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Plastics — Multipurpose test specimens

Plastiques — Éprouvettes à usages multiples

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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).

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 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This fifth edition results from the reinstatement of the previous edition (ISO 3167:2002) which was withdrawn in 2013.

ISO 3167 is intended to be gradually replaced by ISO 20753 which specifies the designations and dimensions of test specimens used for the acquisition of comparable data, and also other frequently used specimens, in one document for ease of reference.

Plastics — Multipurpose test specimens

1 Scope

This International Standard specifies requirements relating to multipurpose test specimens for plastic moulding materials intended for processing by injection or direct compression moulding.

Specimens of types A and B are tensile test specimens from which, with simple machining, specimens for a variety of other tests can be taken (see [Annex A](#)). Because they have such wide utility, these tensile specimens are referred to in this International Standard as multipurpose test specimens.

The principal advantage of a multipurpose test specimen is that it allows all the test methods mentioned in [Annex A](#) to be carried out on the basis of comparable mouldings. Consequently, the properties measured are coherent as all are measured with specimens in the same state. In other words, it can be expected that test results for a given set of specimens will not vary appreciably due to unintentionally different moulding conditions. On the other hand, if desired, the influence of moulding conditions and/or different states of the specimens can be assessed without difficulty for all of the properties measured.

For quality-control purposes, the multipurpose test specimen can serve as a convenient source of further specimens not readily available. Furthermore, the fact that only one mould is required may be advantageous.

The use of multipurpose test specimens is to be agreed upon by the interested parties, because there may be significant differences between properties of the multipurpose test specimens and those specified in the relevant test methods.

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 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*

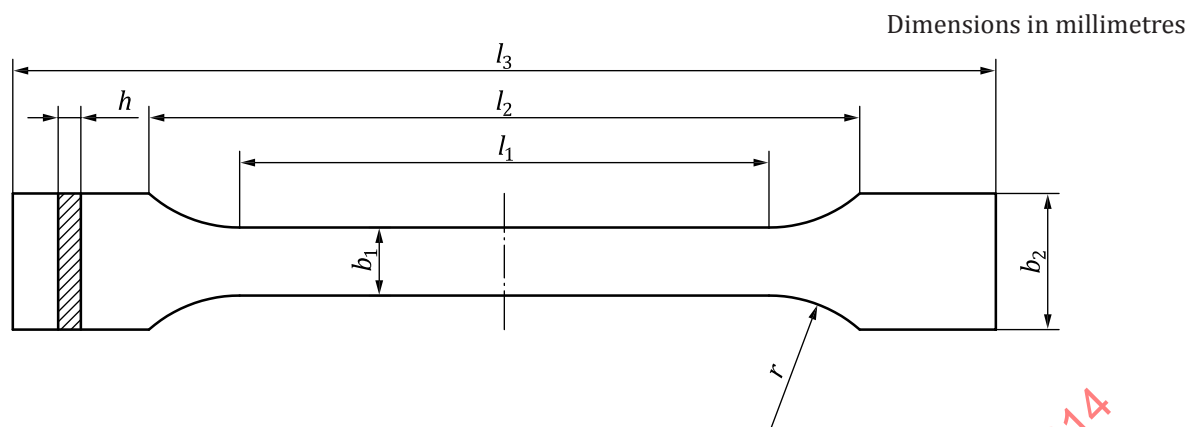
ISO 295, *Plastics — Compression moulding of test specimens of thermosetting materials*

ISO 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*

3 Dimensions of test specimens

For the purposes of this International Standard, the preferred multipurpose test specimen is the type A tensile specimen shown in [Figure 1](#). This can be made suitable for a variety of other tests by simple cutting, because the length l_1 of its narrow parallel-sided portion is $80 \text{ mm} \pm 2 \text{ mm}$.



	Specimen type	A	B
l_3	Overall length ^a	≥ 150 Recommended value ^b 170	≥ 150
l_1	Length of narrow parallel-sided portion	80 ± 2	$60,0 \pm 0,5$
r	Radius	20 to 25 Recommended value ^b 24 ± 1	$\geq 60^c$ Recommended value ^b $60,0 \pm 0,5$
l_2	Distance between broad parallel-sided portions ^d	104 to 113	106 to 120 Recommended range ^b 106 to 110
b_2	Width at ends	$20,0 \pm 0,2$	
b_1	Width of narrow portion	$10 \pm 0,2$	
h	Thickness	$4,0 \pm 0,2$	

^a The recommended overall length of 170 mm for type A is consistent with ISO 294-1 and ISO 10724-1. For some materials, the length of the tabs may need to be extended (e.g. to give an overall length of 200 mm) to prevent breakage or slippage in the jaws of the test machine.

^b The recommended values and ranges may become mandatory on occasion of the next revision of the standard. The lower tolerances on the radius reduce the ranges of the stress concentrations that are found at the transitions between the narrow parallel-sided and the rounded portions. Together with the smaller tolerance on the distance between the broad parallel-sided portions for type B, a common value of the initial distance between jaws can be used for tensile testing (see ISO 527-2).

^c
$$r = \frac{(l_2 - l_1)^2 + (b_2 - b_1)^2}{4(b_2 - b_1)}$$

^d Resulting from l_1 , r , b_1 and b_2 , but within the indicated tolerance.

Figure 1 — Type A and B multipurpose test specimens

4 Preparation of test specimen

4.1 General

Test specimens shall be prepared in accordance with the relevant material specification. When none exists, specimens shall be either directly compression 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 plates that have been compression or injection moulded from the compound.

Strict control of all conditions of the specimen preparation is essential to ensure that all test specimens in a set are actually in the same state.

All surfaces of the test specimens shall be free from visible flaws, scratches or other imperfections. With moulded specimens all flash, if present, shall be removed, taking care not to damage the moulded surface.

The broad sides of each specimen shall be suitably marked (see the note), for injection-moulded specimens to distinguish between the sides formed by the cavity plate and the fixed plate of the mould (see ISO 294-1 or ISO 10724-1), for compression-moulded and machined specimens to identify any asymmetry resulting from the underlying moulding process.

NOTE Asymmetry with respect to thickness can influence the flexural properties, including the temperature of deflection under load (see [Annex A](#)).

For injection-moulded specimens, the sides can be identified by the impressions of the ejection pins and by the draft angle. Compression-moulded and machined specimens shall be marked at their shoulders. ISO bars taken from the central part of multipurpose test specimens shall be marked outside their central 40 mm section, which is loaded by flexural testing.

4.2 Injection moulding of multipurpose test specimens

Type A test specimens shall be injection moulded as specified in ISO 294-1 or ISO 10724-1, as appropriate, and under conditions defined in the relevant International Standard for the material under examination.

4.3 Compression moulding of multipurpose test specimens

Type B test specimens shall be compression moulded directly to their final dimensions as specified in ISO 293 or ISO 295, as appropriate, and under conditions defined in the relevant International Standard for the material under examination.

4.4 Machining of multipurpose test specimens

4.4.1 Machining of test specimens shall be performed either as specified in ISO 2818 or as agreed upon by the interested parties.

4.4.2 Test specimens having a width of 10 mm shall be cut symmetrically from the central parallel-sided portion of the multipurpose test specimen.

The surface of the central parallel-sided portion of the test specimen shall remain as moulded:

- The width of the machined portions of the specimen shall be not less than that of the central parallel-sided portion, but may exceed the width of the latter by not more than 0,2 mm.
- During the machining operation, care shall be taken to avoid any damage to the moulded surfaces of the central portion.

For test specimens longer than 80 mm, the broad ends of the type A multipurpose test specimen (or type B for test specimens longer than 60 mm) shall be machined to the width of the central parallel-sided portion.

4.4.3 Type B multipurpose test specimens shall be machined from suitably processed compression-moulded plates (see [4.3](#)).

5 Report on preparation of test specimens

The report shall contain the following information:

- a) a reference to this International Standard;
- b) an indication of the specimen type (A or B);

- c) the type, source, manufacturer's code, grade and form, including history, etc., if known;
- d) the method of moulding and the conditions used;
- e) the method of machining and the conditions used;
- f) the number of test specimens produced;
- g) the standard atmosphere for conditioning, plus any special conditioning treatment if required by the standard for the material or product concerned;
- h) the date of preparation.

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Annex A

(informative)

Recommended applications for multipurpose test specimens or parts thereof

Table A.1 — Example of test methods and type of specimens

Method	Reference ^a	Type of specimen and/or dimensions mm
Tensile test	ISO 527-2	A or B
Tensile creep test	ISO 899-1	A or B
Flexural test	ISO 178	80 × 10 × 4
Flexural creep test	ISO 899-2	80 × 10 × 4
Compressive test	ISO 604	(10 to 50) × 10 × 4
Impact strength — Charpy	ISO 179-1 and ISO 179-2	80 × 10 × 4
Impact strength — Izod	ISO 180	80 × 10 × 4
Impact strength — tensile	ISO 8256	80 × 10 × 4
Temperature of deflection under load	ISO 75-2	80 × 10 × 4
Vicat softening temperature	ISO 306	(≥ 10) × 10 × 4
Hardness, ball indentation	ISO 2039-1	(≥ 20) × 20 × 4
Environmental stress cracking	ISO 22088-2, ISO 22088-3 and ISO 22088-4	A or B or 80 × 10 × 4
Density	ISO 1183-3	30 × 10 × 4
Oxygen index	ISO 4589-2 and ISO 4589-3	80 × 10 × 4
Comparative tracking index (CTI)	IEC 60112	15 × 15 × 4
Electrolytic corrosion	IEC 60426	30 × 10 × 4
Coefficient of linear expansion	ISO 11359-2	(> 30) × 10 × 4

^a See Bibliography.

Annex B (informative)

Consequences of changes in geometry

B.1 Test specimen length

The length of 170 mm may be too short for some materials in connection with a distance between the grips of 115 mm. While the test specimen length of 170 mm is sufficient for the large majority of tensile tests, clamping problems occasionally arise with highly reinforced grades and with very ductile ones.

If 170 mm is too short for some materials, this is even more true for the length of ≥ 150 mm that was used in the previous edition. The “ $\geq$ ”-sign gives the freedom to use lengths > 170 mm, which is also allowed in this edition. This recommendation is in line with ISO 294-1.

B.2 Radius tolerance

Taking into account the tolerances, the length l_2 between the shoulders is

$$106,125 \text{ mm} \leq l_2 \leq 112,526 \text{ mm} \quad \text{this edition}$$

$$103,996 \text{ mm} \leq l_2 \leq 112,526 \text{ mm} \quad \text{previous edition}$$

The clamping distance (in ISO 527-2) remains unchanged:

$$L = 115 \text{ mm} \pm 1 \text{ mm}$$

The shortest possible distance from clamp to shoulder is:

$$s_{\min} = 0,737 \text{ (same for this and previous edition)}$$

The longest possible distance from clamp to shoulder is:

$$\text{this edition: } 4,932 \text{ mm}$$

$$\text{previous edition: } 6,002 \text{ mm}$$

This is not a very big change, but it affects the effective length. It may be used to determine nominal strain data in the pre-yield range for e.g. modulus determination under severe conditions, where extensometers cannot be used, e.g. in temperature-controlled enclosures, by using grip separation only. However the effective length is quite sensitive to radius changes, and limiting the radius tolerance reduces possible error sources when utilizing this method. It may be introduced in ISO 527-2 on the occasion of the next revision.

The reduction of the radius tolerance of **machined** specimens allows the use of a common clamping distance of (115 ± 1) mm. This is the main benefit of the proposal.

B.3 Notch factor

When the type A specimen, with a radius of 20 mm to 25 mm, was introduced in addition to the type B specimen (radius ≥ 60 mm) in the previous edition of ISO 3167, calculations were made to compare the two types of specimen.

Assuming linear-elastic material behaviour, notch factors of 1,045 (for $r = 60$ mm) and 1,143 ($r = 20$ mm) were found. Therefore tensile strength differences of about 10 % could be expected, and were also found

in machined test specimens of brittle materials. However, when testing injection-moulded specimens, a reduction in tensile strength at yield of

$-1 \% \pm 1 \%$ (average of 22 materials)

was found. Compared to the radius reduction from 60 mm to 20 mm, the recommended increase from (20 mm to 25 mm) to (23 mm to 25 mm) will result in only a very minor reduction of the notch factor, with negligible effect on the test results.

Changes in tensile strength at yield values due to the radius tolerance reduction for injection-moulded specimens are not to be expected. There may be a slight increase in strain-at-break values.

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