INTERNATIONAL STANDARD

ISO 6603-1

Second edition
2000-03-01

Plastics — Determination of puncture impact behaviour of rigid plastics —

Part 1: Non-instrumented impact testing

Plastiques — Détermination du comportement des plastiques rigides perforés sous l'effet d'un choc —

Partie 1: Essais de choc non instrumentés

Reference number
ISO 6603-1:2000(E)

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Printed in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 6603 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6603-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

This second edition cancels and replaces the first edition (ISO 6603-1:1985), which has been technically revised.

ISO 6603 consists of the following parts, under the general title *Plastics — Determination of puncture impact behaviour of rigid plastics*:

— *Part 1: Non-instrumented impact testing*

— *Part 2: Instrumented impact testing*

Annex A of this part of ISO 6603 is for information only.

Plastics — Determination of puncture impact behaviour of rigid plastics —

Part 1: Non-instrumented impact testing

1 Scope

This International Standard specifies methods for the determination of puncture-impact properties of rigid plastics in the form of flat test specimens, such as discs or square pieces, under defined conditions. Specimens may be moulded directly, cut from sheets or taken from finished products. Different types of test specimens and test conditions are defined.

These falling-dart methods are used to investigate the behaviour of plastic sheeting or mouldings under the impact of a striker applied perpendicular to the plane of the specimen.

This part of ISO 6603 can be used if it is sufficient to characterize the impact behaviour of plastics by a threshold value of impact-failure energy based on many test specimens. ISO 6603-2 is used if a force-deflection or force-time diagram, recorded at nominally constant striker velocity, is necessary for detailed characterization of the impact behaviour.

These test methods are applicable to specimens with a thickness between 1 mm and 4 mm.

NOTE For thicknesses less than 1 mm, ISO 7765 should preferably be used. Thicknesses greater than 4 mm may be tested if the equipment is suitable, but the test falls outside the scope of ISO 6603-1 and ISO 6603-2.

These methods are suitable for use with the following types of material:

— rigid thermoplastic moulding and extrusion materials, including filled, unfilled and reinforced compounds and sheets;

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

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

These methods are also applicable to specimens which are either moulded or machined from finished products, laminates and extruded or cast sheet.

The test results are comparable only if the conditions of preparation of the specimens, their dimensions and surfaces as well as the test conditions are the same. In particular, results determined on specimens of different thickness cannot be compared with one another (see annex E of ISO 6603-2:—). Comprehensive evaluation of the reaction to impact stress requires that determinations be made as a function of impact velocity and temperature for different material variables, such as crystallinity and moisture content.

The impact behaviour of finished products cannot be predicted directly from this test, but specimens may be taken from finished products (see above) for test by these methods.

Test data developed by these methods should not be used for design calculations. However, information on the typical behaviour of the material can be obtained by testing at different temperatures and impact velocities (see annex D of ISO 6603-2:—), by varying the thickness (see annex E of ISO 6603-2:—) and by testing specimens prepared under different conditions.

Two statistical methods of test are described in this part of ISO 6603:

— Method A: staircase method (individual) (preferred)

  In this method, a uniform energy increment is employed during testing. The energy is decreased or increased by the uniform increment after testing each specimen, depending upon the observed result (pass or fail) for the preceding test.

— Method B: group method (optional)

  In this method, successive groups of at least ten test specimens are tested. The impact failure energy is calculated by statistics.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 6603. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 6603 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 291:1997, *Plastics — Standard atmospheres for conditioning and testing*.

ISO 293:1986, *Plastics — Compression moulding test specimens of thermoplastic materials*.

ISO 294-3:1996, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 3: Small plates*.

ISO 295:1991, *Plastics — Compression moulding of test specimens of thermosetting materials*.

ISO 1268:1974[1)], *Plastics — Preparation of glass fibre reinforced, resin bonded, low-pressure laminated plates or panels for test purposes*.

ISO 2818:1994, *Plastics — Preparation of test specimens by machining*.

ISO 6603-2:—[2)], *Plastics — Determination of puncture impact behaviour of rigid plastics — Part 2: Instrumented impact testing*.

ISO 7765-1:1988, *Plastics film and sheeting — Determination of impact resistance by the free-falling dart method — Part 1: Staircase methods*.

ISO 7765-2:1994, *Plastics film and sheeting — Determination of impact resistance by the free-falling dart method — Part 2: Instrumented puncture test*.

1) Under revision.

2) To be published (Revision of ISO 6603-2:1989)

3 Terms and definitions

For the purposes of this part of ISO 6603, the following terms and definitions apply:

3.1 General

3.1.1
failure
any break in the surface of the specimen which is visible to the naked eye

3.2 Failure-criteria terms

3.2.1
crack
any fissure that can be observed by the naked eye and that does not penetrate the full thickness of the material (see Figure 1)

3.2.2
break
any fissure through the full thickness of the material (see Figure 2)

3.2.3
penetration
failure in which the striker penetrates through the whole thickness of the test specimen [see Figure 3 b)]

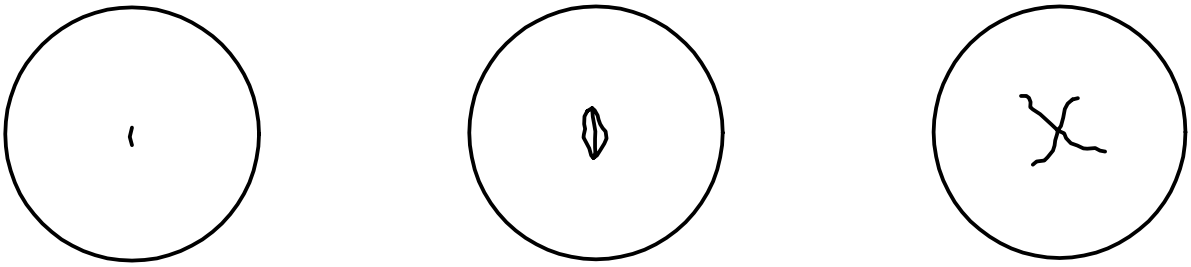
3.2.4
shattering
breaking of the test specimen into two or more pieces [see Figure 3 a)]

3.3 Impact-failure terms

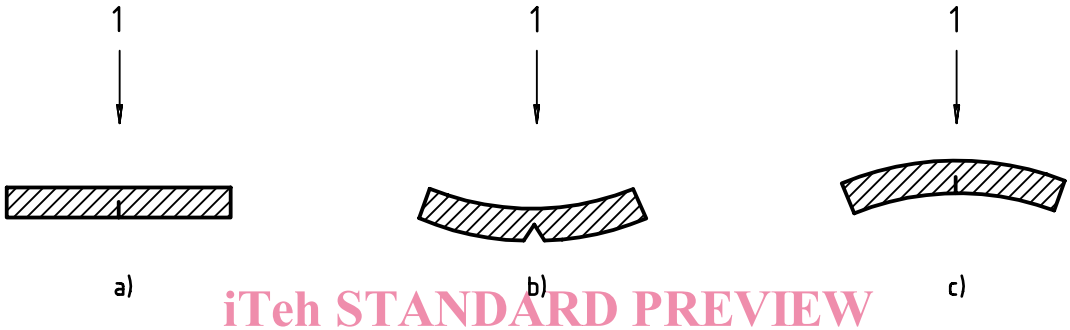
3.3.1
50 % impact-failure energy
E_{50}
the energy that will cause 50 % of the test specimens to fail as defined in 3.1.1

3.3.2
50 % impact-failure mass
M_{50}
the mass that will cause 50 % of the test specimens to fail, as defined in 3.1.1, for a given height of fall

3.3.3
50 % impact-failure height
H_{50}
the height that will cause 50 % of the test specimens to fail, as defined in 3.1.1, using a given falling mass



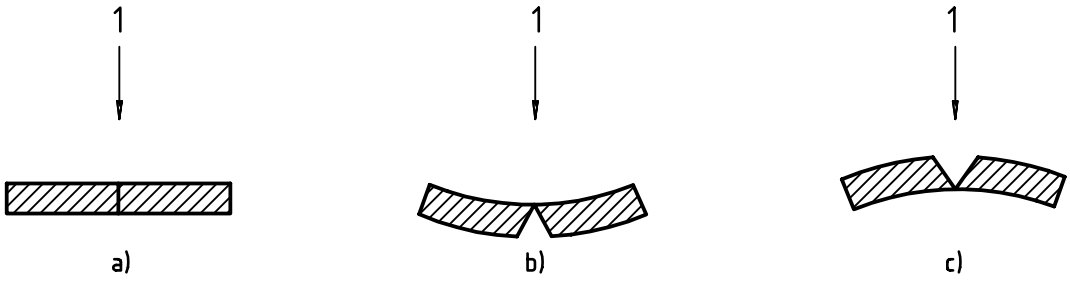
Views of specimen surfaces damaged by a “crack” (examples)



Key

1 Impact direction

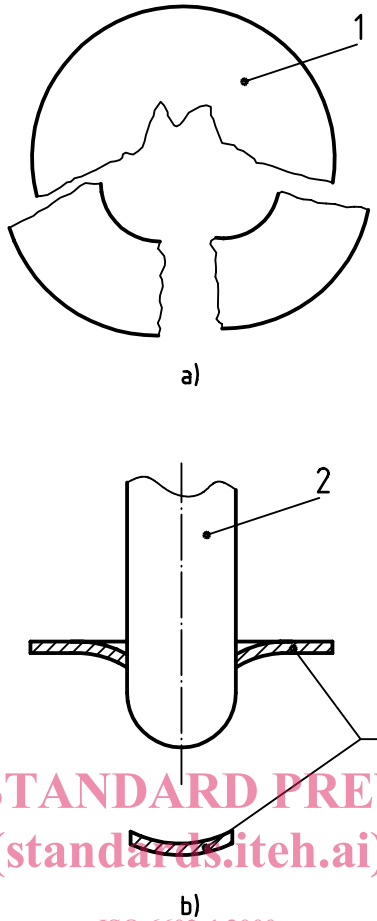
Figure 1 — Sections through specimens damaged by a “crack” [b) and c) after bending by hand]



Key

1 Impact direction

Figure 2 — Sections through specimens damaged by a “break” [b) and c) after bending by hand]



Key

1 Specimen

2 Dart with hemispherical head

Figure 3 — Example of "shattering" failure [a)] and "penetration" [b)]

4 Principle

The impact strength of suitably sized test specimens is determined by striking them with a lubricated weighted striker dropped vertically from a known height. The test specimen is impacted at its centre by a striker, perpendicular to the surface of the specimen.

Two methods of adjusting the energy at impact are permitted: altering the mass at constant height and altering the height at constant mass.

NOTE The variable-height procedure is velocity-dependent, and differing results may be observed depending upon the material's strain rate.

Two statistical methods of test are given:

— Method A: staircase method (individual) (preferred).

— Method B: group method (optional).

5 Apparatus

5.1 Test device

5.1.1 Essential components

The essential components of the test device (see Figure 4) are:

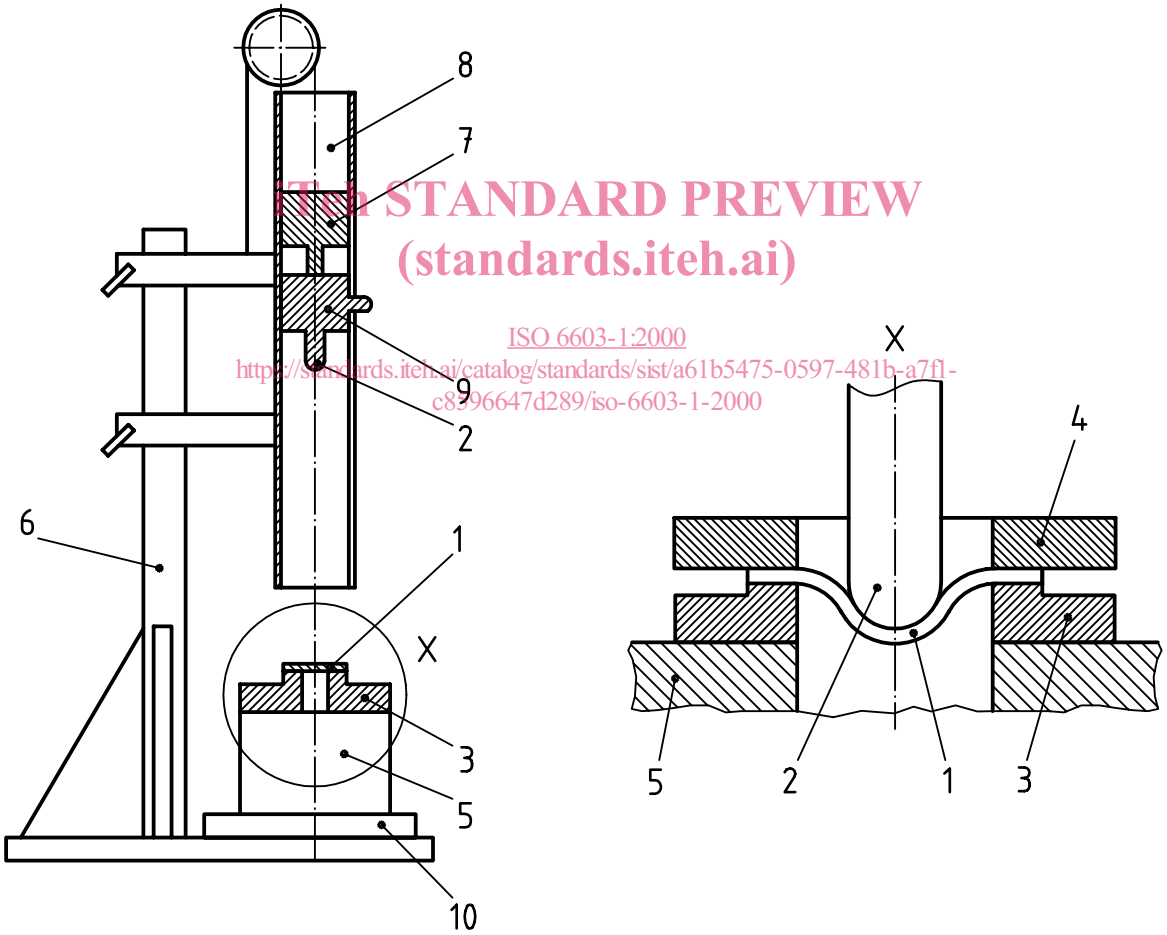
— an energy carrier (dart system), of the inertial-mass type, which includes:

  weights,

  a striker (lubrication is required);

— a specimen support (see Figure 4), optionally with a clamping device (Figure 5).

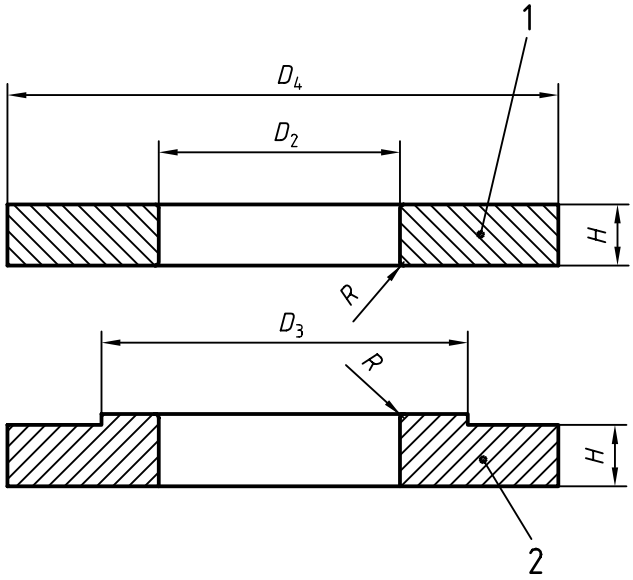
The test device shall permit the test specimen to be punctured at its centre, perpendicular to the specimen surface.



Key

1 Test specimen
2 Hemispherical striker tip
3 Test specimen support
4 Clamping ring (optional)
5 Base
6 Stand for falling-dart system
7 Holding and release system for weighted striker
8 Guide shaft for weighted striker
9 Weighted striker
10 Acoustic isolation (optional)

Figure 4 — Falling-dart system (example)



Key

1 Clamping ring (optional)

2 Specimen support

Dimensions in millimetres

	Specimen type	
	Square of side 60	Disc of diam. 140
D_2	40 ± 2	100 ± 5
D_3	60	140
D_4	min. 90	min. 200
H	12	12
R	1	1

Figure 5 — Schematic drawing of clamping device (optional)

5.1.2 Falling-dart system

The falling-dart system shall be capable of holding and releasing a weighted striker such that it will fall constrained by one or more guides. The fall shall be nominally without friction and losses through windage, or the amount of friction has to be taken into account in the calculations.

5.1.3 Weights (masses)

Appropriate weights are required that can be firmly attached to the striker. The combined mass of the attached weights, and the mass of the striker, shall be known to within 1 %.

5.1.4 Striker

The preferred striker has a polished hemispherical striking surface with a diameter 20 mm ± 0,2 mm. Alternatively, a 10 mm ± 0,1 mm diameter striking surface may be used.

NOTE The size, dimensions and condition of the surface of the striker will affect the results.

The preferred striker is one made of any material with sufficient resistance to wear and of sufficiently high strength to prevent plastic deformation. In practice, hardened tool steel or similar material with a hardness of 54 HRC has been found acceptable. Harder materials or materials with a lower density (for example titanium) with equivalent