
**Rigid cellular plastics — Determination of
flexural properties —**

Part 2:

**Determination of flexural strength and
apparent flexural modulus of elasticity**

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*Plastiques alvéolaires rigides — Détermination des propriétés de
flexion —*

*Partie 2: Détermination de la résistance à la flexion et du module
apparent d'élasticité en flexion*

ISO 1209-2:2004

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Published in Switzerland

Contents

	Page
1 Scope	1
2 Normative references	1
3 Principle	1
4 Apparatus	1
5 Test specimens	2
6 Conditioning	3
7 Procedure	3
8 Expression of results	3
9 Precision	4
10 Test report	5

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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 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 1209-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 10, *Cellular plastics*.

This second edition cancels and replaces the first edition (ISO 1209-1:1990), of which it constitutes a minor revision intended principally to include precision data (see Clause 9).

ISO 1209 consists of the following parts, under the general title *Rigid cellular plastics — Determination of flexural properties*:

- *Part 1: Basic bending test*
- *Part 2: Determination of flexural strength and apparent flexural modulus of elasticity*

Rigid cellular plastics — Determination of flexural properties —

Part 2: Determination of flexural strength and apparent flexural modulus of elasticity

1 Scope

This part of ISO 1209 specifies a method for determining the flexural strength and the apparent flexural modulus of elasticity of rigid cellular plastics.

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 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 1923, *Cellular plastics and rubbers — Determination of linear dimensions*

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3 Principle

A load is applied at a uniform rate by means of a loading edge to a test specimen supported at two positions. The load is applied perpendicularly to the specimen at a position midway between the supporting positions (see Figure 1). The load/deformation curve is recorded. From the curve, the flexural strength and the apparent flexural modulus of elasticity are calculated.

4 Apparatus

4.1 Test machine, consisting of a universal mechanical-testing machine capable of operating at a constant rate of movement of the moveable head.

The range of the test machine shall be such that the applied load can be measured with an accuracy of $\pm 1\%$.

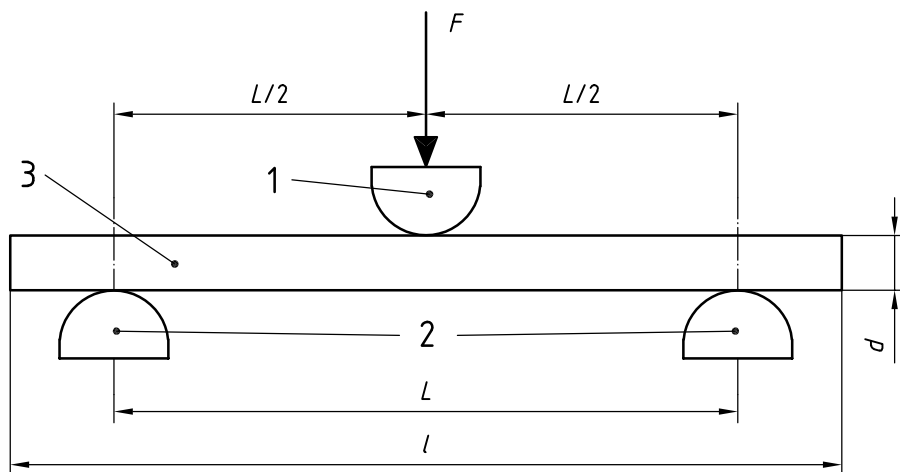
The machine shall include a device for simultaneous recording of force and the corresponding deformation.

4.2 Test specimen support, consisting of two parallel cylindrical support edges set in the same horizontal plane, each having an edge radius of (15 ± 1) mm. The length of the support edges shall be greater than the width of the test specimens.

The span L between the support edges shall be adjustable in the range 200 mm to 450 mm. The recommended span is 300 mm.

4.3 Test specimen loading edge, having the same shape and dimensions as the support edges. The loading edge shall be located midway between and parallel to the support edges.

4.4 Dial-gauge micrometer, as described in ISO 1923.



Key

- 1 loading edge with cylindrical edge having a radius of (15 ± 1) mm
- 2 support edges with cylindrical edge having a radius of (15 ± 1) mm
- 3 test specimen

L distance between support edges

l test specimen length

d test specimen thickness

F applied force

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Figure 1 — Side view of test specimen and support edges

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5 Test specimens

5.1 Shape and dimensions

Each test specimen shall be a rectangular parallelepiped having the dimensions given, together with the corresponding values of the span L between the support edges, in Table 1.

Table 1

Dimension	Recommended value	Limit(s) on value
	mm	mm
Length	350	$\geq (L + 50)$
Width b	$4d$	$\geq 2d$
Thickness d	25	15 to 38
Span L	300	$12d$ to $16d$

NOTE At high thickness values, it will be necessary to select a span value at the low end of the range $12d$ to $16d$ in view of the limits on the adjustment of the span (see 4.2, second paragraph). Conversely, at low thickness values, it will be necessary to select a span value at the high end of the range $12d$ to $16d$.

5.2 Preparation

Test specimens shall be cut without deformation of the original cell structure. The test specimens may have a skin on one or more sides. If so, this fact shall be recorded.

5.3 Number

At least five specimens shall be tested for each sample. When testing materials which are suspected of being anisotropic, duplicate sets of test specimens shall be prepared having axes respectively parallel to and normal to the suspected direction of anisotropy.

When testing specimens with only one surface skin, unless otherwise specified, duplicate sets of test specimens shall be tested, one set with the skin in tension and one set with the skin in compression. Report the results separately.

6 Conditioning

The test specimens shall be conditioned in one of the atmospheres specified in ISO 291. Normal test conditions are $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 10) \% \text{R.H.}$ or $(27 \pm 2) ^\circ\text{C}$ and $(65 \pm 10) \% \text{R.H.}$ Temperatures of $-196 ^\circ\text{C}$, $-70 ^\circ\text{C}$, $-10 ^\circ\text{C}$, $0 ^\circ\text{C}$ and $40 ^\circ\text{C}$ are preferred alternative temperatures, although other conditions may be used, for example those reflecting end use.

7 Procedure

Determine the dimensions of the test specimens in accordance with ISO 1923. Place a test specimen symmetrically upon the support edges and apply an increasing force perpendicular to the longitudinal axis of the specimen by moving the loading edge at a constant speed of:

$(20 \pm 1) \text{ mm/min}$ for the determination of the apparent flexural modulus;

either $(20 \pm 1) \text{ mm/min}$ or $(100 \pm 10) \text{ mm/min}$ for the determination of other flexural properties.

Record the force/deformation curve and draw a line tangential to the steepest part of the curve (see Figure 2).

Record the breaking load when the break occurs before 5 % deflection is reached. It is normally not necessary to continue the test beyond a flexural strain of 5 %.

NOTE With the recommended test specimen and loading arrangement, the strain is at 5 % when the deflection reaches 30 mm.

Inspect the test specimen for any sign of crushing. If any crushing is found, disregard the flexural strength value.

8 Expression of results

8.1 The flexural strength R is given, in kilopascals, by the equation:

$$R = 1,5F_R \times \frac{L}{bd^2} \times 10^6$$

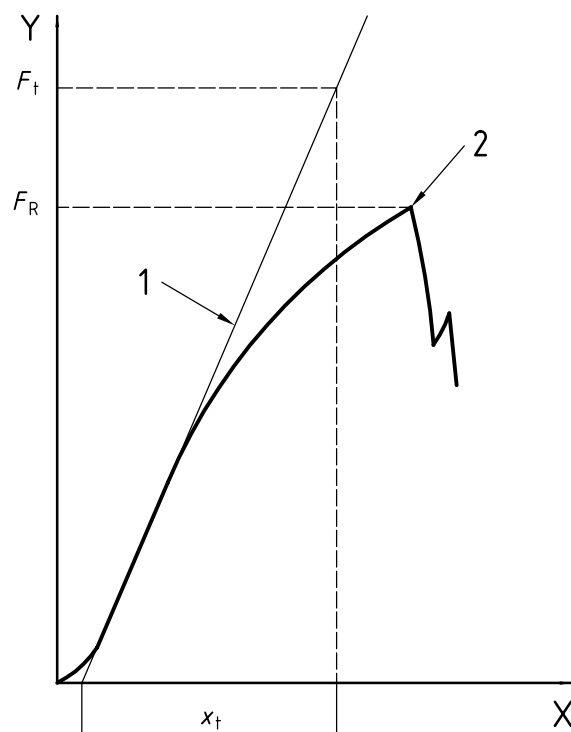
where

F_R is the maximum force applied, in kilonewtons;

L is the span between the support edges, in millimetres;

b is the test specimen width, in millimetres;

d is the test specimen thickness, in millimetres.



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Key

- X deflection (mm)
- Y force (kN)
- 1 tangent
- 2 break

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Figure 2 — Typical force/deformation diagram

8.2 The apparent flexural modulus of elasticity E is given, in kilopascals, by the equation:

$$E = \frac{L^3}{4bd^3} \times \frac{F_t}{x_t} \times 10^6$$

where

F_t is the force, in kilonewtons, corresponding to the deformation x_t (see Figure 2);

x_t is the corresponding deformation, in millimetres;

L , b and d are as defined in 8.1.

9 Precision

An interlaboratory test was performed with 10 laboratories in 1993. Four products with different flexural characteristics were tested: three of which were used for statistical evaluation of the reproducibility (two test results for each product) while one product was used for statistical evaluation of the repeatability (five test results).

The results, analysed in accordance with ISO 5725:1986, *Precision of test methods — Determination of repeatability and reproducibility for a standard test method by inter-laboratory tests* (now withdrawn), are given in Table 2.

Table 2 — Results of interlaboratory testing

Flexural strength/apparent modulus of elasticity	
Repeatability limit (95 % confidence level)	Reproducibility limit (95 % confidence level)
Approximately 5 %	Approximately 15 %

10 Test report

The test report shall include the following information:

- a) a reference to this part of ISO 1209;
- b) a description and identification of the material;
- c) the presence or absence of skins or facings on the test specimens and, if applicable, on which faces;
- d) the conditioning procedure used;
- e) the dimensions of the test specimens;
- f) the span between the support edges and the speed of the loading edge;
- g) the test conditions (temperature, humidity);
- h) the direction of application of the force with respect to any anisotropy;
- i) the individual values of the flexural strength, in kilopascals;
- j) the individual values of the apparent flexural modulus of elasticity, in kilopascals;
- k) the individual values of the breaking load, where applicable, in newtons;
- l) the arithmetic mean of the flexural strength values;
- m) the arithmetic mean of the flexural modulus of elasticity values;
- n) the arithmetic mean of the breaking load values, where applicable;
- o) details of any deviation from this part of ISO 1209, and of any incident that may have influenced the results;
- p) the date of the test.