SLOVENSKI STANDARD
oSIST prEN 19100-2:2024

01-november-2024

Evrokod 10 - Projektiranje steklenih konstrukcij - 2. del: Stekleni elementi pod vplivom obtežb izven ravnine elementov

Eurocode 10 - Design of glass structures - Part 2: Out-of-plane loaded glass components

Eurocode 10 - Bemessung und Konstruktion von Bauteilen aus Glas - Teil 2: Querbelastete Elemente

Eurocode 10 - Calcul des structures en verre - Partie 2 : Composants en verre chargés perpendiculairement

Ta slovenski standard je istoveten z: **prEN 19100-2**

ICS:

81.040.20	Steklo v gradbeništvu	Glass in building
91.080.99	Druge konstrukcije	Other structures

oSIST prEN 19100-2:2024 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 19100-2

September 2024

ICS 81.040.20; 91.080.99

Will supersede CEN/TS 19100-2:2021

English Version

Eurocode 10 - Design of glass structures - Part 2: Out-of-plane loaded glass components

Eurocode 10 - Calcul des structures en verre - Partie 2 : Composants en verre chargés perpendiculairement

Eurocode 10 - Bemessung und Konstruktion von Bauteilen aus Glas - Teil 2: Querbelastete Elemente

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 250.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Ref. No. prEN 19100-2:2024 E

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European foreword

This document (prEN 19100-2:2024) has been prepared by Technical Committee CEN/TC 250 “Structural Eurocodes”, the secretariat of which is held by BSI. CEN/TC 250 is responsible for all Structural Eurocodes and has been assigned responsibility for structural and geotechnical design matters by CEN.

This document is currently submitted to the CEN Enquiry.

This document will supersede CEN/TS 19100-2:2021.

In comparison with the previous edition, the following changes have been made:

— modified title and scope;

— updated references;

— extended Annex A to include addition of coefficients for different loading and boundary conditions and inclusion of examples of stress distribution;

— added a new informative Annex C providing guidance for the determination of the resulting cavity pressure for insulating glass units;

— added a new informative Annex D providing guidance to the design of permanently cold bent glass components.

The first generation of EN Eurocodes was published between 2002 and 2007. This document forms part of the second generation of the Eurocodes, which have been prepared under Mandate M/515 issued to CEN by the European Commission and the European Free Trade Association.

The Eurocodes have been drafted to be used in conjunction with relevant execution, material, product and test standards, and to identify requirements for execution, materials, products and testing that are relied upon by the Eurocodes.

The Eurocodes recognize the responsibility of each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level through the use of National Annexes.

0 Introduction

0.1 Introduction to the Eurocodes

The Structural Eurocodes comprise the following standards generally consisting of a number of Parts:

— EN 1990 *Eurocode — Basis of structural and geotechnical design*

— EN 1991 *Eurocode 1 — Actions on structures*

— EN 1992 *Eurocode 2 — Design of concrete structures*

— EN 1993 *Eurocode 3 — Design of steel structures*

— EN 1994 *Eurocode 4 — Design of composite steel and concrete structures*

— EN 1995 *Eurocode 5 — Design of timber structures*

— EN 1996 *Eurocode 6 — Design of masonry structures*

— EN 1997 *Eurocode 7 — Geotechnical design*

— EN 1998 *Eurocode 8 — Design of structures for earthquake resistance*

— EN 1999 *Eurocode 9 — Design of aluminium structures*

— EN 19100 *Eurocode 10 — Design of glass structures*

The Eurocodes are intended for use by designers, clients, manufacturers, constructors, relevant authorities (in exercising their duties in accordance with national or international regulations), educators, software developers, and committees drafting standards for related product, testing and execution standards.

NOTE Some aspects of design are most appropriately specified by relevant authorities or, where not specified, can be agreed on a project-specific basis between relevant parties such as designers and clients. The Eurocodes identify such aspects making explicit reference to relevant authorities and relevant parties.

0.2 Introduction to EN 19100 (all parts)

EN 19100 (all parts) applies to the structural design of mechanically supported glass components and assemblies of glass components. It complies with the principles and requirements for the safety and serviceability of structures, the basis of their design and verification that are given in EN 1990, *Basis of structural and geotechnical design.*

EN 19100 is subdivided into three parts:

— EN 19100-1, *Eurocode 10 — Design of glass structures — Part 1: General rules*

— EN 19100-2, *Eurocode 10 — Design of glass structures — Part 2: Out-of-plane loaded glass components*

— EN 19100-3, *Eurocode 10 — Design of glass structures — Part 3: In-plane loaded glass components*

0.3 Introduction to EN 19100-2

EN 19100-2 applies to the structural design of out-of-plane loaded glass components in conjunction with EN 19100-1.

0.4 Verbal forms used in the Eurocodes

The verb “shall" expresses a requirement strictly to be followed and from which no deviation is permitted in order to comply with the Eurocodes.

The verb “should” expresses a highly recommended choice or course of action. Subject to national regulation and/or any relevant contractual provisions, alternative approaches could be used/adopted where technically justified.

The verb “may" expresses a course of action permissible within the limits of the Eurocodes.

The verb “can" expresses possibility and capability; it is used for statements of fact and clarification of concepts.

0.5 National Annex for EN 19100-2

National choice is allowed in this document where explicitly stated within notes. National choice includes the selection of values for Nationally Determined Parameters (NDPs).

The national standard implementing EN 19100-2 can have a National Annex containing all national choices to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

When no national choice is given, the default choice given in this document is to be used.

When no national choice is made and no default is given in this document, the choice can be specified by a relevant authority or, where not specified, agreed for a specific project by appropriate parties.

National choice is allowed in EN 19100-2 through notes to the following clauses:

4.1(1)	4.2.1(2)	4.2.1(3)	4.2.2(1)
4.2.3(1) – 2 choices	4.3.1(2)	4.3.1(3)	4.3.2(6) – 2 choices
4.3.2(7)	4.3.3(2)	9(3)	9(5)
10.3.2(12)	10.3.3(3)	10.4(2)	

National choice is allowed in EN 19100-2 on the application of the following informative annexes:

Annex A	Annex B	Annex C	Annex D

The National Annex can contain, directly or by reference, non-contradictory complementary information for ease of implementation, provided it does not alter any provisions of the Eurocodes.

1 Scope

1.1 Scope of prEN 19100-2

(1) prEN 19100-2 gives basic structural design rules for glass components and assemblies primarily subjected to out-of-plane loading.

NOTE Out-of-plane loads are loads acting normal to (e. g. wind) or having a component (e. g. dead load, snow) acting normal to the glass plane.

1.2 Assumptions

(1) The assumptions given in EN 1990 apply.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

NOTE See the Bibliography for a list of other documents cited that are not normative references, including those referenced as recommendations (i.e. through 'should' clauses) and permissions (i.e. through 'may' clauses).

EN 1990, *Eurocode — Basis of structural and geotechnical design*

EN 13830:2015+A1:2020, *Curtain walling — Product standard*

prEN 19100-1:2024, *Eurocode 10 — Design of glass structures — Part 1: General rules*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 19100-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
chord shortening
difference of the length of the chord of the deflected glass component compared to the original length of the glass component

3.1.2
clamp
device supporting an edge zone of a glass pane on both sides with or without compression

Note 1 to entry: The term clamp comprises also toggles and patch fittings.

3.1.3
point fixing
local device able to receive and transfer forces imposed by the glass

3.1.4
point fixing system
set of components to achieve a point fixing

Note 1 to entry: Some components of the point fixing system can be integrated in the glazing.

3.1.5
cantilever system
set of components used to fasten a glass along one edge only

3.1.6
undercut hole
blind hole with recess in one glass ply

3.1.7
cold bent glass
glass components that are elastically bent at ambient temperature to permanently achieve a desired shape

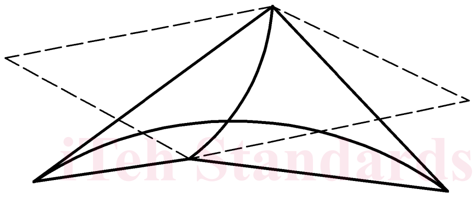

Figure 3.1 — Example of double-curved geometry

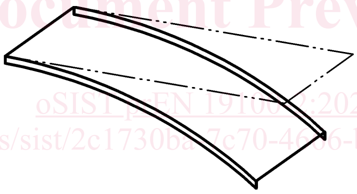

Figure 3.2 — Example of single-curved geometry

3.1.8
restraint forces
elastic forces that arise from the bending of the glass component

3.1.9
substructure
structure permanently supporting the glass component (clamps, point fixing, line bearing), ensuring the desired shape via their mechanical constraints (point- and/or linear supported), that needs to withstand the restraint forces of the cold bent glass component

3.1.10
intrinsic stresses
stresses inside the glass component, the glass pane or in the glass component’s parts resulting from the cold bending

Note to entry: Not to be confused with the cavity pressure in IGUs, originating from changes in air pressure.

3.1.11
extrinsic stresses
stresses inside the glass component, the glass pane or in the glass component's parts resulting from loads and deflections other than the cold bending

3.1.12
cold bending load case
instant of bringing the glass in the desired shape, via an elastic bending process and mechanical constraints onto the substructure

Note to entry: This can either be done on-site or in a workshop.

3.1.13
edge seal
combination of sealants and spacers of various materials, confining the cavity of an IGU along its edges and keeping the distance between the single panes

3.1.14
hot bending
curving glass by heating it to the softening temperature, then bending it to shape by its own weight or external force

3.1.15
lamination bending
curving glass by cold bending followed by a lamination process, intended to keep the desired curvature

3.2 Symbols and abbreviations

3.2.1 Latin upper-case letters

A	Area of the IGU panel [mm²]
A_i	Area of the cross-section of the i-th ply [mm²]
D_{ef}	Effective flexural stiffness [Nmm]
D_i	Flexural stiffness of the i–th glass plate [Nmm]
D_{abs}	Flexural stiffness at the layered limit [Nmm]
D_{full}	Flexural stiffness at the monolithic limit [Nmm]
E	Modulus of elasticity of glass [MPa]
$\overline{F}$	External concentrated load [N]
G_{int}	Shear modulus of the interlayer [MPa]
$\overline{H}$	External line load per unit length [N/mm]
L	Variable used for any kind of distance [mm]
M	Bending moment [Nm]
N	Number of glass panes composing the IGU
T_0	Reference absolute temperature in the cavities at the time of sealing [K]
U	(Numerically evaluated) Strain energy of the deflected plate
V_{0j}	Reference volume of the gas in the interpane cavity at the time of sealing [mm³]

3.2.2 Latin lower-case letters

a	Small size glazing length [mm]
b	Major size glazing length [mm]
c_i	Dummy value
d_i	Distance (with sign) of the mid-plane of the glass ply i from the mid-plane of the laminated glass [mm]
h	Thickness of glass in case of monolithic glass or deflection-effective thickness $h_{\mathrm{ef,w}}$ in the case of laminated glass [mm]
h_{IG}	Equivalent thickness of the IGU [mm]
$h_{\mathrm{ef,w}}$	Effective thickness of a laminated glass for calculating out-of-plane bending deflection [mm]
$h_{\mathrm{ef},\sigma,\mathrm{i}}$	Effective thickness of a laminated glass for calculating out-of-plane bending stress of ply i [mm]
h_{i}	Nominal thickness of pane i of an insulating glass unit or ply i of a laminated glass [mm]
h_{int}	Interlayer thickness [mm]
$h_{\mathrm{int,i},\sigma}$	Effective thicknesses for calculating the maximum stresses at the interface in the i-th ply [mm]
l_{H}	Length of the line distributed load [mm]
n	Plies number
n_{i}	Natural frequency
n_1	Natural frequency of the first mode of vibration
$p_{\mathrm{res,i}}$	Resulting pressure on glass ply i [MPa]
p_0	Reference pressure of the gas in the interpane cavities at the time of sealing [MPa]
$\overline{p}$	External uniformly distributed load [MPa]
q	Arbitrary uniform pressure [MPa]
s	Minimum nominal mechanical edge cover or edge support depth (see EN 12488) [mm]
s_{i}	Cavity width [mm]
t_{p}	Remaining time to occurrence of total failure of the glass component
$w\ (x,y)$	Out-of-plane displacement of a single panel, with the same shape of the IGU at hands, simply supported at its edges and subjected to an arbitrary uniform pressure q [mm]
w_{A}	Mean value, of w (x, y) on the pane area, where the uniformly distributed load is applied
w_{L}	Mean value of w (x, y) on the line, where the line-distributed load is applied
w_{P}	Value of w (x, y) at the point where the concentrated load is applied

3.2.3 Greek upper-case letters

Δp_j	Pressure variation of the gas in the j-th cavity, due to external loads and/or permanent and variable cavity loading [MPa]
$\overline{\Delta p}$	Barometric pressure variation with respect to p_0 (considered positive if the actual pressure is higher than p_0) [MPa]
$\overline{\Delta T_j}$	Temperature variation of the gas in the *j*-th cavity, with respect to T_0 (considered positive if the actual temperature is higher than T_0) [K]
Ω_i	Number of vibration loops according the small glazing size length
Ω_j	Number of vibration loops according the big glazing size length

3.2.4 Greek lower-case letters

η	Shear coupling parameter coefficient
η_b	Shear coupling parameter for beam
η_p	Shear coupling parameter for plate
μ_j^-, μ_j^+	Non-dimensional coefficients (j = 1, ..., N-1)
ρ	Density [kg/m³]
ρ_{IG}	Equivalent density of insulating glass [kg/m³]
ρ_{int}	Interlayer density [kg/m³]
ρ_{LG}	Equivalent density of laminated glass [kg/m³]
σ_i	Stress of the ply *i* [MPa]
$\sigma_{int,i}$	Stress at the interface of the interlayer *i* and the ply *i* [MPa]
ν	Poisson's ratio of glass
$\varphi(x,y)$	Non-dimensional shape function for the deflection of a simply-supported plate, with area *A* and flexural stiffness *D*, under arbitrary uniform pressure *q*
φ_A	Value of the non-dimensional shape function over the plate area
φ_L	Value of the non-dimensional shape function on the line where the line-distributed load is applied
φ_P	Value of the non-dimensional shape function at the point where the concentrated load is applied
Ψ	Coefficient accounting for different loading and boundary conditions
Ψ_b	Boundary coefficient for beam, see Table A.2
Ψ_p	Boundary coefficient for plate, see Table A.1
ω	Shear transfer coefficient (see EN 16612)

4 Basis of design

4.1 Requirements

(1) For an out-of-plane loaded glass component, the limit state scenario (LSS) should be chosen according to prEN 19100-1:2024, 4.2.4.

NOTE For a glass component, the LSS can be set by the National Annex, see prEN 19100-1:2024, 4.2.4.

(2) Special attention shall be paid to the robustness of the structure, see prEN 19100-1 and EN 1990.

(3) In case of fracture of a ply or of a component, the consequences for the safety and integrity of adjoining structure, components and people shall be analysed and verified.

NOTE Countries are encouraged to establish tables with typical glass component assemblies depending on application and supports.

(4) When ensuring sufficient robustness, depending on the function, importance and installation position (e.g. height over ground or floor resp., vertical or non-vertical), care shall be taken on the following aspects:

— risk of injury in case of glass failure, see e.g. CEN/TS 19100-4;

— risk of damage of other components in case of glass failure;

— careful choice of glass type and interlayer, which in combination or independently provide the necessary robustness of the glass component during the lifetime and after breakage;

— providing adequate cross-sectional redundancy by sufficient number of plies of the glass component;

— protection measures;

— realistic design, calculation and detailing.

(5) In case of laminated glass, the shear interaction provisions as given in prEN 19100-1:2024, 7.2.2 should be used.

NOTE Guidance can be taken from Annex A or from EN 16612.

4.2 Fracture limit state (FLS) verification

4.2.1 General

(1) In the FLS, sufficient safety during impact shall be verified (failsafe verification), see prEN 19100-1:2024, 4.2.3(2).

(2) In the FLS, an appropriate load combination should be used for the static loading that arises during the event of impact.

NOTE The load combination in the FLS is the accidental load combination according to EN 1990 unless the National Annex gives a different load combination.

(3) In the FLS, the supported glass component may be verified by experimental testing (4.2.2) or, alternatively, by a theoretical assessment (4.2.3) provided equivalence is given.

NOTE 1 Verification can include reference to previously executed tests or calculations.

NOTE 2 The National Annex can specify type of impactor, energy, ambient temperature and acceptance criteria.