DRAFT INTERNATIONAL STANDARD
ISO/DIS 179-2

ISO/TC **61**/SC **2** Secretariat: **KATS**

Voting begins on: **2018-08-03** Voting terminates on: **2018-10-26**

Plastics — Determination of Charpy impact properties —

Part 2: **Instrumented impact test**

Plastiques — Détermination des caractéristiques au choc Charpy —

Partie 2: Essai de choc instrumenté

ICS: 83.080.01

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/DIS 179-2:2018(E)

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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 (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 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

ISO 179 consists of the following parts, under the general title *Plastics — Determination of Charpy impact properties*:

— *Part 1: Non-instrumented impact test*

— *Part 2: Instrumented impact test*

Annexes A to C of this part of ISO 179 are for information only.

Changes made relative to ISO 179-2:1997 are:

— Amendment1:2011 has been included into this document as "Annex D Precision Statement".

— Minor editorial changes.

— Revision of referrals to ISO 13802 according to the currently valid edition (2015) of this standard.

— Clarification of force calibration requirements (yet missing). A relative error of 1 % throughout the measuring range appears realistic. Discussion with manufactrueres is ongoing.

Plastics — Determination of Charpy impact properties —

Part 2: Instrumented impact test

1 Scope

1.1 This part of ISO 179 specifies a method for determining Charpy impact properties of plastics from force-deflection diagrams. Different types of rod-shaped test specimens and test configurations, as well as test parameters depending on the type of material, the type of test specimen and the type of notch are defined in Part 1 of ISO 179.

Dynamic effects such as load-cell/striker resonance, test specimen resonance and initial-contact/inertia peaks are described (see Figure 1, Curve b, and Annex A).

1.2 ISO 179-1 is suitable for characterizing the impact behaviour by the impact strength only and for using apparatus whose potential energy is matched approximately to the particular energy to break to be measured (see ISO 13802, Annex E). This part of ISO 179 is used if a force-deflection or force-time diagram is necessary for detailed characterization of the impact behaviour, and for developing automatic apparatus, i.e. avoiding the need, mentioned above, to match energy.

1.3 For the range of materials which may be tested by this method, see ISO 179-1, Clause 1.

1.4 For the general comparability of test results, see ISO 179-1, Clause 1.

1.5 The method may not be used as a source of data for design calculations on components. However, the possible use of data is not the subject of this part of ISO 179. Any application of data obtained using this part of ISO 179 should be specified by a referring standard or agreed upon by the interested parties.

Information on the typical behaviour of materials can be obtained by testing at different temperatures, by varying the notch radius and/or specimen thickness and by testing specimens prepared under different conditions.

It is not the purpose of this part of ISO 179 to give an interpretation of the mechanism occurring at every point on the force-deflection diagram. These interpretations are a task for on-going scientific research.

1.6 The test results are comparable only if the conditions of test specimen preparation, as well as the test conditions, are the same. Comprehensive evaluation of the reaction to impact stress requires that determinations be made as a function of deformation rate and temperature for different material variables such as crystallinity and moisture content. The impact behaviour of finished products cannot, therefore, be predicted directly from this test, but test specimens may be taken from finished products for testing by this method.

1.7 Impact strengths determined by this method may replace those determined using ISO 179-1 if comparability has been established by previous tests.

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

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

ISO 16012, *Plastics — Determination of linear dimensions of test specimens*

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

3 Terms and definitions

For the purposes of this part of ISO 179, the definitions given in Part 1 apply, together with the following.

3.1
impact velocity
v_0
the velocity of the striker relative to the test specimen supports at the moment of impact

Note 1 to entry: It is expressed in metres per second (m/s).

3.2
inertial peak
the first peak in a force-time or force-deflection diagram

It arises from the inertia of that part of the test specimen accelerated after the first contact with the striker (see Figure 1, Curve b, and Annex A).

3.3
impact force
F
the force exerted by the striking edge on the test specimen in the direction of impact

Note 1 to entry: It is expressed in newtons (N).

3.4
deflection
s
the displacement of the striker relative to the test specimen supports after impact, starting at first contact between striker and test specimen

Note 1 to entry: It is expressed in millimetres (mm).

3.5
impact energy
W
the energy expended in accelerating, deforming and breaking the test specimen during the deflection s

Note 1 to entry: It is expressed in joules (J).

Note 2 to entry: It is measured by integrating the area under the force-deflection curve from the point of impact to the deflection s.

3.6
maximum impact force
F_M
the maximum value of the impact force in a force-time or force-deflection diagram (see Figure 1)

Note 1 to entry: It is expressed in newtons (N).

3.7
deflection at maximum impact force
s_M
the deflection at which the maximum impact force F_M occurs (see Figure 1)

Note 1 to entry: It is expressed in millimetres (mm).

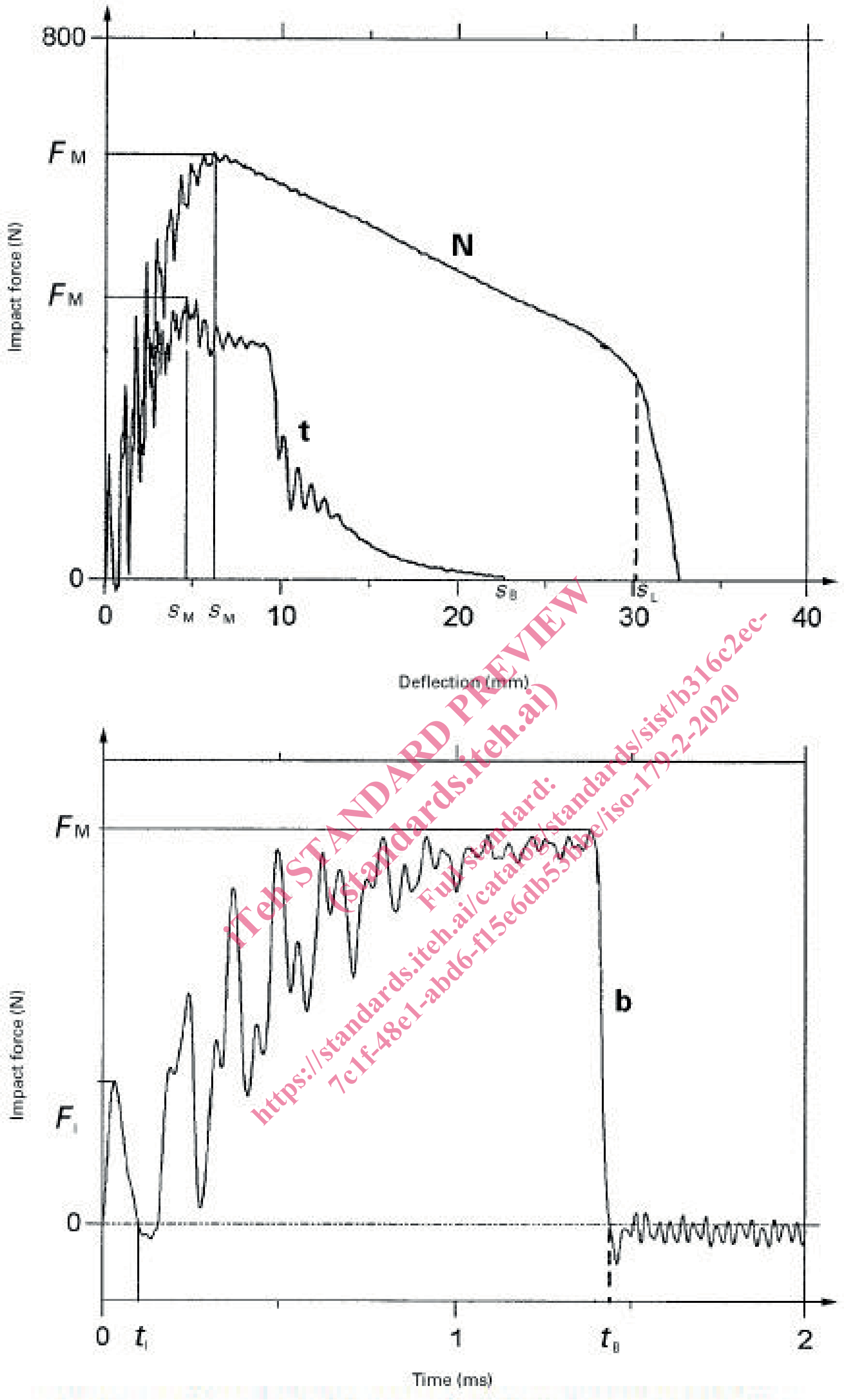
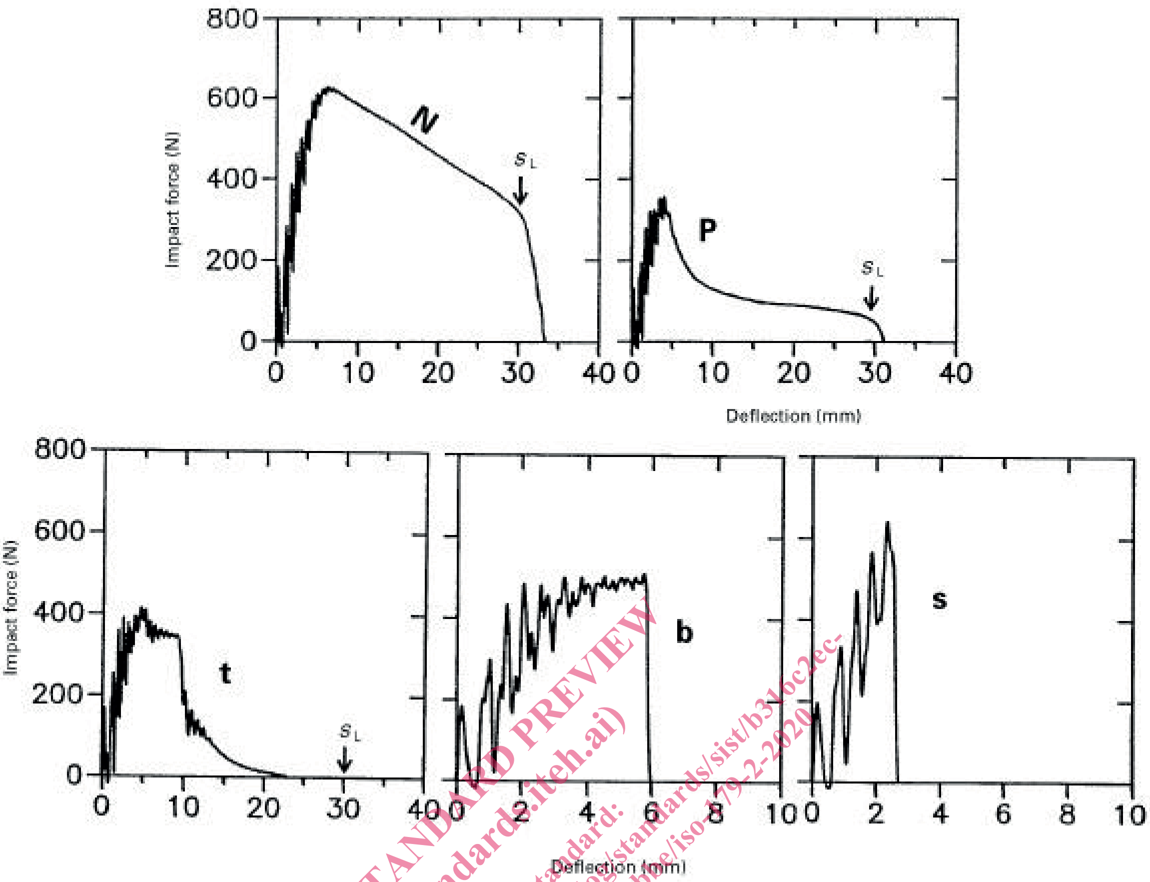


Figure 1 — Typical force-deflection (top: N and *t*) and force-time (bottom: b) curves
(for the types of failure, see **Figure 2**)



Key

N no break: yielding followed by plastic deformation up to the deflection limit s_L

P partial break: yielding followed by stable cracking, resulting in a force at the deflection limit s_L which is greater than 5 % of the maximum force

t tough break: yielding followed by stable cracking, resulting in a force at the deflection limit s_L which is less than or equal to 5 % of the maximum force

b brittle break: yielding followed by unstable cracking

s splintering break: unstable cracking followed by splintering

s_L deflection limit; beginning of pull-through

NOTE Due to the different modes of deformation, force-deformation curves obtained using this part of ISO 179 show features which are different from those obtained using ISO 6603-2[1]. In particular, the first damage event in instrumented puncture tests frequently appears as a slight sudden force decrease (crack initiation), followed by a gradual force increase. Force increases after crack initiation are never observed in instrumented three-point-bending impact tests. Furthermore, inertial effects are not as pronounced in plate impact tests as they are in bending impacts tests (see Annex A).

Figure 2 — Typical force-deflection curves showing different failure modes for Type 1 specimens tested edgewise

3.8
energy to maximum impact force

W_M

the energy expended up to the deflection at maximum impact force

Note 1 to entry: It is expressed in joules (J).

3.9
deflection at break
s_B
the deflection at which the impact force is reduced to less than or equal to 5 % of the maximum impact force F_M (see Figure 1)

Note 1 to entry: It is expressed in millimetres (mm).

It is necessary to differentiate between the deflection at break s_B and the deflection limit s_L at the beginning of pull-through (see Figure 1, Curve N) which is determined by the length l and width b of the test specimen and the distance L between the specimen supports. For Type 1 specimens in the edgewise position, s_L is in the range 32 mm to 34 mm.

Note 2 to entry: Using Type 1 specimens tested edgewise, apparent deflection limits are sometimes observed, i.e. unexpectedly low values (down to only 20 mm) at which the impact force drops to zero, but the specimens do not break. Carrying out the test slowly shows that, in such cases, the specimen changes from the edgewise to the more stable flatwise position by a combined bending-twisting deformation. This can easily be confirmed by checking the specimen after the test: it is bent with respect to an axis not parallel, but inclined to, the specimen width.

This behaviour is caused by the high ratio between the edgewise and the flatwise flexural rigidity of the specimen and is triggered by a small asymmetry feature e.g. the draft angle.

The effects of such instability phenomena may be decreased by attaching guide elements to the hammer close to, but not connected to, the instrumented striking edge. The guide elements shall allow passage of the test specimen but be close enough together to prevent, the central part of the specimen from twisting to any great extent.

3.10
impact energy at break
W_B
the impact energy up to the deflection at break s_B

Note 1 to entry: It is expressed in joules (J).

3.11
charpy (notched) impact strength
a_{cU} (a_{cN})
the impact energy at break relative to the initial central cross-sectional area A (A_N) of the unnotched (notched) specimen (see 8.4 and ISO 179-1, 3.1 and 3.2)

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

3.12
type of failure
the type of deformation behaviour of the material under test (see Figure 2). It may be either no break (N), partial break (P), tough (t), brittle (b) or splintering (s)

Types *t*, *b* and *s* represent subgroups of the complete break C and hinge break H defined below. For these types, values of the impact energy at break W_B, and thus for the Charpy impact strength, may be averaged to give a common mean value. For specimens giving a partial break *P* and for materials exhibiting interlaminar shear fracture, see ISO 179-1, 7.7. For specimens showing more than one failure type, see ISO 179-1, 7.7 and ISO 179-1, subclause 10l).

Failure types (see ASTM D256):

C = Complete Break — A break where the specimen separates into two or more pieces.

