

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

Part 1: Fundamentals of testing glass

The European Standard EN 1288-1:2000 has the status of a
British Standard

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National foreword

This British Standard is the official English language version of EN 1288-1:2000.

The UK participation in its preparation was entrusted by Technical Committee B/520, Glass and glazing in building, to Subcommittee B/520/4, Properties and glazing methods, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 24, an inside back cover and a back cover.

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This European Standard was approved by CEN on 5 September 1999.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 129, Glass in building, the Secretariat of which is held by IBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2000, and conflicting national standards shall be withdrawn at the latest by December 2000.

CEN/TC 129/WG8, Mechanical Strength, prepared the draft, Glass in building – Determination of the bending strength of glass – Part 1: Fundamentals of testing glass.

There are four other parts to this standard:

- 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.

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.

1 Scope

This European Standard 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 standard.

This standard 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.

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

The test methods specified in this standard 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

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

EN 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.
EN 1288-3	Glass in building - Determination of the bending strength of glass – Part 3: Test with specimen supported at two points (four point bending).
EN 1288-4	Glass in building - Determination of the bending strength of glass – Part 4: Testing of channel shaped glass.
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.
EN 572-1	Glass in building - Basic soda lime silicate glass products - Part 1: Definitions and general physical and mechanical properties.

EN 572-2	Glass in building - Basic soda lime silicate glass products - Part 2: Float glass.
EN 572-3	Glass in building - Basic soda lime silicate glass products - Part 3: Polished wired glass.
EN 572-4	Glass in building - Basic soda lime silicate glass products - Part 4: Drawn sheet glass.
EN 572-5	Glass in building - Basic soda lime silicate glass products - Part 5: Patterned glass.
EN 572-6	Glass in building - Basic soda lime silicate glass products - Part 6: Wired patterned glass.
EN 572-7	Glass in building - Basic soda lime silicate glass products - Part 7: Wired or unwired channel shaped glass.
EN 1748-1	Glass in building - Special basic products - Part 1: Borosilicate glasses.
EN 1748-2	Glass in building - Special basic products - Part 2: Glass ceramics.
EN 1863-1	Glass in building – Heat strengthened soda lime silicate glass – Part 1: Definition and description.
EN 12150-1	Glass in building – Thermally toughened soda lime silicate safety glass – Part 1: Definition and description.
EN 12337-1	Glass in building – Chemically strengthened soda lime silicate glass – Part 1: Definition and description.
EN ISO 12543-1	Glass in building - Laminated glass and laminated safety glass - Part 1: Definitions and description of component parts.
prEN 13024-1	Glass in building – Thermally toughened borosilicate safety glass – Part 1: Definition and description.

3 Definitions

For the purposes of this European Standard, the following definitions apply.

3.1 flat glass: any glass product conforming to EN 572-2, EN 572-3, EN 572-4, EN 572-5, EN 572-6, EN 1748-1, EN 1748-2, or any transformed glass made from these products without deliberately inducing profile or curvature

3.2 bending stress: the tensile bending stress induced in the surface of a specimen

NOTE: For testing purposes, the bending stress should be uniform over a specified part of the surface.

3.3 effective bending stress: a 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: the bending stress or effective bending stress which leads to breakage of the specimen

3.5 equivalent bending strength: the apparent bending strength of patterned glass, for which the irregularities in the thickness do not allow precise calculation of the bending stress

3.6 profile bending strength: the quotient of the maximum bending moment and the section modulus of a channel shaped glass (EN 572-7)

3.7 stress intensity factor: a measure of the stress at a crack tip

3.8 prestressed glass: any glass product conforming to EN 1863, EN 12150, EN 12337, and prEN 13024-1

4 Symbols

F	Applied load
h	Specimen thickness
L	Length of side of square test sample
k	Constant for calculation of bending stress in EN 1288-3
K_1, K_2	Constants for calculation of bending stress in EN 1288-5
M_{bB}	Maximum bending moment
p	Gas pressure applied within loading ring in EN 1288-2
P_{bB}	Profile bending strength (of channel shaped glass) = M_{bB}/Z
r_1	Radius of loading ring
r_2	Radius of supporting ring
r_3	Radius of circular specimen
r_{3m}	Average specimen radius (for evaluation)
y_0	Central deflection of specimen
Z	Section modulus (of channel shaped glass)
μ	Poisson number of specimen

NOTE: For soda lime silicate glass (see EN 572-1) a value of 0,23 is used.

σ_b	Bending stress
σ_{beff}	Effective bending stress
σ_{bB}	Bending strength
σ_{beqB}	Equivalent bending strength
σ_{rad}	Radial stress
σ_T	Tangential stress
σ_L	Stress in a direction along the length of the specimen

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 N/mm² can be predicted from the molecular structure, but bulk glass normally fails at stresses considerably below 100 N/mm².

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 standard are intended to evaluate the tensile bending strength of glass.

The bending strength is influenced by the following factors:

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