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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

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: Querbelaastete 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.

This draft European Standard was established by CEN 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 CEN-CENELEC Management Centre has the same status as the official versions.

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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.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.



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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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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
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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

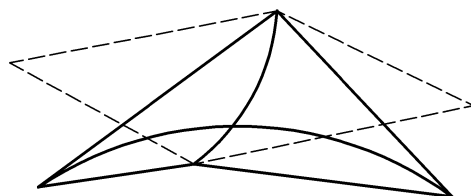


Figure 3.1 — Example of double-curved geometry

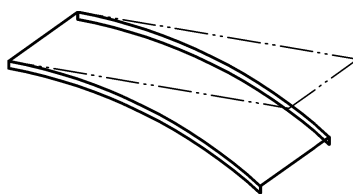


Figure 3.2 — Example of single-curved geometry

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 [mm ²]
A_i	Area of the cross-section of the i-th ply [mm ²]
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 [mm ³]

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 $h_{ef,w}$ in the case of laminated glass [mm]
h_{IG}	Equivalent thickness of the IGU [mm]
$h_{ef,w}$	Effective thickness of a laminated glass for calculating out-of-plane bending deflection [mm]
$h_{ef,\sigma,i}$	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]
$h_{int,i,\sigma}$	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
$p_{res,i}$	Resulting pressure on glass ply i [MPa]
p_0	Reference pressure of the gas in the interpane cavities at the time of sealing [MPa]
$\bar{p}$	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 ($j = 1, \dots, N-1$)
ρ	Density [kg/m ³]
ρ_{IG}	Equivalent density of insulating glass [kg/m ³]
ρ_{int}	Interlayer density [kg/m ³]
ρ_{LG}	Equivalent density of laminated glass [kg/m ³]
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.

4.2.2 Verification of the fracture limit state by testing

(1) If the FLS is verified by experimental testing, this may be performed either on the original (as built) structure in situ or on an appropriate test specimen. Further provisions may be as specified by the relevant authority or, where not specified, agreed for a specific project by the relevant parties.

NOTE Provisions on experimental testing can be given in the National Annex.

(2) If testing is not performed by using the original component on the original structure in situ, it shall be ensured that the used equivalent test specimen including all relevant details correspond to the original structure including supports, load introduction, etc.

(3) The tests shall be planned and evaluated such that clear conclusions with regard to safety and reliability can be drawn. Attention should be paid to the required number of tests.

NOTE 1 The lower the number of tests the higher the margin between mean value of the test results and the design resistance.

NOTE 2 Currently EN 1990 does not give complete guidance on glass specific testing.

(4) After experimental testing on original built structure in situ, it should be checked whether the structure still complies with its original resistance.

(5) The test results shall be evaluated by a transparent and reproducible procedure assessing safety and reliability according to the requirements of EN 1990.

4.2.3 Verification of the fracture limit state by theoretical assessment

(1) If the FLS is verified by a theoretical assessment all static and dynamic effects originating from impact and/or damage/fracture of parts of the glass component or of the whole shall reasonably be taken into account for the short time of impact.

NOTE 1 Generally, a theoretical assessment in the FLS is performed by a transient numerical simulation.

NOTE 2 A method for the numerical verification of impact effects can be given in the National Annex.

NOTE 3 Further provisions for the theoretical assessment in the FLS can be given in the National Annex.

(2) The applicability of the theoretical model shall be validated.

NOTE Normally, the applicability of a theoretical model is validated by experimental benchmark tests.

4.3 Post fracture limit state (PFLS) verification

4.3.1 General

(1) In the PFLS sufficient safety after fracture for a limited period of time shall be verified (verification of residual resistance of the glass component or verification of an alternative load path). The fracture may be of one or several glass plies or of the component.

NOTE The resistance of the glass component in the post fracture limit state (PFLS) is influenced by the type of glass (e.g. breakage pattern, type of interlayer, number of plies), the size of the glass component and its support.

(2) In the PFLS, an appropriate load combination should be used.

NOTE The load combination in the PFLS is the accidental load combination according to EN 1990 and prEN 19100-1 unless the National Annex gives a different load combination.

(3) Aspects that should be considered for the determination of the time period can originate from the following: time to secure the environment, temporary support, time to replace, time to remove the load etc. The time limited characteristic variable actions may be reduced according to EN 1991-1-6.

NOTE Post fracture time periods in the PFLS can be set by the National Annex.

(4) In the PFLS the glass component can be verified by experimental testing (4.3.2) or alternatively by a theoretical assessment (4.3.3), provided equivalence is given.

NOTE 1 Due to the viscoelastic properties of the interlayers and the complex mechanical behaviour of the broken glass laminate, the verification can sometimes only be done by testing of the original glass component including its supports.

NOTE 2 Verification can include reference to previously executed tests or calculations.

4.3.2 Verification of the post fracture limit state by testing

(1) If the PFLS is verified by experimental testing, this may be performed either on the original (as built) structure in situ or on appropriate test specimen or on an appropriate equivalent laboratory specimen.

(2) Additional requirements for 4.3.2(1) may be as specified by the relevant authority or, where not specified, agreed for a specific project by the relevant parties.

(3) If the PFLS is verified by experimental testing on the original (as built) structure in situ, after experimental testing the intact initial state should be restored.

(4) If testing is not performed by using the original component on the original structure in situ, it shall be ensured that the used equivalent test specimen or equivalent laboratory specimen including all relevant details correspond to the original structure including supports, load introduction, etc.

(5) Experimental tests should be planned and evaluated such that clear conclusions with regard to safety and reliability can be drawn. Special attention should be paid to the required number of tests.

NOTE The lower the number of tests the higher the margin between mean value of the test results and the design resistance.

(6) To determine the residual load bearing capacity time the glass component should be loaded by an appropriate load pattern with an appropriate magnitude.

NOTE 1 If the load pattern is a distributed load p , the value of p is 0,5 kPa unless the National Annex gives different values.

NOTE 2 The National Annex can specify requirements on breakage of further glass plies.

(7) The remaining time t_p to occurrence of total failure of the glass component shall meet the requirements, see 4.3.1.

NOTE 1 The value of t_p can be set in the National Annex.

NOTE 2 Apart from the breakage of the glass cross-section, total failure can also occur due to different failure mechanisms, e.g. disengaging from supports, tearing of the interlayer, excessive deformation.

(8) After experimental testing on original built structure in situ, it should be checked whether the structure still complies with its original resistance.

4.3.3 Verification of the post fracture limit state by theoretical assessment

(1) Alternatively to 4.3.2, a theoretical assessment of the PFLS may be performed. Here all relevant actions, time and ambient effects after the fracture event for the specified residual time period shall be taken into account.

(2) Generally, in case of accessibility, the glass ply directly in contact with actions should be assumed as fractured (e.g. the upper ply of a glass roof or a glass floor).

NOTE 1 The number of glass plies to be assumed fractured depends on their probability of fracture during the lifetime of the glass component.

NOTE 2 The mechanical behaviour, including the residual resistance, of the glass component in the post fracture limit state (PFLS) is influenced by the type of glass component (e.g. mode of breakage, type of interlayer, number of plies), the size of the glass component and its supporting system.

NOTE 3 Further provisions for the theoretical assessment in the PFLS can be given in the National Annex.

5 Materials

(1) For the material properties, prEN 19100-1:2024, Clause 5 shall be applied.

6 Durability

(1) The rules for durability in EN 1990 and prEN 19100-1:2024, Clause 6 shall be applied.

7 Structural analysis

(1) The rules for structural analysis in prEN 19100-1:2024, Clause 7 shall be applied.

(2) For calculation of laminated glass, the rules given in prEN 19100-1:2024, 7.2.2 shall be followed.

NOTE For Level 2 calculation according to 7.2.2 of prEN 19100-1:2024, the Annex A of this document gives information on an analytical determination of the effective thicknesses for deformation and stresses of laminated glass. Other approaches, if appropriate, can be used.

(3) When applicable, EN 16612 gives further information on calculation methods to determine stresses and deflections for glass components under uniformly distributed loads.

(4) For calculation of the resulting cavity pressure and the load distribution on the respective panes of IGUs the method as given in Annex C of this document, or as given in EN 16612, may be used.

NOTE The method as given in EN 16612 is limited to uniformly distributed loads only.

(5) Load combinations for calculating IGUs should be chosen according to prEN 19100-1.

8 Ultimate limit states

(1) For ultimate limit states, the rules in prEN 19100-1 shall be applied.

9 Serviceability limit states

(1) For serviceability limit states, the rules in prEN 19100-1 shall be applied.

(2) For deformation class 1-SLS (see prEN 19100-1:2024, Table 9.1) deflection limits are not subject of this document.

(3) For deformation class 2-SLS (see prEN 19100-1:2024, Table 9.1) this document gives typical deflection limits depending on application and boundary conditions. Due to the technical circumstances like sealant or edge design the limits may alter. Differences may also arise from different habits of the individual countries.

NOTE Typical values for deflections limits for deformation class 2-SLS to be used together with the characteristic load combination are given in Table 9.1 (NDP) unless the National Annex gives other values or other deflection limitation approaches.

(4) If deflection is not critical, larger design values may be considered.

Table 9.1 (NDP) — Typical deflection limits for glass components of deformation class 2-SLS

	Support condition	Deflection limit of the support of the edges	Deflection limit at a free edge	Deflection limit at centre
Glass component	Continuously supported along all edges	according to EN 13830:2015+A1:2020, 5.7		$L/50^a$
	Continuously supported along 2 or 3 edges	according to EN 13830:2015+A1:2020, 5.7	$L/100^c$	
	Non-continuously supported along 2 or 3 edges	$L/150^b$	$L/100^c$	$L/50^a$
	Point-fixed		$L/100^{c, d}$	$L/50^{a, d}$
Floor	Continuously supported along all edges			$L/200^a$
Floor or stair tread	Continuously supported along 2 edges			$L/200^c$
Balustrade	Cantilevered from the lower edge		Deflection should not open a gap wider than 50 mm between two adjacent elements at 1 m above finished floor level	
IGU	Continuously supported along all edges	according to EN 13830:2015+A1:2020, 5.7		$L/50^a$
	Continuously supported along 2 or 3 edges	according to EN 13830:2015+A1:2020, 5.7	$L/150^c$	
	Point-fixed		$L/150^c$	
^a L is the length of the short edge. ^b L is the distance between two point-fixings. ^c L is the length of the unsupported edge. ^d Either the deflection limit of $l/100$ at the edge or $l/50$ in the centre should be applied, not together. The decision whether to apply one or the other limit depends on the individual case.				

NOTE In some cases, assessment of critical frequencies is more appropriate, see Annex B of this document.

(5) For deformation class 3-ULS, the actual retained depth of the deformed glass pane inside the edge cover shall be verified accounting for the glass chord shortening due to its deflection and to the tolerances.

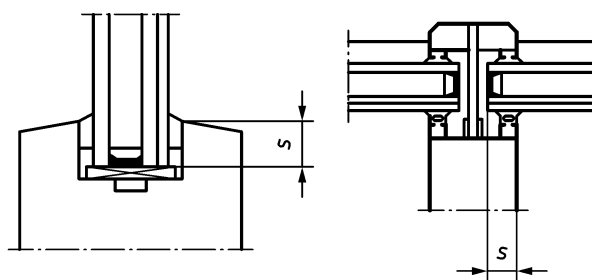
NOTE 1 Recommended minimum nominal mechanical edge cover is given in Table 9.2 (NDP) unless the National Annex gives other values.

Table 9.2 (NDP) — Recommended minimum nominal mechanical edge covers s for glass components of deformation class 3-ULS^a

Application	Further specification	Minimum nominal mechanical edge cover or edge support depth ^b s [mm]
Single glass component	Vertical	12
	Non-vertical	12
Floor		30
Balustrades	4 edges continuously supported	12
	1 edge continuously supported (clamped)	70
IGU	Vertical	12
	Non-vertical ^c	12
^a This table is not exhaustive. ^b See Figure 9.1. ^c Accessible for maintenance only; otherwise see floors.		

NOTE 2 The limit for the edge cover can depend on the application and on the expected service life of the glass component and sealants.

NOTE 3 There can be situations where the values given in Table 9.2 are not sufficient. These cases can require further analysis resulting in values, fulfilling ULS requirements considering tolerances.



Key

s mechanical edge cover

Figure 9.1 — Nominal mechanical edge covers

10 Joints, connections and supports

10.1 General

(1) The following methods for supporting glass components are considered in this clause:

- continuously supported glazing along their edges;
- point supported glazing;
- glazing restrained at one edge (cantilevered glass component).

(2) All bolted joints, supports and connections shall be secured against unintended loosening or detachment. This may involve consideration of accidental breakage of glass components.

(3) The risks induced by the falling of glass fragments in case of accidental breakage shall be considered.

NOTE This includes the risk of people injuries but also the stability of the possible adjacent glazing and of the structure.

(4) The fastenings shall allow the glass unit to move and rotate freely so that the thermal expansion and the movements of the supports do not cause additional stresses in the glass unit.

10.2 Continuously edge supported glass components

(1) The mechanical edge cover (see Figure 9.1) shall be chosen such that long-term mechanical stability of the glass component is ensured. Appropriate minimum edge cover values shall be checked and ensured, taking into account thermal expansion, load effects, tolerances and building movements.

(2) The edge support should fulfil the criteria of EN 12488. In this case, the boundary conditions at the edges may be assumed as simply supported for ULS and SLS verifications.

(3) The chord shortening value shall be ascertained by appropriate analysis, to check that sufficient edge retention is always maintained, or that tolerable shear stress is applied to the sealant joint, Table 9.2 and Clause 9(5) NOTE 3.

NOTE Out-of-plane loaded glass components can show a significant chord shortening when sagging. This can cause the glass component disengaging from the mechanical edge retention, or it can induce high transversal shear action or other stress action on edge sealant joints.

(4) Consideration should be given to the suitability of the support when the structural glass component is evaluated for FLS and PFLS as required.

(5) In the case of bonded glazing, provisions of EN 16759, EN 15434, EN 13022-1 and EN 13022-2 should also be considered.

(6) In the case of IGUs with a U profile glued into the sealant, and such that the internal glass is punctually fixed with toggles to the secondary structure. When the toggles are distant of more than 300 mm, 10.3 should also be considered.

(7) Continuous edge support also applies when pressure plates are used, covered by clipped caps or not, when they are distant of less than 300 mm, and when they hold the glazing on the full thickness of the IGU. When these pressure plates are distant of more than 300 mm, 10.3 should be considered.

10.3 Point supported glass components

10.3.1 General

(1) Verification of a point-fixed glass component shall be completed allowing for both the glass and the fitting, taking into account the stiffness of the fitting, its interface with the glass and the application of forces to both the glass and the fitting.

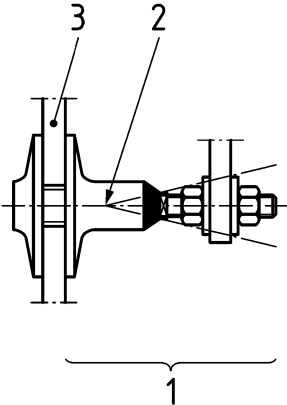
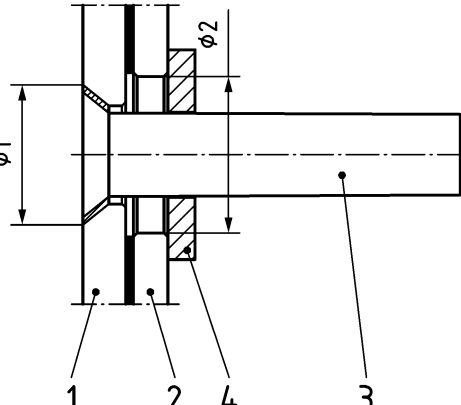
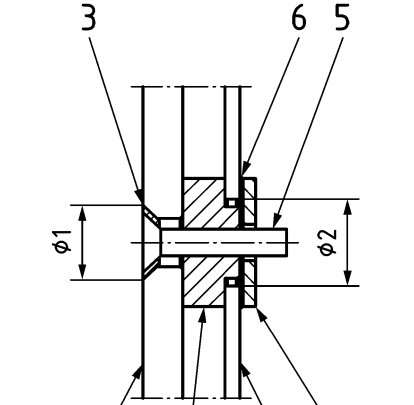
NOTE 1 A point-fixed glass component cannot be verified disregarding the point-fixing system.

NOTE 2 There are different options for the moment rotation behaviour of fixing devices: articulated (rotations without moments), semi rigid (rotations producing moments) or rigid (no rotations but moments). Articulated supports are able to accommodate greater rotational movement of the glass relative to the glazing support attachment. This can allow the use of panes on more flexible support systems like cable structures. If the centre point of the articulation is not in the axis of the pane moments of eccentricity occur.

10.3.2 Point supported glass components with fittings in holes

(1) Examples for point supported glass components with fittings in holes are given in Table 10.1.

Table 10.1 — Examples for point supported glass components with fittings in holes

a	b	c
point fixing to a monolithic glass pane with cylindrical hole	countersunk point fixing to a laminated glass pane	point fixing to an IGU
		
Key 1 point fixing 2 rotation point 3 pane	Key 1 glass ply with countersunk hole 2 glass ply with cylindrical hole 3 countersunk point fixing 4 flange	Key 1 glass ply with countersunk hole 2 cylindrical glass ply 3 countersunk isolator 4 boss 5 countersunk point fixing 6 gasket 7 flange

(2) This clause covers glass components with holes drilled through the full thickness of glass pane. Holes for laminates or IGU's which do not pass through all of the glass plies or panes of the construction may be used. Consideration should be given to the dead load transfer of the unsupported pane.

NOTE Systems featuring undercut fixing elements are not covered here.

(3) For undercut holes, consult the system developer.

(4) When holes or recesses are needed to allow the load transfer, the glass shall be subsequently pre-stressed, see prEN 19100-1:2024, 7.3.2(1).

(5) The holes may be cylindrical or countersunk. The edges of the holes in contact with the bolt shall be at least ground or when possible, smooth ground or polished. The edges of the holes shall be chamfered at both sides of the glass component for cylindrical holes or at the side opposite to the countersunk face.

(6) When laminated glass is used, the respective diameters of the holes in the different plies may be adjusted in such a way that no stress is applied on the interlayer by the punctual fixing device.

NOTE In this situation, only one ply of the laminated glass is held by the bolt, the holes in the other ply being oversized.

(7) In case of laminated glass, the truncated part of the hole should be located in only one glass ply while in the other ones only cylindrical holes should be located.

(8) Example of laminated glass with countersunk hole is given in Table 10.1, column b.

NOTE Other systems are available but are not covered by this document.

(9) Point fixings shall be made of suitable material (metal, ceramic, polymer...) having adequate mechanical and physical properties and sufficient durability. Depending on the degree of exposure to possible corrosion, either an appropriate material non-sensitive to corrosion, or systems of protection from corrosion, should be selected. All materials of point fixings shall be compatible with glass and interlayers.

(10) Direct contact between hard metallic material and glass shall be avoided by means of an intermediate material.

NOTE 1 Examples of intermediate materials are:

- aluminium alloys (series 1000s), excluding alloys with a high level of copper or zinc (like series 2000 or 7000);
- synthetic materials: PTFE, Polyamide, Polychloroprene, Silicone, etc., checking their full chemical compatibility with other materials in contact (e.g. glass interlayers);
- appropriate resins and mortars.

NOTE 2 When the hole is cylindrical, the glass is supported on both sides, see Table 10.1, column a.

(11) The system shall allow for the relative movement of glass and supporting structure due to e.g. variable loads, thermal effects, etc.

(12) A point fixing system should be analysed in view of both the glass and the fitting assembled together, taking into account the effective structural system, the stiffness of the fitting, its interface with the glass, the glass combination and the application of forces to both the glass and the fitting. All sectional forces including internal moments should be verified.

NOTE The National Annex can give further rules on materials of point fixings.

(13) The design and safety verification of point fixings themselves should be performed according to the design code of the respective material.