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

**Part 1:
Fundamentals of testing glass**

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

Partie 1: Principes fondamentaux des essais sur le verre

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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).

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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*.

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*

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

Part 1: Fundamentals of testing glass

1 Scope

This part of ISO 1288 specifies the determination of the bending strength of monolithic glass for use in buildings. The testing of insulating units or laminated glass is excluded from this part of ISO 1288.

This part of ISO 1288 describes

- considerations to be taken into account when testing glass,
- explanations of the reasons for designing different test methods,
- limitations of the test methods, and
- gives pointers to safety requirements for the personnel operating the test equipment.

ISO 1288-2, ISO 1288-3, ISO 1288-4 and ISO 1288-5 specify test methods in detail.

The test methods specified in this part of ISO 1288 are intended to provide large numbers of bending strength values that can be used as the basis for statistical evaluation of glass strength.

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 1288-2, *Glass in building — Determination of the bending strength of glass — Part 2: Coaxial double ring test on flat specimens with large test surface areas*

ISO 1288-3, *Glass in building — Determination of the bending strength of glass — Part 3: Test with specimen supported at two points (four point bending)*

ISO 1288-4, *Glass in building — Determination of the bending strength of glass — Part 4: Testing of channel shaped glass*

ISO 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*

ISO 16293-1, *Glass in building — Basic soda lime silicate glass products — Part 1: Definitions and general physical and mechanical properties*

NOTE ISO TC 160/SC 1 is commencing work on standards for “thermally tempered soda lime silicate safety glass”, “heat strengthened soda lime silicate glass” and “chemically strengthened glass.”

3 Terms and definitions

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

3.1

flat glass

any glass product conforming to ISO 16293-2, ISO 16293-3, ISO 16293-4 and ISO 16293-5, or any transformed glass made from these products without deliberately inducing profile or curvature

3.2

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.

3.3

effective bending stress

weighted average of the tensile bending stresses, calculated by applying a factor to take into account non-uniformity of the stress field

3.4

bending strength

bending stress (3.2) or *effective bending stress* (3.3) which leads to breakage of the specimen

3.5

equivalent bending strength

apparent *bending strength* (3.4) of patterned glass, for which the irregularities in the thickness do not allow precise calculation of the *bending stress* (3.2)

3.6

profile bending strength

quotient of the maximum bending moment and the section modulus of a channel shaped glass

3.7

stress intensity factor

measure of the stress at a crack tip

3.8

prestressed glass

any glass product that has a surface prestress, i.e. thermally tempered soda lime silicate safety glass, heat strengthened soda lime silicate glass and chemically strengthened glass

4 Symbols

F	applied load	N
h	specimen thickness	M
L	length of side of square test sample	M
k	constant for calculation of bending stress in ISO 1288-3	M
K_1, K_2	constants for calculation of bending stress in ISO 1288-5	
M_{bB}	maximum bending moment	Nm
p	gas pressure applied within loading ring in ISO 1288-2	Pa
p_{bB}	profile bending strength (of channel shaped glass) = M_{bB}/Z	Pa
r_1	radius of loading ring	M
r_2	radius of supporting ring	M

r_3	radius of circular specimen	M
r_{3m}	average specimen radius (for evaluation)	M
y_0	central deflection of specimen	M
Z	section modulus (of channel shaped glass)	m ³
μ	poisson number of specimen	
NOTE	For soda lime silicate glass (see ISO 16293-1), a value of 0,23 is used.	
σ_b	bending stress	Pa
σ_{beff}	effective bending stress	Pa
σ_{bB}	bending strength	Pa
σ_{beqB}	equivalent bending strength	Pa
σ_{rad}	radial stress	Pa
σ_T	tangential stress	Pa
σ_L	stress in a direction along the length of the specimen	Pa

5 Factors to be taken into account when testing glass

5.1 Glass as a material

5.1.1 General

Glass is a homogeneous isotropic material having almost perfect linear-elastic behaviour over its tensile strength range.

Glass has a very high compressive strength and theoretically, a very high tensile strength, but the surface of the glass has many irregularities which act as weaknesses when glass is subjected to tensile stress. These irregularities are caused by attack from moisture and by contact with hard materials (e.g. grit) and are continually modified by moisture which is always present in the air.

Tensile strengths of around 10 000 MPa can be predicted from the molecular structure, but bulk glass normally fails at stresses considerably below 100 MPa.

The presence of the irregularities and their modification by moisture contributes to the properties of glass which need consideration when performing tests of strength.

Because of the very high compressive strength, glass always fails under tensile stress. Since glass in buildings is very rarely used in direct tension, the most important property for load resistance is the tensile bending strength. All the tests described in this part of ISO 1288 are intended to evaluate the tensile bending strength of glass.

The bending strength is influenced by the following factors:

- surface condition (see [5.1.2](#));
- rate and duration of loading (see [5.1.3](#));
- area of surface stressed in tension (see [5.1.4](#));
- ambient medium, through stress corrosion cracking, as well as healing of surface damage in the glass (see [5.1.5](#) and Reference [1]);