.

b) reproducibility: two test results obtained by different laboratories shall be judged not equivalent if they differ by more than the *R* value for that material. *R* is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

Any judgement in accordance with A.3 above would have approximately 95 % (0,95) probability of being correct.

Table A.1 — Data for two consecutive days, notched impact strength

Notched impact strength in kilojoule per square metre (kJ/m^2)

Laboratory/ day	ABS		PBT		PBT GF30	
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.
A1	22,32	1,72	5,96	2,48	11,13	1,53
A2	22,46	0,64	6,46	0,96	11,31	0,84
	—	—	—	—	—	—
B1	20,70	0,32	4,81	0,37	10,12	0,62
B2	21,08	0,44	4,59	0,16	10,41	0,46
	—	—	—	—	—	—
C1	20,27	0,35	4,37	0,29	9,19	0,36
C2	19,97	0,27	4,11	0,13	8,93	0,31
	—	—	—	—	—	—
D1	20,57	0,41	5,09	0,12	9,85	0,52
D2	20,54	0,46	5,16	0,06	10,06	0,64
	—	—	—	—	—	—
E1	21,59	0,85	7,73	0,38	12,00	1,23
E2	20,59	0,56	7,61	0,28	11,96	1,61
	—	—	—	—	—	—
Average	21,01	—	5,59	—	10,50	—

Table A.2 — Precision, notched impact strength

Notched impact strength in kilojoule per square metre (kJ/m^2)

Material	Average	s_r	s_R	r	R
ABS	21,01	0,35	0,89	0,99	2,49
PBT	5,59	0,20	1,38	0,55	3,86
PBT GF30	10,50	0,15	1,14	0,42	3,19

s_r = standard deviation within laboratory

s_R = standard deviation between laboratories

r = 95 % repeatability limit = 2,8 s_r

R = 95 % reproducibility limit = 2,8 s_R

Bibliography

[1] ASTM E691-11, *Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method*