
**Glass in building — Determination of
the bending strength of glass —**

**Part 5:
Coaxial double-ring test on flat
specimens with small test surface areas**

*Verre dans la construction — Détermination de la résistance du verre
à la flexion —*

*Partie 5: Essais avec doubles anneaux concentriques sur éprouvettes
planes, avec de petites surfaces de sollicitation*

PROOF / ÉPREUVE



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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 160, *Glass in building*, Subcommittee SC 2, *Use considerations* in conjunction with Technical Committee CEN/TC 129, *Glass in building*.

ISO 1288 consists of the following parts, under the general title *Glass in building — Determination of the bending strength of glass*:

- *Part 1: Fundamentals of testing glass*
- *Part 2: Coaxial double-ring test on flat specimens with large test surface areas*
- *Part 3: Test with specimen supported at two points (four-point bending)*
- *Part 4: Testing of channel-shaped glass*
- *Part 5: Coaxial double-ring test on flat specimens with small test surface areas*

This International Standard has been based on EN 1288-5, *Glass in building — Determination of the bending strength of glass — Part 5: Coaxial double-ring test on flat specimens with small test surface areas* prepared by Technical Committee CEN/TC 129 "Glass in building".

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Glass in building — Determination of the bending strength of glass —

Part 5: Coaxial double-ring test on flat specimens with small test surface areas

1 Scope

This part of ISO 1288 specifies a method for determining the comparative bending strength of glass for use in buildings, excluding the effects of the edges.

See ISO 1288-1, 5.1.4 for an explanation as to why this test method should only be used for comparing the strength of types of glass and not for assessing strength for design purposes.

The limitations of this part of ISO 1288 are described in ISO 1288-1.

ISO 1288-1 should be read in conjunction with this part of ISO 1288.

This test method is not suitable for patterned glass.

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 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

bending stress

tensile bending stress induced in the surface of a specimen

Note 1 to entry: For testing purposes, the bending stress should be uniform over a specified part of the surface.

4 Symbols

F	load	N
F_{\max}	load at breakage, "breaking load"	N
h	thickness of specimen	m
L	side length of square specimens	m
K_1, K_2	constants for calculation of bending stress	

r_1	radius of loading ring	m
r_2	radius of supporting ring	m
r_3	radius of circular specimens	m
r_{3m}	average specimen radius (for evaluation)	m
t	time	s
σ	stress	Pa
σ_{bB}	bending strength	Pa
μ	Poisson number of specimen	
	NOTE for soda lime silicate glass (see ISO 16293-1), a value of 0,23 is used.	
$\Delta F/\Delta t$	rate of increase of load	N/s
$\Delta \sigma/\Delta t$	rate of increase of stress	Pa/s

5 Principle of test method

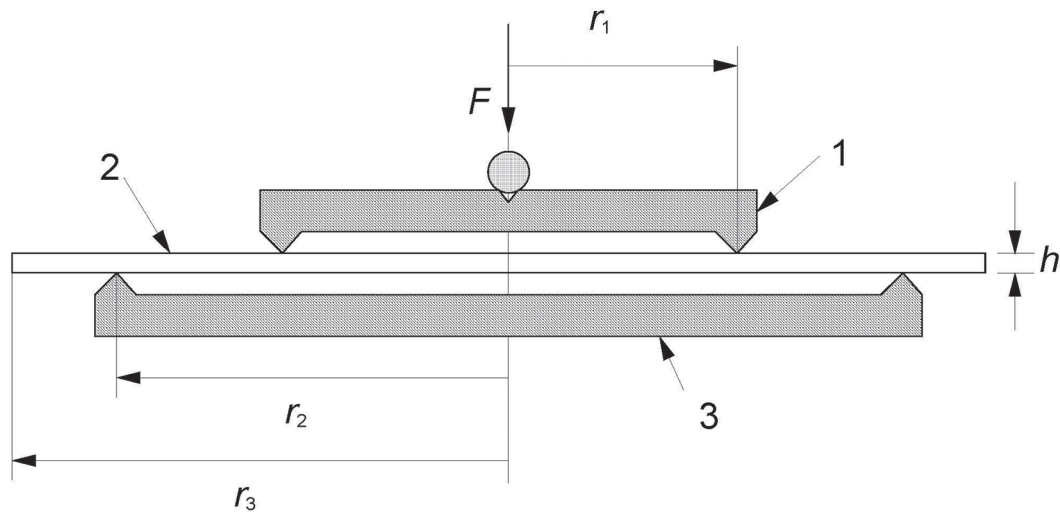
A circular or square plane-parallel specimen with radius r_3 , or length of side L , resting on a supporting ring (radius r_2) shall be loaded by means of a loading ring (radius r_1) arranged concentrically relative to the supporting ring (see [Figure 1](#)).

Outside the loading ring, the radial and tangential stresses in the specimen decrease towards the edge so that the risk of failure there is small.

For limited loads, F , (depending on the values of r_1 , r_2 , r_3 and h) there is, in the central region of the convexly bent specimen surface, a tensile stress field (see Reference [3]) extending in all directions and uniform, the area in this field being bounded by the loading ring.

By increasing the load, F , the tensile stress in the middle of the specimen is increased at a constant rate until failure occurs, the expected point of failure being in the most severely stressed surface region defined by the loading ring.

The bending strength, σ_{bB} , shall be calculated from the maximum load, F_{max} , measured when failure occurs and the specimen thickness, h , taking into account the dimensions of the square or circular specimens and the value for Poisson number, μ , of the specimen.

**Key**

- 1 loading ring
- 2 specimen
- 3 supporting ring

Figure 1 — Test arrangement (indicating the principle), illustrated for a circular specimen

6 Apparatus

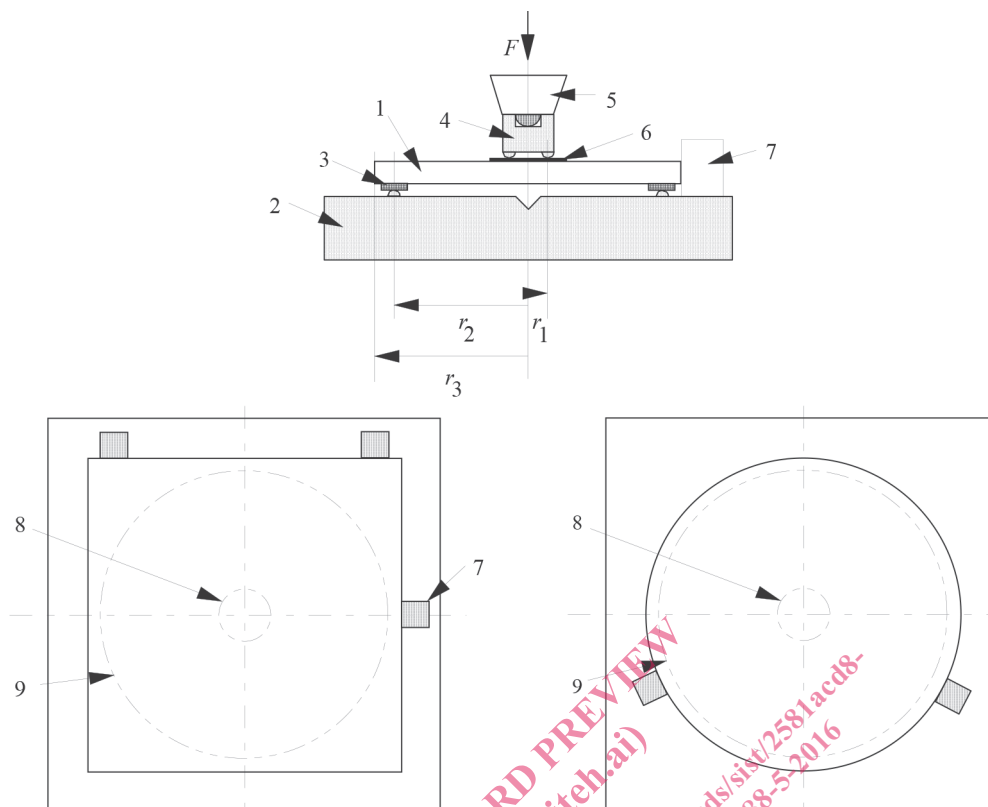
6.1 Testing machine

The bending test shall be carried out using a suitable bending testing machine, which shall incorporate the following features.

- a) The stressing of the specimen shall be capable of being applied from zero up to a maximum value in a manner which minimizes shock and is stepless.
- b) The stressing device shall be capable of the specified rate of stressing.
- c) The testing machine shall incorporate a load measuring device with a limit of error of $\pm 2,0$ % within the measuring range.

6.2 Loading device

The loading device shall be arranged as illustrated in [Figure 2](#), with dimensions conforming to [Table 1](#) for the two combinations of loading ring and supporting ring accepted for the coaxial double-ring bending test.



Key

- 1 specimen
- 2 base plate of hardened steel provided with a supporting ring
- 3 spacer of silicone rubber
- 4 loading ring of hardened steel
- 5 load transmitting member with a centring feature for the loading ring
- 6 spacer of paper or synthetic material approximately 0,1 mm thick
- 7 adjusting jaw for centring the specimen
- 8 contact circle of loading ring
- 9 contact circle of supporting ring

Figure 2 — Loading device

Table 1 — Dimensions of loading ring and supporting ring

Dimensions in millimetres

Loading device	Radius of loading ring r_1	Radius of supporting ring r_2	Radius r_3 or $L/2$ of specimen as specified in Table 2
R30	6	30	33
R45	9	45	50
R60	20	60	120
R105	35	105	210

The radius of curvature of the bearing surface of the supporting ring shall be 2,5 mm.

The silicone rubber shall be 3 mm thick, or alternatively a rubber section, 3 mm thick, matched to the supporting ring with a hardness of (40 ± 10) IRHD (according to ISO 48).

The radius of curvature of the bearing surface of the loading ring shall be 2,5 mm.

6.3 Measuring instruments

The following measuring instruments are required:

- a measuring instrument enabling the diameter or the length of the side of the specimen to be measured to the nearest 1 mm;
- a measuring instrument allowing the thickness of the specimen to be measured to the nearest 0,01 mm.

7 Sample

7.1 Shape and dimensions of specimens

Circular or square specimens as specified in [Table 2](#) and [Table 3](#) shall be used.

Table 2 — Dimensions of specimens

Dimensions in millimetres

Loading device	Diameter (= $2r_3$) or side length L	Thickness h	
		minimum	maximum
R30	66 ± 2	see Table 3	6
R45	100 ± 2	see Table 3	9
R60	240 ± 5	see Table 3	12
R105	420 ± 5	see Table 3	19

Table 3 — Minimum thickness of specimens as a function of bending strength

Dimensions in millimetres

Bending strength σ_{bB} MPa	Minimum thickness of specimens for loading device			
	R45	R30	R60	R105
$\sigma_{bB} \leq 100$	2,0	1,0	2,5	4,5
$100 < \sigma_{bB} \leq 200$	2,5	1,5	3,5	6,0
$200 < \sigma_{bB} \leq 300$	3,0	2,0	4,5	7,5
$300 < \sigma_{bB} \leq 400$	3,5	2,5	5,0	8,5
$400 < \sigma_{bB} \leq 500$	3,5	2,5	5,5	9,5
$500 < \sigma_{bB} \leq 600$	4,0	3,0	6,0	10,5

In cases in which not even the approximate value of the anticipated bending strength is known beforehand, the data given in the last line of [Table 3](#) (values for bending strength up to 600 MPa) shall be taken for the minimum thickness of the specimens. After the first tests have been evaluated, the appropriate minimum thickness shall be determined from [Table 3](#).

The following tolerances shall apply to that portion of the specimen bounded by the contact circle of the supporting ring:

- the flatness tolerance shall be 0,1 mm;
- the parallelism tolerance shall be 2 % of the specimen thickness.