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**Plastics — Determination of tensile  
properties —**

**Part 2:  
Test conditions for moulding and  
extrusion plastics**

*Plastiques — Détermination des propriétés en traction —*

*Partie 2: Conditions d'essai des plastiques pour moulage et extrusion*





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# Contents

Page

Foreword .....	iv
<b>1 Scope .....</b>	<b>1</b>
<b>2 Normative references .....</b>	<b>1</b>
<b>3 Terms and definitions .....</b>	<b>2</b>
<b>4 Principle and methods .....</b>	<b>2</b>
<b>5 Apparatus .....</b>	<b>2</b>
<b>5.1 General .....</b>	<b>2</b>
<b>5.2 Extensometer .....</b>	<b>2</b>
<b>5.3 Recording of data .....</b>	<b>2</b>
<b>6 Test specimens .....</b>	<b>2</b>
<b>6.1 Shape and dimensions .....</b>	<b>2</b>
<b>6.2 Preparation of test specimens .....</b>	<b>3</b>
<b>6.3 Gauge marks .....</b>	<b>3</b>
<b>6.4 Checking the test specimens .....</b>	<b>3</b>
<b>6.5 Anisotropy .....</b>	<b>3</b>
<b>6.6 Number of test specimens .....</b>	<b>3</b>
<b>7 Conditioning .....</b>	<b>3</b>
<b>8 Procedure .....</b>	<b>3</b>
<b>9 Calculation and expression of results .....</b>	<b>3</b>
<b>10 Precision .....</b>	<b>4</b>
<b>11 Test report .....</b>	<b>4</b>
<b>Annex A (informative) Small specimens .....</b>	<b>6</b>
<b>Annex B (informative) Precision statement .....</b>	<b>8</b>
<b>Bibliography .....</b>	<b>11</b>

## 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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 527-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

This second edition cancels and replaces the first edition (ISO 527-2:1993), which has been technically revised.

ISO 527 consists of the following parts, under the general title *Plastics — Determination of tensile properties*:

- *Part 1: General principles*
- *Part 2: Test conditions for moulding and extrusion plastics*
- *Part 3: Test conditions for films and sheets*
- *Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites*
- *Part 5: Test conditions for unidirectional fibre-reinforced plastic composites*

# Plastics — Determination of tensile properties —

## Part 2: Test conditions for moulding and extrusion plastics

### 1 Scope

**1.1** This part of ISO 527 specifies the test conditions for determining the tensile properties of moulding and extrusion plastics, based upon the general principles given in ISO 527-1.

**1.2** The methods are selectively suitable for use with the following range of materials:

- rigid and semi-rigid thermoplastics moulding, extrusion and cast materials, including compounds filled and reinforced by, for example, short fibres, small rods, plates or granules but excluding textile fibres (see ISO 527-4 and ISO 527-5). See ISO 527-1:2012, Clause 3 for the definition of “rigid” and “semi-rigid”.
- rigid and semi-rigid thermosetting moulding and cast materials, including filled and reinforced compounds but excluding textile fibres as reinforcement (see ISO 527-4 and ISO 527-5);
- thermotropic liquid crystal polymers.

The methods are not normally suitable for use with rigid cellular materials or sandwich structures containing cellular material. For rigid cellular materials see ISO 1926.

The methods are not suitable for flexible films and sheets, of thickness smaller than 1 mm, see ISO 527-3.

**1.3** The methods are applied using specimens which may be either moulded to the chosen dimensions or machined, cut or punched from injection- or compression-moulded plates. The multipurpose test specimen is preferred (see ISO 20753).

### 2 Normative references

The following referenced documents are indispensable for the application 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 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 527-1:2012, *Plastics — Determination of tensile properties — Part 1: General principles*

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 11403-3, *Plastics — Acquisition and presentation of comparable multipoint data — Part 3: Environmental influences on properties*

ISO 20753, *Plastics — Test specimens*

### 3 Terms and definitions

See ISO 527-1: 2012, Clause 3.

### 4 Principle and methods

See ISO 527-1:2012, Clause 4.

## 5 Apparatus

### 5.1 General

See ISO 527-1:2012, Clause 5, specifically 5.1.1 to 5.1.4.

### 5.2 Extensometer

For this part of ISO 527, a gauge length of 75 mm is preferred when a multipurpose test specimen is used.

A gauge length of 50 mm is also acceptable for quality-control purposes or where specified.

If strains are recorded only on one side of the test specimen, ensure that low strains are not falsified by bending, which may result from even faint misalignment and initial warpage of the test specimen and which generates strain differences between opposite surfaces of the test specimen.

**NOTE** Increasing the gauge length leads to higher accuracy, especially for the modulus determination. The absolute accuracy of the measurement of elongation required for a  $\pm 1$  % accuracy of modulus determination is  $\pm 1,5 \mu\text{m}$ . This is less severe than the  $\pm 1 \mu\text{m}$  needed if a gauge length of 50 mm is used. Furthermore, necking outside of the gauge length will be less frequent.

### 5.3 Recording of data

See ISO 527-1:2012, 5.1.6.

**NOTE** For the determination of the tensile modulus under the conditions  $v = 1\text{mm/min}$ ,  $L_0 = 75\text{mm}$ ,  $L = 115 \text{ mm}$  and  $r = 0,0005 \text{ mm}$ , the recording frequency for the strain signal greater than or equal to  $22 \text{ s}^{-1}$  would be appropriate according to ISO 527-1:2012, Equation 1. This frequency increases as the gauge length increases. With larger gauge length the absolute elongation measured by the extensometer is larger for the same crosshead displacement, i.e. the recording instrument will see more data points in the same time span.

## 6 Test specimens

### 6.1 Shape and dimensions

Wherever possible, the test specimens shall be dumb-bell-shaped types 1A and 1B, as shown in Figure 1 and Table 1. Type 1A shall be used for directly injection-moulded multipurpose test specimens, type 1B for machined specimens. Type 1A may also be used for compression-moulded specimens. For the use of proportionally scaled miniaturized specimens, see Annex A and/or ISO 20753.

**NOTE 1** At 4 mm thickness, specimen types 1A and 1B are identical to the multipurpose test specimens according to ISO 3167, types A and B, respectively, and to types A1 and A2 of ISO 20753.

For purposes where large numbers of test specimens are to be exposed in limited space, for example, during analysis of environmental influences due to radiation, heat and/or chemicals (see ISO 11403-3), small test specimens of type C of ISO 20753 can be used. In such cases, frequently only the relative change of strength is of interest, and specimens of type CW are particularly useful. To accommodate wall thicknesses of the final application, thicknesses different from those preferred in ISO 20753 may be used.

**NOTE 2** Other miniaturized specimens with different scale factors are defined in ISO 20753

## 6.2 Preparation of test specimens

Test specimens shall be either directly injection- or compression-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, or obtained from cast or extruded plates (sheet). The moulding conditions shall be in accordance with the relevant International Standard for the material or, if none exists, agreed between the interested parties.

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 specimen shall be free from visible flaws, scratches or other imperfections. From moulded specimens, all flash, if present, shall be removed, taking care not to damage the moulded surface.

Test specimens from finished goods shall be taken from flat areas or zones having minimum curvature. For reinforced plastics, test specimens should not be machined to reduce their thickness unless absolutely necessary. Test specimens with machined surfaces will not give results comparable to specimens having non-machined surfaces.

## 6.3 Gauge marks

See ISO 527-1:2012, 6.3.

## 6.4 Checking the test specimens

See ISO 527-1:2012, 6.4.

## 6.5 Anisotropy

Injection moulded and extruded plates, as well as finished goods, exhibit some degree of anisotropy as a result of flow-induced orientation. The direction dependence of the tensile properties can be assessed by machining specimens parallel and normal to the flow direction characterizing the moulding process. In the absence of information on such directions, specimens shall be machined in directions as agreed between the interested parties.

## 6.6 Number of test specimens

See ISO 527-1:2012, Clause 7.

## 7 Conditioning

See ISO 527-1:2012, Clause 8.

## 8 Procedure

See ISO 527-1:2012, Clause 9.

For measurement of the tensile modulus (see ISO 527-1:2012, 3.9), the speed of testing shall be 1 mm/min for specimen types 1A and 1B (see Figure 1). This corresponds to a strain rate of approximately 1 % min<sup>-1</sup>. For small specimens see Annex A.

## 9 Calculation and expression of results

See ISO 527-1:2012, Clause 10.

## 10 Precision

See Annex B (informative).

## 11 Test report

The test report shall include the following information:

a) a reference to this part of ISO 527, including the type of specimen and the testing speed according to:

Tensile test ISO 527-2/1A/50

Type of specimen (see Figure 1 and Table 1) \_\_\_\_\_

Testing speed, in millimetres per minute \_\_\_\_\_

For items b) to q) in the test report, see ISO 527-1:2012, 12 b) to q).

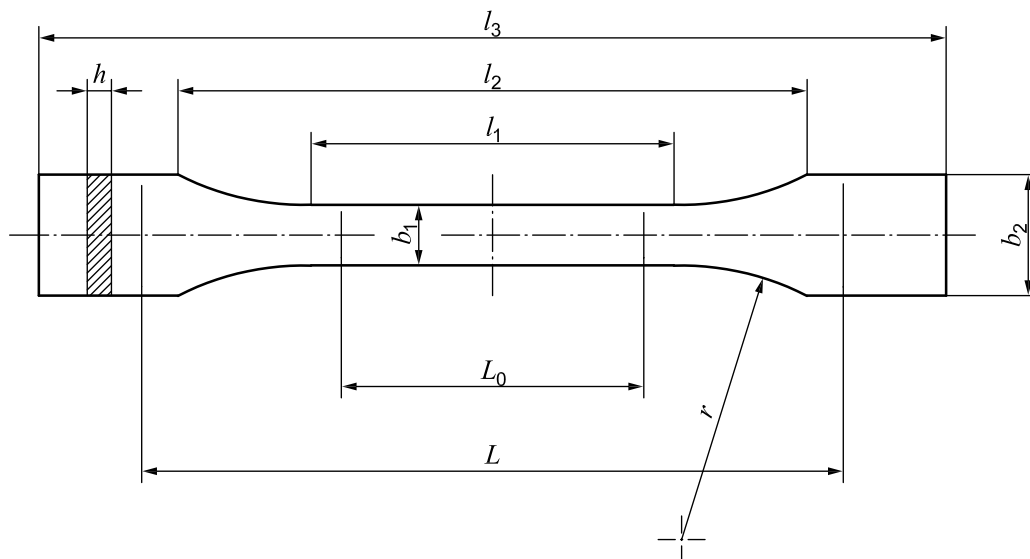


Figure 1 — Type 1A and 1B test specimens



Table 1 — Dimensions of type 1A and 1B test specimens

Dimensions in millimetres

	Specimen type	1A	1B
$l_3$	Overall length <sup>a</sup>	170	≥150
$l_1$	Length of narrow parallel-sided portion	80 ± 2	60,0 ± 0,5
$r$	Radius	24 ± 1	60 ± 0,5
$l_2$	Distance between broad parallel-sided portions <sup>b</sup>	109,3 ± 3,2	108 ± 1,6
$b_2$	Width at ends	20,0 ± 0,2	
$b_1$	Width at narrow portion	10,0 ± 0,2	
$h$	Preferred thickness	4,0 ± 0,2	
$L_0$	Gauge length (preferred)	75,0 ± 0,5	50,0 ± 0,5
	Gauge length (acceptable if required for quality control or when specified)	50,0 ± 0,5	
$L$	Initial distance between grips	115 ± 1	115 ± 1

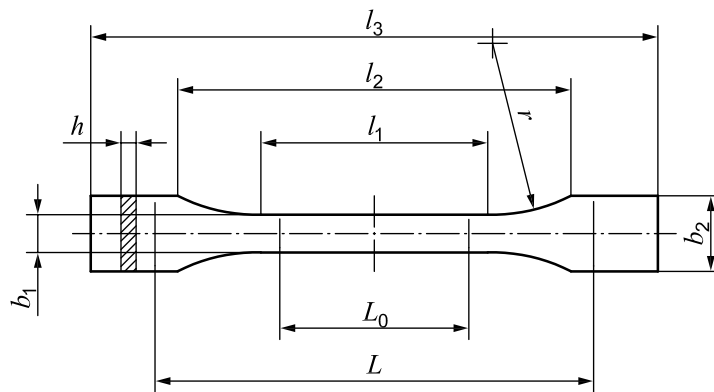
<sup>a</sup> The recommended overall length of 170 mm of the type 1A is consistent with ISO 294-1 and ISO 10724-1. For some materials, the length of the tabs may need to be extended (e.g.  $l_3 = 200$  mm) to prevent breakage or slippage in the jaws of the testing machine.

<sup>b</sup>  $l_2 = l_1 + [4r(b_2 - b_1) - (b_2 - b_1)^2]^{1/2}$ , resulting from  $l_1$ ,  $r$ ,  $b_1$  and  $b_2$ , but within the indicated tolerances.

**Annex A**  
(informative)

**Small specimens**

If, for any reason, it is not possible to use a standard type 1 test specimen, specimens of the types 1BA, 1BB (see Figure A.1 and Table A.1), 5A or 5B (see Figure A.2 and Table A.2) or those specified in ISO 20753 may be used, provided that the speed of testing is adjusted to the value given in 5.1.2, Table 1 of ISO 527-1:2012, which gives the nominal strain rate for the small test specimen closest to that used for the standard-sized specimen. The nominal strain rate is the ratio of the speed of testing (see ISO 527-1:2012, 3.5) versus the initial distance between the grips. Where modulus determinations are required, the test speed is recommended to correspond to a strain rate of 1 % min<sup>-1</sup>. It may be technically difficult to measure modulus on small specimens because of small gauge lengths and short testing times. Results obtained from small specimens are not comparable with those obtained from type 1 specimens.



**Figure A.1 — Type 1BA and 1BB test specimens**

**Table A.1 — Dimensions of type 1BA and 1BB test specimens**

Dimensions in millimetres

Specimen type	1BA	1BB
$l_3$ Overall length	$\geq 75$	$\geq 30$
$l_1$ Length of narrow parallel-sided portion	$30,0 \pm 0,5$	$12,0 \pm 0,5$
$r$ Radius	$\geq 30$	$\geq 12$
$l_2$ Distance between broad parallel-sided portions	$58 \pm 2$	$23 \pm 2$
$b_2$ Width at ends	$10,0 \pm 0,5$	$4 \pm 0,2$
$b_1$ Width at narrow portion	$5,0 \pm 0,5$	$2,0 \pm 0,2$
$h$ Thickness	$\geq 2$	$\geq 2$
$L_0$ Gauge length	$25,0 \pm 0,5$	$10,0 \pm 0,2$
$L$ Initial distance between grips	$l_2^{+2}_0$	$l_2^{+1}_0$

NOTE The specimen types 1BA and 1BB are proportionally scaled to type 1B with a reduction factor of 1:2 and 1:5, respectively, with the exception of thickness.

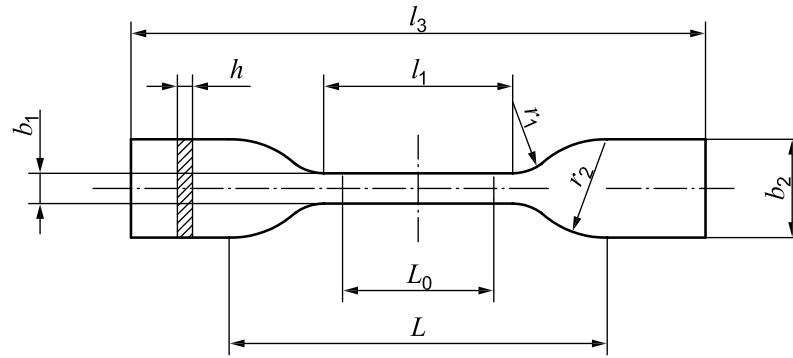


Figure A.2 — Type 5A and 5B test specimens

Table A.2 — Dimensions of type 5A and 5B test specimens

Dimensions in millimetres

	Specimen type	5A	5B
$l_3$	Overall length	$\geq 75$	$\geq 35$
$b_2$	Width at ends	$12,5 \pm 1$	$6 \pm 0,5$
$l_1$	Length of narrow parallel-sided portion	$25 \pm 1$	$12 \pm 0,5$
$b_1$	Width at narrow portion	$4 \pm 0,1$	$2 \pm 0,1$
$r_1$	Small radius	$8 \pm 0,5$	$3 \pm 0,1$
$r_2$	Large radius	$12,5 \pm 1$	$3 \pm 0,1$
$L$	Initial distance between grips	$50 \pm 2$	$20 \pm 2$
$L_0$	Gauge length	$20 \pm 0,5$	$10 \pm 0,2$
$h$	Thickness	$2 \pm 0,2$	$1 \pm 0,1$
NOTE The specimen types 5A and 5B are similar to type 5 of ISO 527-3 and represent types 2 and 4, respectively, of ISO 37.			

## Annex B (informative)

### Precision statement

#### B.1 Definitions and information

**B.1.1** Tables B.1 to B.4 are based on a round-robin test involving three to seven laboratories and four to seven materials. The results given in the tables constitute a subgroup of a round-robin test performed by a group of seven German, Austrian and Swiss laboratories, using a total of 25 materials. Test specimens were always prepared and distributed by one source. Each laboratory obtained and reported five (5) individual test results for each material. The results reported have been evaluated according to ISO 5725-2.

**CAUTION** — Due to the limited number of laboratories and materials, the following explanations of  $r$  and  $R$  (see B.1.2.1 to B.1.2.3) are only intended to present a meaningful way of considering the *approximate* precision of this test method. The data in Tables B.1 and B.4 should not be rigorously applied to acceptance or rejection of material, as those data are specific to the round-robin and may not be representative of other lots, conditions, materials, or laboratories.

**B.1.2** The concept of “ $r$ ” and “ $R$ ” can be seen in Tables B.1 to B.4.

**B.1.2.1** *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.1.2.2** *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.

**B.1.2.3** The judgments in B.1.2.1 and B.1.2.2 will have approximately 95 % (0,95) probability of being correct.

#### B.2 Precision data

In the following tables, the statistical properties used are:

- $s_r$  = within-laboratory standard deviation,
- $s_R$  = between-laboratories standard deviation,
- $r$  = 95 % repeatability limit =  $2,8s_r$ ,
- $R$  = 95 % reproducibility limit =  $2,8s_R$ ,
- $n_{\text{Lab}}$  = number of laboratories reporting results.

Table B.1 — Precision, tensile modulus (MPa)

		$L_0 = 50 \text{ mm}$				
Material	$n_{\text{Lab}}$	Average	$s_r$	$s_R$	$r$	$R$
RAHECO	7	435	17	30	47	83
ABS	6	1 799	15	92	42	258
PC	6	2 448	34	98	94	274
PMMA	7	3 375	33	136	92	381
POM GF30	7	8 641	229	425	641	1 190
PBT GF30	6	9 882	168	680	471	1 904
LCP	7	30 414	966	2 547	2 705	7 131
		$L_0 = 75 \text{ mm}$				
Material	$n_{\text{Lab}}$	Average	$s_r$	$s_R$	$r$	$R$
RAHECO	7	491	8	29	21	80
ABS	6	1 799	14	63	40	175
PC	6	2 456	23	78	64	217
PMMA	7	3 411	36	79	102	220
POM GF30	7	8 711	86	291	242	816
PBT GF30	6	9 954	119	370	332	1 037
LCP	7	30 580	1 014	1 699	2 840	4 757

Table B.2 — Precision, stress at yield (MPa)

		$L_0 = 50 \text{ mm}$				
Material	$n_{\text{Lab}}$	Average	$s_r$	$s_R$	$r$	$R$
RAHECO	7	13,7	0,14	0,61	0,4	1,7
PEBA	7	22,2	0,36	1,21	1	3,4
ABS	6	36,4	0,18	1,93	0,5	5,4
PC	6	63,6	0,18	0,89	0,5	2,5
PA 63T	7	84	0,32	5,11	0,9	14,3

**Table B.3 — Precision, strain at yield (%)**

		$L_0 = 50 \text{ mm}$				
Material	$n_{\text{Lab}}$	Average	$s_r$	$s_R$	$r$	$R$
ABS	6	2,6	0,07	0,21	0,2	0,6
PC+ABS	6	4,5	0,07	0,18	0,2	0,5
POM	7	7,3	0,18	0,54	0,5	1,5
PA 63T	7	7,5	0,11	0,79	0,3	2,2
RAHECO	7	13,1	0,46	2,00	1,3	5,6
		$L_0 = 75 \text{ mm}$				
Material	$n_{\text{Lab}}$	Average	$s_r$	$s_R$	$r$	$R$
ABS	6	2,7	0,04	0,04	0,1	0,1
PC+ABS	6	4,4	0,07	0,21	0,2	0,6
POM	7	7,2	0,21	0,71	0,6	2,0
PA 63T	7	7,4	0,32	0,93	0,9	2,6
RAHECO	7	12,8	0,75	2,25	2,1	6,3

**Table B.4 — Precision, strain at break (%)**

		$L_0 = 50 \text{ mm}$				
Material	$n_{\text{Lab}}$	Average	$s_r$	$s_R$	$r$	$R$
LCP	7	0,6	0,1	0,1	0,2	0,2
ABS	4	2,8	0,4	0,4	1	1,1
PA66GF30	7	3,1	0,1	0,7	0,4	2,0
PA12	3	17,7	1,2	2,3	3,4	6,5
		$L_0 = 75 \text{ mm}$				
Material	$n_{\text{Lab}}$	Average	$s_r$	$s_R$	$r$	$R$
LCP	7	0,6	0,1	0,1	0,2	0,2
ABS	4	6,2	1,1	1,3	3,2	3,6
PA66GF30	7	3,4	0,1	0,2	0,4	0,6
PA12	3	16,3	1,2	2,8	3,4	7,9

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