INTERNATIONAL STANDARD

ISO 28278-1

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Glass in building — Glass products for structural sealant glazing —

Part 1:
Supported and unsupported monolithic and multiple glazing

Verre dans la construction — Produits verriers pour vitrage extérieur collé —

Partie 1: Vitrages monolithiques ou multiples, supportés ou non supportés

Reference number
ISO 28728-1:2011(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 28728-1 was prepared by Technical Committee ISO/TC 160, *Glass in building*, Subcommittee SC 2, *Use considerations*.

ISO 28728 consists of the following parts, under the general title *Glass in building — Glass products for structural sealant glazing*:

— *Part 1: Supported and unsupported monolithic and multiple glazing*

— *Part 2: Assembly rules*

Glass in building — Glass products for structural sealant glazing —

Part 1: Supported and unsupported monolithic and multiple glazing

1 Scope

This part of ISO 28278 specifies requirements for the suitability of supported and unsupported glass products (see Figure 1) for use in the structural sealant glazing (SSG) technique. Regarding glass products, this part of ISO 28278 constitutes a supplement to the requirements specified in the corresponding ISO standards with regard to verifying suitability for use in SSG systems.

Only soda lime silicate glass is taken into consideration in this part of ISO 28278.

The glass products are installed and bonded into the support under controlled environmental conditions, as described in ISO 28278-2.

Plastic glazing is excluded from the scope of this part of ISO 28278.

The structural, weatherproofing and sealant and outer seal of insulating glass unit (IGU) products, which are commonly used in structural glazing applications, are those based on organo-siloxane, “silicone” polymers, and recommended for use by the sealant manufacturer. Where there is a risk of earthquake, the sealant design may not be sufficient to resist the loads, and complementary arrangements may be necessary.

This part of ISO 28278 does not preclude the use of other sealant types where these can demonstrate suitability for service according to this part of ISO 28278 and when used following the recommendations of the sealant manufacturer.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO 527-3:1995, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets*

ISO 868:2003, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)*

ISO 1183-1:2004, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pyknometer method and titration method*

ISO 3231:1993, *Paints and varnishes — Determination of resistance to humid atmospheres containing sulfur dioxide*

ISO 7389, *Building construction — Jointing products — Determination of elastic recovery of sealants*

ISO 9227:2006, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 10563:2005, *Building construction — Sealants — Determination of change in mass and volume*

ISO 11358-2, *Plastics — Thermogravimetry (TG) of polymers — Part 2: Determination of activation energy*

ISO 11600, *Building construction — Jointing products — Classification and requirements for sealants*

ISO 12543 (all parts), *Glass in building — Laminated glass and laminated safety glass*

ISO 16269-6, *Statistical interpretation of data — Part 6: Determination of statistical tolerance intervals*

ISO 20492 (all parts), *Glass in buildings — Insulating glass*

ISO 28278-2:2010, *Glass in building — Glass products for structural sealant glazing — Part 2: Assembly rules*

ASTM C 1184:2000, *Standard Specification for Structural Silicone Sealants*

ASTM C 1265:2005, *Standard Test Method for Determining the Tensile Properties of an Insulating Glass Edge Seal for Structural Glazing Applications*

3 Terms and definitions

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

NOTE Figure 1 is included only as an aid to explaining the terminology used in this International Standard. The components indicated in broken and dotted lines are covered by other technical specifications such as ETAG 002 or standards concerned with curtain wall façades.

3.1
structural sealant glazing
SSG
assembly in which glass products are fixed to the structural seal frame by means of a sealant that has been shown to be capable of withstanding the load actions applied to the glass products of the structural seal frame

3.2
anchorage
anchorage of the structural seal support frame on the framework

NOTE See (1) in Figure 1.

3.3
backer rod
pre-formed continuous strip that limits the section and height of a fillet of weather sealant

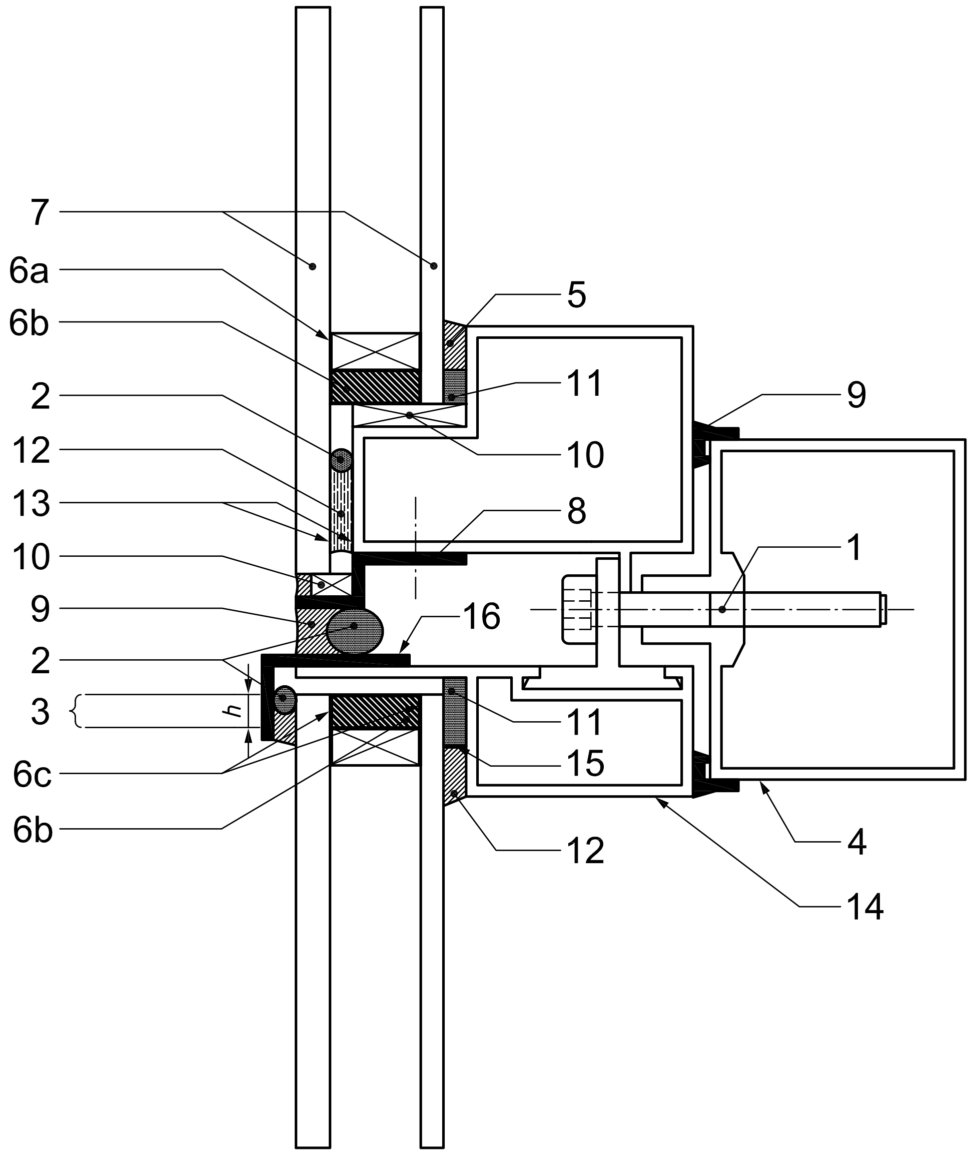
NOTE See (2) in Figure 1.

3.4
hermetic seal bite
dimension of the second barrier of the hermetic seal measured parallel to the glass unit at the panel level

NOTE See (3) in Figure 1.

3.5
façade framework
members to which the structural seal support frame is connected and which transmit the loads to the building

NOTE See (4) in Figure 1.



Key

1 anchorage
2 backer rod
3 height of the outer seal
4 façade framework
5 finishing material
6 hermetic seal
  6a (inner seal)
  6b (outer seal)
  6c outer seal adhesion surface
7 glass unit
8 self-weight mechanical support
9 weather seal
10 setting blocks
11 adhesive spacer
12 structural seal
13 structural seal adhesion surface
14 structural seal support frame
15 anti-adhesive film
16 retaining device

Figure 1 — Terminology

3.6
finishing material
elastomeric sealant extruded into the joint, of sufficient cross-section as to constitute a barrier to air and water when cured, or a pre-extruded gasket with a fin of sufficient cross-section

NOTE See (5) in Figure 1 and (4) in Figure 3.

3.7
outer seal
sealant intended to ensure a hermetic seal, providing a barrier to water and vapour penetration, and light, around the edge of an insulating unit whilst remaining compliant with displacements caused by wind or other loads

NOTE 1 The hermetic seal is called “structural” (see 3.14) when it also has the supplementary function of adequately transmitting to the seal support frame the forces applied to the glass.

NOTE 2 See (6b) in Figure 1 and (3) in Figure 3.

3.8
glass unit
element consisting of a single glass pane (monolithic or laminated) or an insulating glass unit (IGU) specified for use in SSG

NOTE 1 The IGU may be one of two types: a unit with aligned edges for which the two panes have the same nominal dimensions, or a unit with stepped edges for which the two panes have different dimensions.

NOTE 2 See Figure 2 and (7) in Figure 1.

3.9
insulating glass unit
IGU
pre-assembled unit comprising panes of glass that are sealed at the edges and separated by dehydrated space(s), intended for use in buildings

3.10
self-weight mechanical support
element situated beneath the bottom edge of the glass unit that transmits the weight of the latter to the structural seal support frame

NOTE See (8) in Figure 1.

3.11
weather seal
fillet of sealant or weather fin of adequate cross-section constituting a barrier to air and water

NOTE See (9) in Figure 1.

3.12
setting blocks
bearing elements situated between the self-weight mechanical support and the bottom edge of a glass unit used to position the glass unit in the structural seal support frame and to avoid a permanent shear load

NOTE See (10) in Figure 1.

3.13
adhesive spacer
continuous pre-formed strip defining the cross-section of the fillet of sealant and used to align the glass relative to the structural seal support frame

NOTE See (11) in Figure 1.

3.14
structural seal
joint of elastic structural sealant extruded between glass element or glass and framework which is, when cured, of adequate transverse cross-section as to transfer appropriate forces applied on the glass to the structural seal support frame

NOTE See (12) in Figure 1 and (5) in Figure 3.

3.15
structural seal adhesion surface
continuous surface of the glass or structural seal support frame to which the structural sealant bonds

NOTE See (13) in Figure 1 and (6) in Figure 3.

3.16
structural seal support frame
metallic element to which the glass product is bonded

NOTE See (14) in Figure 1.

3.17
anti-adhesive film
film at the interface between two materials, used to prevent them bonding together

NOTE See (15) in Figure 1.

3.18
retaining device
piece intended to hold the glass product in place and therefore reduce any danger that may result in the event of a structural seal failure

NOTE See (16) in Figure 1.

3.19
cohesive failure
cohesive rupture
rupture in a body of the sealant

3.20
adhesive failure
adhesive rupture
rupture at the interface between the sealant and the substrate

3.21
initial cure
stage in the curing where the sealant has appropriate cohesive strength to resist different levels of action

3.22
creep factor
shear design stress under permanent static load

3.23
initial type testing
determination of the performance of a product (characteristics, durability), on the basis of either actual tests or other procedures

NOTE Other procedures include conventional, standardized, tabulated or generally accepted values, standardized or recognized calculation methods, and test reports when made available, in accordance with this International Standard.

3.24
test report
document that covers the results of tests undertaken on a representative sample of the product from production or on a prototype design of the product

3.25
product description
document that details the relevant parameters for defining a product that complies with its relevant standard

NOTE It includes specific reference(s) to characteristics that are modified by the production process and by raw materials.

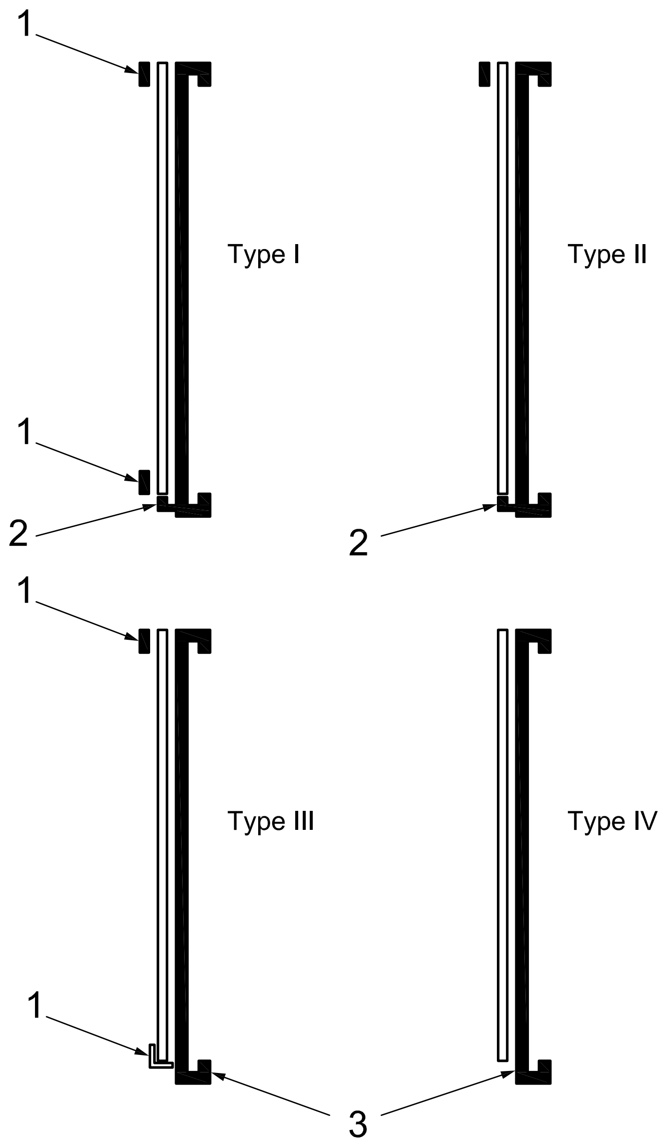
3.26
significant change
variation in performance beyond the permitted tolerance for the characteristic

4 Symbols

a	length of the smaller dimension of the glass	m
A_g	glass area	m^2
b	breadth of IGU air space	mm
b_w	width of the bead	mm
c	height of sealant necessary for structural purposes: $c = (0{,}5p \cdot a) / (\sigma \cdot \beta)$	mm
e_i	initial glass thickness per test piece for L_o	mm
E_o	modulus (tangent or secant)	kPa
F	relevant combined load for wind, snow and self-weight	Pa
F_s	shear force	Pa
$F_{t,i}$	tensile loading	Pa
F_{mean}	average breaking force	Pa
h	height of structural sealant	mm
h_o	height of sealant as specified in ISO 20492-2	mm
h_u	height of the outer seal of the unsupported IGU	mm
K_o	tangent stiffness at the origin	kPa
K_{sec}	rigidity modulus/secant stiffness	kPa
K_x	stiffness of the sample at x % elongation in the initial state	kPa
K_y	stiffness of the sample at y % elongation after conditioning	kPa
L	length of the loaded test piece	mm
L_o	initial length of the test piece	mm
l_s	vertical length of the outer seal	mm
l_b	length of the bead	mm
m	number of observations per test piece	—
n	number of test pieces per test for the temperature concerned	—
p	relevant combined load of the wind, snow, climatic effects and self-weight	kPa
P_u	weight of the unsupported IGU	kPa

R_{des}	design resistance	kPa
$R_{\mathrm{u,5}}$	characteristic force giving 75 % confidence that 95 % of the test results will be higher than this	kPa
r	distance between structural seal and glass edge	mm
r_{o}	step between both glass components	mm
s	standard deviation of the series	—
s_{min}	minimum dimension of glass	m
s_{max}	maximum dimension of glass	m
t_1	minimum glass thickness of the outermost component of an IGU	mm
t_2	minimum glass thickness of the innermost component of an IGU	mm
t	time	—
u_{c}	displacement under compression	mm
u_{ij}	displacement under tension or compression	mm
w	width of structural sealant	mm
X	breaking stress	kPa
X_i	value of the breaking stress of test piece i, either under tension or shear	kPa
$\overline{x}$	average breaking stress, either under tension or shear	kPa
$\overline{x}_{\mathrm{o}}$	average breaking stress, either under tension or shear, in the initial state	kPa
$\overline{x}_{\mathrm{c}}$	average breaking stress, either under tension or shear, after conditioning or ageing	kPa
$\overline{x}_{\mathrm{tear}}$	average tear breaking strength	kPa
ΔH	maximum difference in altitude between production transport and assembly at site	m
σ	allowable stress of the sealant	MPa
β	coefficient depending on relative thickness of insulating glass panes	—
τ	shear stress	kPa
$\tau_{\alpha\beta}$	eccentricity of 5 % with 75 % confidence	—
Γ_{∞}	shear design stress value declared by the sealant manufacturer	kPa
Γ_{des}	shear design stress under dynamic load	kPa
σ_{des}	design stress	kPa
σ_{ij}	tensile stress at the tensile displacement u_{ij}	kPa
γ_{c}	safety factor	—

5 Principle



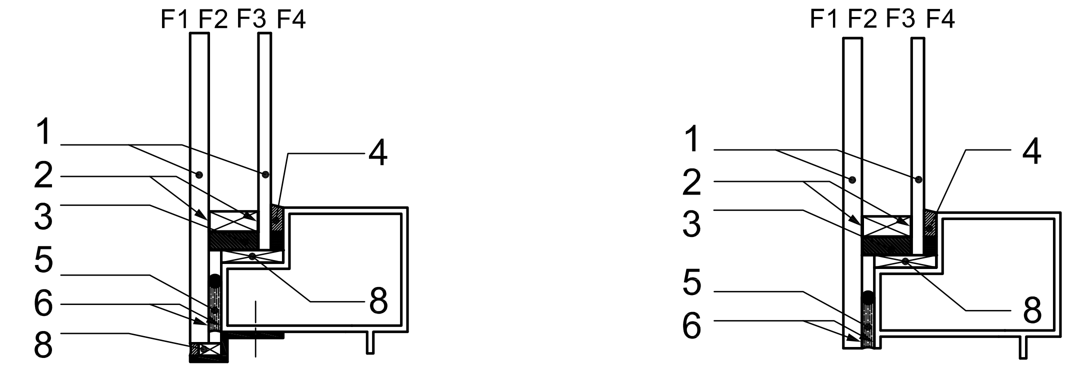
Key

1 retaining device

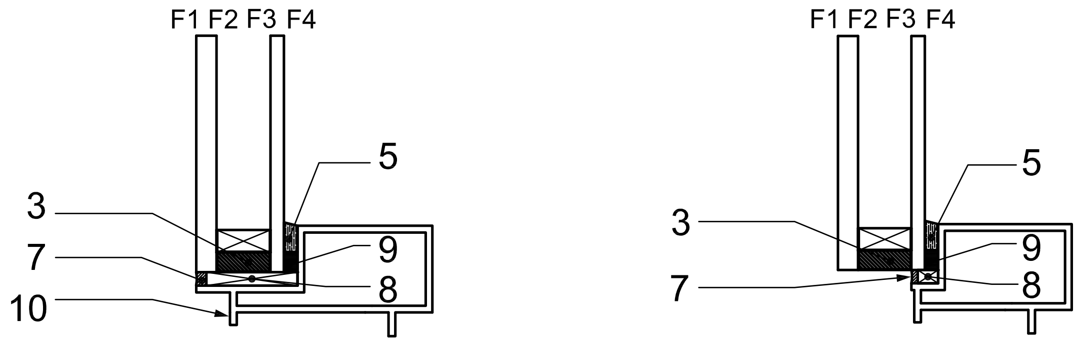
2 mechanical self-weight support

3 structural sealant support frame

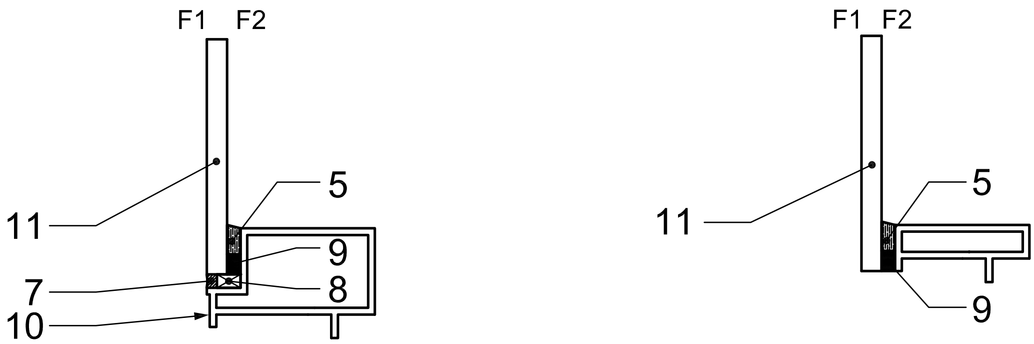
Figure 2 — Schematic examples of the different types of SSG system



a) Situation 1



b) Situation 2



c) Situation 3

Key

1 insulating glass unit

2 inner seal

3 outer seal

4 finishing material

5 structural seal

6 structural seal adhesion surface

7 weather seal

8 setting block

9 adhesive spacer

10 structural seal support frame

11 laminated or monolithic glass

F1 face 1

F2 face 2

F3 face 3

F4 face 4

NOTE The section drawings above are examples of structural sealant glazing system types II and IV.

Figure 3 — Principle

SITUATION 1

The SSG seal is applied on face 2 of the insulating glass unit (IGU). The outer IGU sealant has no structural function and therefore only contributes to the resistance of the unit against the ingress of water (vapour and liquid), and air. Depending on the type and construction of the IGU sealant, any leakage of gas from the unit will be minimised. The SSG seal must have good adhesion to the glass and steel surfaces to withstand the mechanical stresses that result from the exposure of the IGU to the climatic elements and in particular the effects of solar radiation.

SITUATION 2

The SSG seal is applied on face 4 of the IGU. The outer IGU sealant has a structural function as well as having to maintain the integrity and performance of the IGU. Any stress or loads applied to the outer glass will be transferred to the IGU sealant.

SITUATION 3

The SSG seal is applied on face 2 of the laminated or monolithic glass unit. The sealant has a structural function and any loads applied to the glass will be transferred to it.

6 Required characteristics of glass products

6.1 Appropriate glass products

This part of ISO 28278 only allows the use of the following glass products.

6.1.1 Float glass

Until an ISO standard is published, the following standards may apply:

— EN 572-2;

— JIS R 3202;

— ASTM C 1036.

6.1.2 Polished wired glass

Until an ISO standard is published, the following standards may apply:

— EN 572-3;

— JIS R 3204.

6.1.3 Drawn sheet glass

Until an ISO standard is published, the following standard may apply:

— EN 572-4.

6.1.4 Patterned glass

Until an ISO standard is published, the following standards may apply:

— EN 572-5;

— JIS R 3203.

6.1.5 Coated glass

The following standards may apply:

- EN 1096;
- ASTM C 1376;
- JIS R 3221.

6.1.6 IGU

Until ISO 20492 (all parts) is published, the following standards may apply:

- EN 1279;
- ASTM E 2190;
- ASTM C 1249;
- JIS R 3209.

6.1.7 Heat strengthened soda lime silicate glass

The following standards may apply:

- EN 1863;
- ASTM C 1048;
- JIS R 3222.

6.1.8 Thermally toughened soda lime silicate safety glass

The following standards may apply:

- EN 12150;
- ASTM C 1048;
- JIS R 3206.

6.1.9 Heat soak tested thermally toughened soda lime silicate safety glass

The following standard may apply:

- EN 14179.

6.1.10 Laminated glass and laminated safety glass

The following standard may apply:

ISO 12543 (all parts).

6.2 Dimensional tolerances

The tolerances for the different glass products can be found in the appropriate glass standards listed in 6.1.

6.2.1 Glass shapes — Curved glass

Curved glass shall be considered to be flat for the purposes of calculating the products of the IGU seals and glass thickness if the height of the glass at the centre of curve is ≤ 1/100 of the length of the curved side.

6.3 Corners, notches and holes

For annealed glass, corners [Figure 4 a)], notches [Figure 4 b)] and holes [Figure 4 c)] for annealed glass are not considered in this part of ISO 28278.

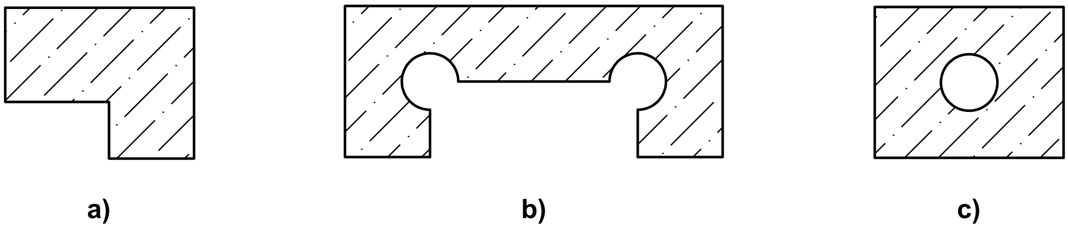


Figure 4 — Corner, notch and hole

For toughened and heat strengthened glass, corners [Figure 4 a)], notches [Figure 4 b)] and holes [Figure 4 c)] are described in the following standards:

- EN 1863;
- EN 12150;
- EN 14179.

In the case of IGUs, any angles cut in the glass forming the corner of the IGU shall not be less than 15° (Figure 5).

Dimensions in millimetres

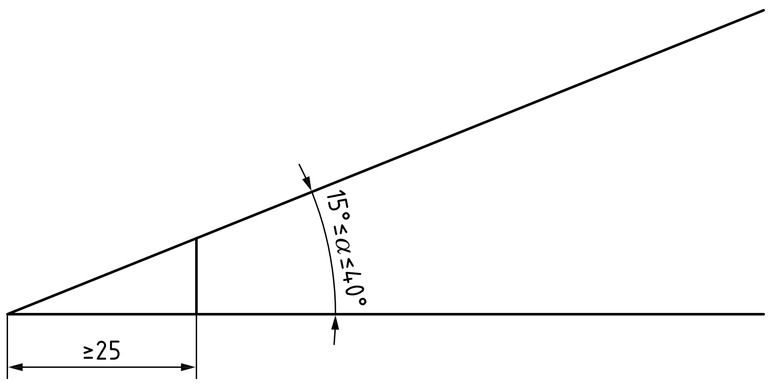


Figure 5 — Angle of IGUs

7 Verification of the suitability of glass products for use in SSG systems when exposed to ultraviolet (UV) radiation

7.1 General

The conformance of the glass product is determined by its capacity to resist the stresses specified in this clause and by fulfilling the requirements regarding mechanical resistance and stability, reaction and resistance to fire, hygiene, health, environment, safety, protection against noise, energy economy and heat retention, and durability as a function of the situation and of the type of glass (see Scope).

7.2 IGU

ASTM C 1401-02, 22.5 may apply.

7.2.1 Situation 1 (see Figure 3)

In Situation 1 the outer seal of the IGU has no structural seal function.

Regarding the IGU itself:

Suitability for use of the IGU is determined in accordance with ISO 20492 (all parts). However, the requirements of ISO 20492-4 should be amended as follows.

Outer seal:

a) The assessment tests of ISO 20492-4 should be amended as follows:

   1) Exposure to heat: test conditions of ISO 20492-4 should be replaced by those in B.2.3.3, class T3 −100 °C.

   2) Exposure to UV: test conditions of ISO 20492-4 should be replaced by the Exposure to UV test and specifications as defined in Annex F and B.2.7 of this part of ISO 28278.

   or

b) The test methods and specifications of B.2.2, B.2.3 and B.2.4 of this part of ISO 28278 are applicable.

   or

c) A structural sealant as defined in ISO 28278-2 can be used for the outer seal of the IGU in Situation 1, Figure 3.

The test report of ISO 20492 should be amended accordingly.

7.2.2 Situation 2 (see Figure 3)

The outer seal of the IGU has a structural function and shall satisfy the following:

a) Suitability for use of the IGU is determined in accordance with ISO 20492.

b) The outer seal of the IGU shall satisfy the test methods and specifications of B.2.2, B.2.3 and B.2.4 of this International Standard.

c) The test report in ISO 20492-4, D.6 should be amended accordingly.

EN 1279-4, D.6 may apply.

7.2.3 Coated glass

7.2.3.1 Adhesion of coatings to glass surfaces and adhesion of coatings to interlayer used for laminated glass products

The adhesion of coatings to glass surfaces and adhesion of coatings to the interlayer used for laminating glass products should be performed in conformity with Annex D of ISO 20492-4:2010. In the case of the outer seal, it should be amended as follows:

7.2.3.1.1 Bonding — Outer seal without structural function

Assessment tests in conformity with Annex D and Clause 6 of ISO 20492-4 shall be carried out but amended as follows:

a) Heat exposure test, 5.1.3.2 of ISO 20492-4 performed in conformity with B.2.3.3, class T3 –100 °C.

   1) UV exposure test, 5.1.3.4 of ISO 20492-4 performed in conformity with B.2.7.

   2) The test report referred to in ISO 20492-4, D.6 should be amended accordingly.

   or

b) The tests methods and specifications of B.2.2, B.2.3 and B.2.4 of this International Standard are applicable.

The test report referred to in ISO 20492-4, D.6, should be amended accordingly.

EN 1279-4:2003, D.6 may apply.

7.2.3.1.2 Bonding — Outer seal with structural function

Assessment tests in conformity with B.2.2, B.2.3 (only apply if not performed on clear glass) and B.2.4 of this part of ISO 28278 shall be carried out.

Provided the structural sealant is specifically developed and recommended by the sealant manufacturer for use in this application, the test report referred to in ISO 20492-4:2010 should be amended accordingly.

Annex D of EN 1279-4 may also apply.

7.2.3.2 Substitution of the coated glass when the coating at the edge does not require removal

First, proceed in accordance with 5.2.3 of ISO 20492-4:2010, but then carry out assessment tests in accordance with Annex D and Clause 5 amended as follows:

— Heat exposure test, 5.1.3.2 of ISO 20492-4:2010 (5.1.3.2 of EN 1279-4:2003) performed in conformity with Annex B of this part of ISO 28278.

— UV exposure test, 5.1.3.4 of ISO 20492-4, performed in conformity with Annex B of this part of ISO 28278.

Subclauses 4.2.3 and 5.1.3.4 of EN 1279-4:2003 may also apply.

The rules of extrapolation in EN 1096-2, Annex F are also applicable.

7.2.4 Possibility of substituting the outer IGU seal

First, proceed in accordance with 5.2.2 of ISO 20492-4:2010.

Subclause 4.2.2 of EN 1279-4:2003 may also apply.

Then, produce a test report that takes into account the performance of the outer seal versus its functional requirements regarding UV resistance only or UV resistance and/or structural function in conformity with B.2.2, B.2.3 and B.2.4 of this part of ISO 28278.

7.2.5 Further requirements for the outer IGU seal when in an unsupported case

In addition to the requirements specified in 7.2.1 to 7.2.4, the outer seal shall meet the following supplementary requirement:

— the mechanical properties of the outer seal shall comply with the specification corresponding to Creep Grade C1 of B.2.3.8 of this part of ISO 28278 (Displacement under permanent load).

7.2.6 Case for a façade glazed between 0° and 30° from the vertical (towards the outside) and between 0° and 7° from the horizontal

The requirements described in 7.2.5 are applicable.

7.3 Laminated glass or monolithic glass — Situation 3 (see Figure 3)

The monolithic glass shall comply with 6.1.1.

The laminated glass or laminated safety glass shall comply with the definition of laminated glass or laminated safety glass according to 6.1.10.

Each component of the laminated glass shall be supported.

7.4 Assessment of the adhesion between the sealant and the glass

7.4.1 Float glass

When the tests according to B.2.3 and B.2.4 required by this part of ISO 28278 are performed on float glass in accordance with 6.1.1, the adherence between glass and structural sealant can be extrapolated to the following glass types:

— heat strengthened soda lime silicate glass conforming with 6.1.7;

— thermally toughened soda lime silicate safety glass conforming with 6.1.8 or 6.1.9, except enamelled glass (see 7.4.3).

7.4.2 Coated glass

When tests according to B.2.3 and B.2.4 of this part of ISO 28728 are performed on one of the following glass substrates that have been coated, the adhesion between coated glass and structural sealant can be extrapolated for the rest of the glass substrates in this list:

— basic soda lime silicate glass products conforming with 6.1.1;

— heat strengthened soda lime silicate glass conforming with 6.1.7;

— thermally toughened soda lime silicate safety glass conforming with 6.1.8 or 6.1.9.

NOTE When the tests in B.2.3 and B.2.4 are performed on one identified coating, the test can apply to other coatings in accordance with Annex F of EN 1096-2.

7.4.3 Enamelled glass

When the tests according to B.2.3 and B.2.4 are performed for one delivery, the dynamic tensile/peel test on structural sealant in Annex A of ISO 28278-2:2010 is required in order to extrapolate the assessment of the adhesion to other deliveries.

NOTE See 22.4 Spandrel of ASTM C 1401-02.

7.4.4 Patterned glass

When the tests according to B.2.3 and B.2.4 are performed for one type of patterned glass, the dynamic tensile/peel test on structural sealant in Annex A of ISO 28278-2:2010 is required in order to extrapolate the assessment of the adhesion to other deliveries.

8 Design

8.1 Calculation of the thickness of the glass

The thickness of the glass is calculated in accordance with national regulations.

The glass product (thickness and types of glass components) shall ensure the resistance against wind, snow, permanent load, and other mechanical, (quasi-)static action.

The current method of determining mechanical resistance in the country of destination shall be applied, as long as no International Standard is applicable for the design of the construction or building site concerned.

8.2 Calculation of the height of the outer sealant of the IGU for supported and unsupported glazing

8.2.1 Supported IGU

8.2.1.1 Flush edge unit

The outer seal of the IGU has a structural function (see Figure 6).

The height, h, of the outer seal is given by Equation (1):

$$h = c \geq \frac{0{,}5 \cdot F \cdot s_{\mathrm{min}}}{\sigma \cdot \beta} \tag{1}$$

NOTE Minimum 6 mm.

where

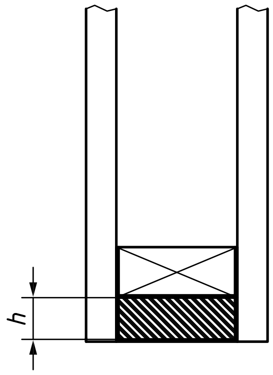
h is the height of the outer seal barrier (mm);

c is the height of sealant necessary for structural purposes: $c = (0{,}5\ p \cdot a) / (\sigma \cdot \beta)$ (mm);

σ is the allowable stress of the sealant (MPa);

β is the coefficient depending on the relative thickness of the components (Figure 7);

s_{min} is minimum dimension of glass, (mm).



Key

h height of the outer seal barrier (mm)

Figure 6 — Height of the outer seal of the IGU, with a structural function

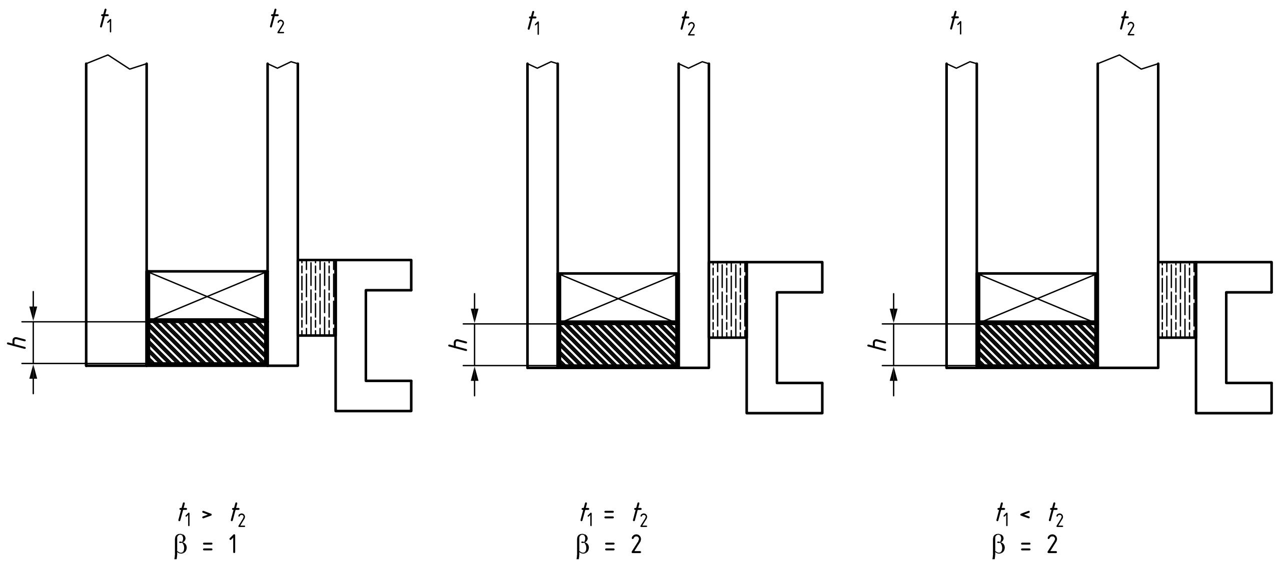
P shall be determined, for the combined loading from wind, snow and self-weight, in accordance with national standards dealing with these actions.

In CEN-member countries, wind load shall be determined according to EN 1991-1-4, and snow load shall be determined according to EN 1991-1-3. In non-CEN-member countries, the national standard may apply.

For units whose diameter or short span is < 500 mm and those with non-rectangular shapes, the climatic effect shall be taken into account.

In the United States of America, ASTM E 1300 should be used to determine glass or fabricated glass product thicknesses (ASTM C 1401-02, 22.1).

For small units and non-rectangular shapes, the climatic effect shall be taken into account.



Key

h height of the outer seal barrier (mm)

t_1 minimum glass thickness of the outermost component of an IGU (mm)

t_2 minimum glass thickness of the innermost component of an IGU (mm)

β coefficient depending on the relative thickness of the components (Figure 7)

NOTE β can be evaluated according the following document: Structural mechanics behaviour of insulating glass units, May 1986 by the Glass Research and Testing Laboratory.

Figure 7 — Coefficient β as a function of the relative thickness of the glass components

8.2.1.2 Stepped IGUs

The step, r, between both glass components is limited to: $r_o \leq 5$ T.

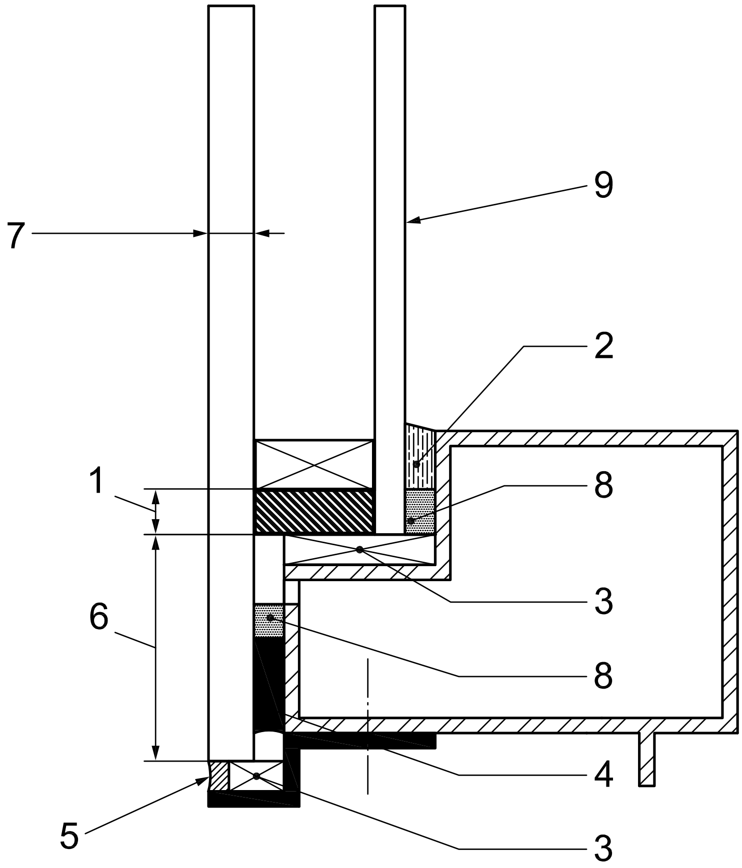
The calculation of the height, h, of the outer seal of an IGU shall vary according to whether the outermost or innermost glass of the stepped IGU is used to structurally bond the unit.

Position 1: Bonding to the outermost component

As the outermost glass is designed to withstand all climatic loads, the height, h, of the second seal barrier of an IGU will be identical to that of an IGU installed in a rebate, with a minimum height $h = 4$ mm (see Figure 8).

$$h_o = \text{e (mm)}$$

where h_o is the height of sealant expressed in millimetres, as specified in ISO 20492-2 (EN 1279-2).



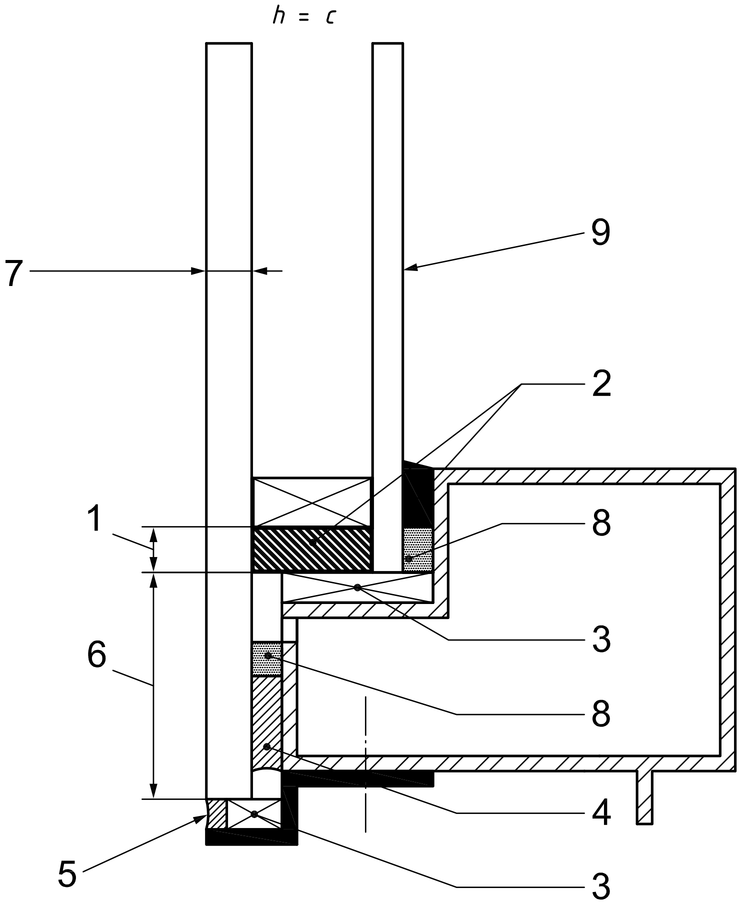
Key

1 height of the outer seal of an insulating glass unit, without structural function but UV-resistant
2 finishing material
3 setting block
4 structural seal
5 possible weather seal
6 step between both glass components (r_o)
7 outermost component
8 backer rod
9 innermost component

Figure 8 — Bonding to the outermost component

Position 2: Bonding to the innermost component

The height, h, of the outer seal of an IGU with structural function is calculated in accordance with 8.2.1.1 (see Figure 9).



Key

1 height of the outer seal with structural function and UV-resistance of an-SSG insulating glass unit (h)
2 finishing seal
3 setting block
4 structural seal
5 possible weather seal
6 step between both glass components (r_o)
7 outermost component
8 backer rod
9 innermost component

Figure 9 — Bonding to the innermost component

8.3 Calculation of the height of the outer sealant of the IGU for unsupported glazing

8.3.1 Calculation of the height regarding the relevant combined load of the wind, snow and self-weight and relevant combined load for wind, snow and self weight

8.3.1.1 Outer seal with a structural function

See 8.2.1.

8.3.1.2 Outer seal without structural function

See 8.2.1.2, Position 1.

8.3.2 Calculation of the height of the outer seal to bear the permanent shear loading

The outer seal is considered to be supported along the vertical length of the glass pane l_s.

$$h_u \geq \frac{P_u}{2 \cdot \Gamma_\infty \cdot l_s} \tag{2}$$

where

h_u is the height of the outer seal of the unsupported IGU;

P_u is the weight of the unsupported IGU;

Γ_∞ is the shear design stress value declared by the sealant manufacturer (see B.2.3.8.2);

l_s is the vertical length of the outer seal taken into account: short (a) or long (b) side of the glass pane.

In addition, when the outer seal has a structural function it is always necessary to verify that:

$$h_u \geq \frac{0{,}5 \cdot P \cdot a}{\sigma \cdot \beta} \tag{3}$$

Annex A
(informative)

Assembly requirement

A.1 Setting blocks for glass panes or IGUs

Two setting blocks are positioned under the bottom edge of the glass unit. They are used to transfer the self-weight of the glass to the structural seal support frame.

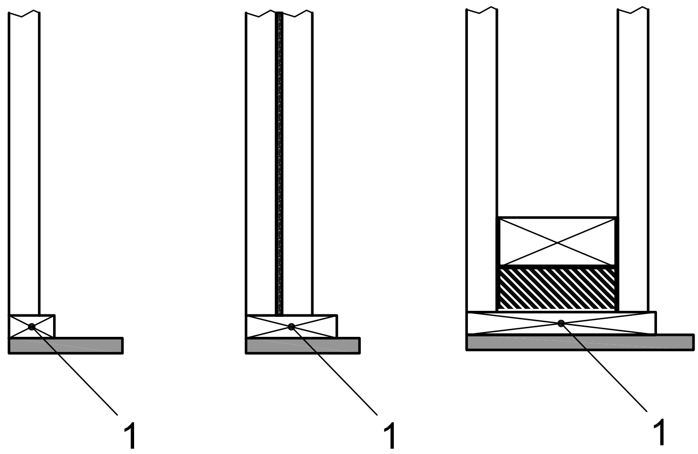
A.1.1 General case

A.1.1.1 Transverse positioning of the setting blocks

A.1.1.1.1 Setting block extending over the full thickness of the glass

In the absence of a weather seal in front of the setting block, the latter can extend over the full thickness of the glass (see Figure A.1).

Otherwise, the requirements of A.1.1.1.2 are applicable.



Key

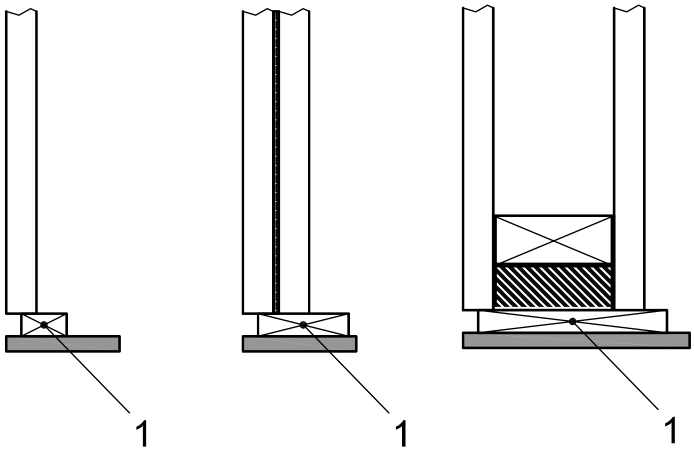
1 setting block

Figure A.1 — Transverse position of the setting block in the absence of a weather seal

A.1.1.1.2 Setting block extending to half of the glass thickness

In the case of a weather seal, monolithic glass, the outermost pane of an IGU and laminated glass may be supported over only half of its thickness provided that

- the width of the effective support for the glass unit from the setting block is at least 3 mm, which implies a minimum nominal thickness of 6 mm for the outermost glass pane (see Figure A.2), and
- the length of the setting block is doubled to take into account the resulting increase in compressive stress due to increasing glass weight.



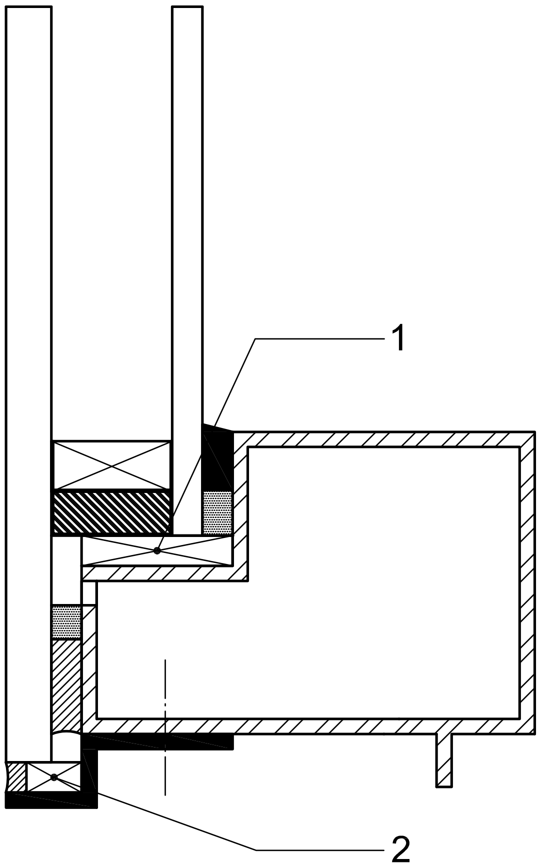
Key

1 setting block

Figure A.2 — Transverse position of the setting block

A.1.1.1.3 Setting blocks for stepped IGUs

The previous rules for setting blocks described above also apply in this case. The use of adjustable setting blocks should take these rules into account (see Figure A.3).



Key

1 setting block

2 adjustable setting block

Figure A.3 — Positioning of setting blocks in the case of stepped IGUs

A.1.1.2 Longitudinal positioning of setting blocks

Setting blocks should be positioned according to the type of frame. No more than two setting blocks should be used at the bottom edge of the glass in the case of fixed glazing. The minimum distance between the corner of the frame and the nearest edge of the block should be the length of a setting block and never less than 50 mm.

A.1.1.3 Length of setting blocks

Setting blocks should be positioned according to the type of frame. No more than two setting blocks should be used at the bottom edge of the glass in the case of fixed glazing. The minimum distance between the corner of the frame and the nearest edge of the block should be the length of a setting block and never less than 50 mm.

A.1.2 Supporting the self-weight of monolithic glass

For monolithic glass, the weather seal may be used as a setting block as long as its mechanical properties and intrinsic durability are equivalent to those of the structural seal (see Figure A.4).

The weather seal should have attained its nominal strength characteristics before being subjected to loading.

Dimensions in millimetres

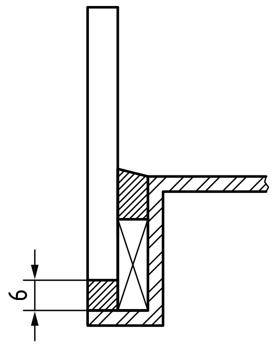


Figure A.4 — Setting block for monolithic glass

A.2 Supported glass with outside weather seal

When the glass is supported and has a weather seal, the nominal minimum glass thickness must never be less than 6 mm and must always be supported on setting blocks for at least half of its thickness. When an external weather seal is used for SSG, the minimum thickness for the weather seal shall be 3 mm. If the glass thickness is increased, the setting block width must be increased to support at least half the thickness of the glass but at the same time must not reduce the weather seal thickness to below 3 mm (see Figure A.5).

Key

1 setting block
2 weather seal
3 mechanical support

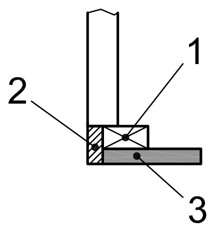


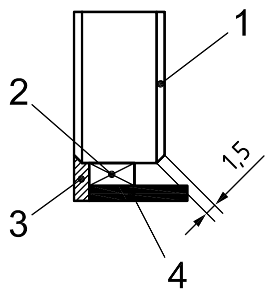
Figure A.5 — Minimum glass thickness when setting blocks extend to half the thickness

A.3 Supported glass with worked edges and weather seal

The edges of the glass should be as near to perpendicular to the faces as is practical.

The maximum edge arris dimension for the glass should be 1,5 mm (see Figure A.6).

Dimensions in millimetres



Key

1 edge arris

2 setting block

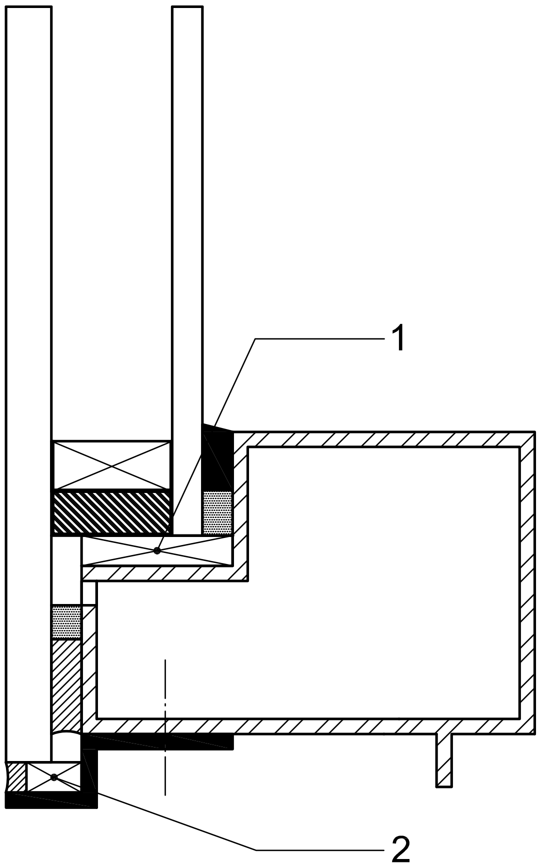
3 weather seal

4 mechanical support

Figure A.6 — Supported glass with outside weather seal

A.3.1.1.1 Setting blocks for stepped IGUs

The previous rules for setting blocks described above also apply in this case. The use of adjustable setting blocks should take these rules into account (see Figure A.7).



Key

1 setting block

2 adjustable setting block and/or mechanical support

Figure A.7 — Positioning of setting blocks in the case of stepped IGUs

A.3.1.2 Longitudinal positioning of setting blocks

Setting blocks should be positioned according to the type of frame. No more than two setting blocks should be used at the bottom edge of the glass in the case of fixed glazing. The minimum distance between the corner of the frame and the nearest edge of the block should be the length of a setting block and never less than 50 mm.

A.3.1.3 Length of setting blocks

Setting blocks should be positioned according to the type of frame. No more than two setting blocks should be used at the bottom edge of the glass in the case of fixed glazing. The minimum distance between the corner of the frame and the nearest edge of the block should be the length of a setting block and never less than 50 mm.

A.3.2 Supporting the self-weight of monolithic glass

For monolithic glass, the weather seal may be used as a setting block as long as its mechanical properties and intrinsic durability are equivalent to those of the structural seal (see Figure A.4).

A.4 Water drainage from the system

In addition to the normal practice of drainage, the SSG system should be designed to keep the structural sealant free from stagnant water. The façade should be designed to prevent water from collecting in the vicinity of the structural bond.

Annex B
(normative)

Structural and/or ultraviolet (UV) resistant sealant (for use with structural sealant glazing and/or IGUs with exposed seals)

B.1 Sealant

B.1.1 General

For conformity purposes, the sealant manufacturer shall describe the product in a product description, which will be part of the factory production control documentation, or of the quality assurance system.

Disclosure of the product description is entirely at the discretion of the sealant manufacturer or his agent.

The product description shall contain at least a normative part, and may contain an informative part when the manufacturer foresees further development of the product.

The product description shall be prepared under the responsibility of the sealant manufacturer or his agent.

When the bonding of sealant is tested on a substrate that is not a glass material (i.e. a metallic coating on glass), the non-glass substrate (in this case the metal coating), its treatment and its preparations for bonding, as applied or to be applied for the work, shall be used in testing.

B.1.2 The compulsory part of the product description

The compulsory part of the description consists of three sub-parts:

a) the component description:

- name and/or type of the sealant, whether it concerns a mono- or a multiple- component sealant;
- in the case of a multiple-component sealant, the mixing ratio and the tolerances of the mixing ratio within which the performances of the characteristics and properties which do not change significantly;

b) the initial cure information:

- relevant data (or figure or values) depending on the temperature and the relative humidity, the chemistry of the curing system, number of components, mixing ratio and tolerances, section of the sealant to be applied, and the nature of the adhesion surfaces;

c) the cured sealant description:

- a list of identification test results in accordance with B.2.2 in order to ensure no significant change in the characteristics, properties and durability of the sealant.

The definition of product families shall be consistent with the normative part of the product description.

The substitution of raw materials or any change in the process shall maintain the conformity with the product description. The substituting material can be added to the product family and also to the product description when compliance has been demonstrated.

B.2 Requirements

B.2.1 General

B.2.1.1 Identification

Sealant shall be identified by the trade name and by the tests referred to in B.2.2.

Intrinsic properties shall be identified according to B.2.3.

B.2.1.2 Application

The sealant shall be applied in conformity with the manufacturer's recommendations.

B.2.2 Identification tests

B.2.2.1 General

All tests of B.2.2, except B.2.2.4, are carried out on cured products. When no curing time has explicitly been stated by the sealant manufacturer, a curing time of at least 28 days at (23 ± 2) °C and (50 ± 5) % RH shall be maintained.

The identification test performances are independent of the production equipment used, provided that a factory production control in accordance with Annex E is followed.

B.2.2.2 Thermogravimetric analysis

The test shall be carried out in accordance with ISO 11358-2, non-oxidative condition, temperature slope 10 °C/min.

After conditioning/curing: (23 ± 2) °C, (50 ± 5) % RH, 28 days.

Number of test pieces: 1.

Evaluation:

— curve and the first derivate of the curve;

— TG: the percentage of cumulative losses up to 900 °C;

— DTG: the zones of maximum loss through volatilization;

— DTA: exothermic or endothermic conversion zones.

NOTE TG = Thermogravimetric Analysis;

DTG = Derivative Thermogravimetry;

DTA = Differential Thermoanalysis.

Evaluation: after complete curing, each value shall be within the minimum and maximum value declared by the sealant manufacturer.

B.2.2.3 Specific gravity

Determination of the specific mass shall be carried out in accordance with ISO 1183-1:2004, Method A.

Test samples shall be taken from

— cured product,

— non-cured product (mono component sealant),

— components (multiple component sealant).

Number of test pieces per test sample: 3.

Evaluation: after complete curing, each value shall be within the minimum and maximum value declared by the sealant manufacturer.

B.2.2.3.1 Hardness Type A

Measurement of the hardness type A shall be carried out in accordance with ISO 868:2003.

The test time shall be 3 s and every sample shall be taken five times.

The measurement shall be carried out on three test pieces after full curing of the sealant.

The number of test specimen shall be three.

Evaluation: after complete curing, each value shall be within the minimum and maximum value declared by the sealant manufacturer.

B.2.2.4 Change in volume or shrinkage

The aim of this test is to evaluate the degree of change of volume or shrinkage of the structural sealants to limit the initial stresses in the SSG joints.

The test shall be carried out in accordance with ISO 10563:2005.

The number of test pieces shall be three.

Evaluation: average change in volume shall not exceed 10 %. After complete curing, each value shall be within the minimum and maximum value declared by the sealant manufacturer.

B.2.2.5 Elemental analysis

Elemental analysis shall be carried out to evaluate the relative concentration of C, Ca, Si, Sn and Ti.

Evaluation: the measured concentration shall be reported, highlighting the relevant characteristics. After complete curing, each value shall be within the minimum and maximum value declared by the sealant manufacturer.

B.2.3 Intrinsic properties

B.2.3.1 General

When determining these properties, the tests are to be carried out on test pieces according to this subclause.

The rigidity modulus, breaking stress, X, and strength, $R_{u,5}$, are defined in Annex C.

The intrinsic properties are independent of the production equipment used, provided that a factory production control in accordance with Annex E is followed.

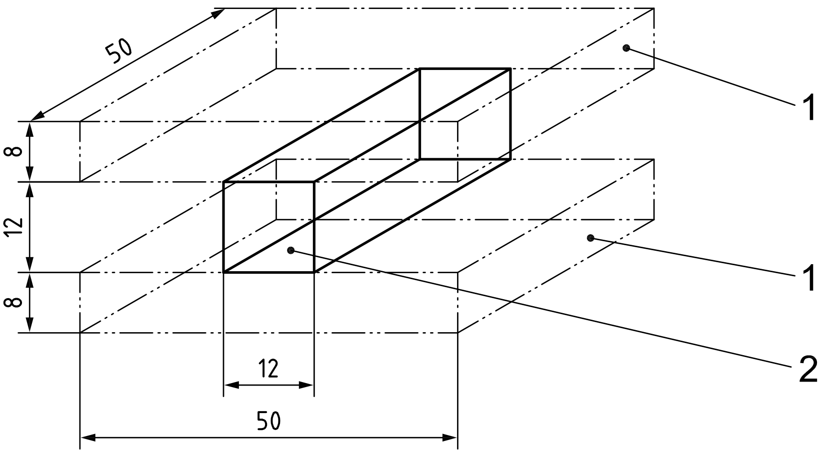
B.2.3.2 Standard substrates and test pieces

Alternative 1

Float glass manufactured in accordance with 6.1.1 is to be used as the standard glass substrate.

Unless otherwise specified in this part of ISO 28728, test pieces are to be used with the dimensions given in Figure B.1. Substrate dimensions may be different from those given in Figure B.1. The dimensions of the sealant joint, however, shall always be 12 mm × 12 mm × 50 mm.

Dimensions in millimetres



Key

1 float glass

2 sealant

Figure B.1 — Standard test piece

Unless otherwise specified in this part of ISO 28728, the test pieces shall be conditioned for 28 days at (23 ± 2) °C and (50 ± 5) % RH, or in conformity with the specification given by the sealant manufacturer.

The stresses are given in MPa by the ratio of the breaking force in N and the initial cross-sectional area in mm^2.

Alternative 2

Assembly of the test specimen and conditioning shall be carried out in accordance with 6.1 of ASTM C 1135-00.

B.2.3.3 Tensile

Alternative 1

Tests are carried out in conformity with EN 28339, Conditioning A.

Pulling of the test pieces is carried out at the following temperatures:

— for class T1: −20 °C, +23 °C, +80 °C;

— for class T2: −40 °C, +23 °C, +80 °C (for cold climates);

— for class T3: +23 °C, +100 °C (for hot climates).

Number of test specimens: 10 for each temperature.

Evaluation:

a) General:

Visual examination: rupture shall be ≥ 90 % cohesive.

b) Sealant for structural purposes:

Criteria:

— Minimum values of $\Delta\bar{x}$ and $R_{u,5}$ are given in Table B.1;

— Rupture shall be ≥ 90 % cohesive.

Table B.1 — Criteria for sealant for structural purposes

	Criteria
Class T1:	
80 °C	$\Delta\bar{x} \geq 75$ %
23 °C	$R_{u,5} \geq 0{,}5$ MPa
−20 °C	$\Delta\bar{x} \geq 75$ %
Class T2:	
80 °C	$\Delta\bar{x} \geq 75$ %
23 °C	$R_{u,5} \geq 0{,}5$ MPa
−40 °C	$\Delta\bar{x} \geq 75$ %

where $\Delta\bar{x} = \bar{x}_{0°C} / \bar{x}_{23°C}$.

NOTE $\bar{x}$ is defined in Annex C.

From the stress-at-elongation graph recorded, the following values shall be noted:

— type of failure (cohesive or adhesive);

— stress at elongations of 5 %, 10 %, 15 %, 20 % and 25 %;

— stress and elongation at rupture, only for test specimens conditioned at +23 °C;

— secant stiffness at 12,5 %, K12,5 (see C.2).

c) Sealant for use for non-structural IGU seals:

— For strength and elongation criteria, see EN 1279-4.

Alternative 2a:

— Standard conditions: Procedure, calculation and report shall be carried out in accordance with Clause 8 of the ASTM C 1135-00:2005.

— Test at high temperature, at low temperature, after immersion. The procedure shall be carried out in accordance with 8.6.1, 8.6.2, and 8.6.2.1 to 8.6.2.4 of ASTM C 1184-00:2000 a1.

Requirements: in accordance with ASTM C 1184-00a1:

- Standard conditions 345 kPa
- 88 °C 345 kPa
- –29 °C 345 kPa
- Water immersion 345 kPa
- 5 000 h, QUV 345 kPa

Alternative 2b:

- Standard conditions: Procedure, calculation and report shall be carried out in accordance with Clause 8 of the ASTM C 1265-94:2005.
- Test at high temperature, at low temperature, after immersion. The procedure shall be carried out in accordance with 8.1.6 of ASTM C 1369-07:2007.

Requirements in accordance with ASTM C 1369-07:

- Standard conditions 345 kPa
- 88 °C 345 kPa
- –29 °C 345 kPa
- Water immersion 345 kPa

B.2.3.4 Shear at 23 °C

Alternative 1:

Tests are carried out in conformity with Annex D.

Direction of force: longitudinal.

Number of test specimens: 10.

Pulling of the test pieces shall be at the following temperatures: –20 °C, +23 °C, +80 °C.

For cold areas: –40 °C, +23 °C, +80 °C.

Evaluation: Shear displacement.

Criteria identical to B.2.3.3.

Alternative 2:

Tests are carried out in conformity with Annex D.

Direction of force: longitudinal.

Number of test specimens: 10.

Pulling of the test pieces at the following temperatures: –20 °C, +23 °C, +80 °C.

For cold areas: −40 °C, +23 °C, +80 °C.

Evaluation: Shear displacement.

Criteria identical to B.2.3.3, Alternative 2.

B.2.3.5 Elastic recovery

The purpose of the test is to evaluate the elastic recovery behaviour and consequently the relaxation behaviour after long-term loading.

The test is carried out in accordance with ISO 7389 or EN 27389, with a load to give 25 % elongation (= 125 % of original length).

Record the following:

— initial stress and elongation;

— final stress and elongation;

— elongation after unloading the test pieces.

Number of test specimens: 3.

Evaluation: forsealant for structural purposes, the average of the elastic recovery shall be at least 95 %.

B.2.3.6 Tear strength

Alternative 1:

The aim of this test is to establish the mode of propagation of a cut in the structural sealant.

Five test pieces are prepared as specified in B.2.3.2.

After curing, the test pieces are cut at the ends of the sealant, as shown in Figure B.2.

The samples are tested to destruction in accordance with B.2.3.3 and EN 28339 at a temperature of: 23 °C ± 2 °C.

Number of test pieces: 5.

Evaluation: The average tear breaking strength value shall be as follows:

— when inserted in the structural seal (e.g. mechanical self-weight support, safety devices, other elements as relevant):

  at least 0,75 times the average value as measured by B.2.3.3 at 23 °C: $\Delta\bar{x} > 0{,}75$

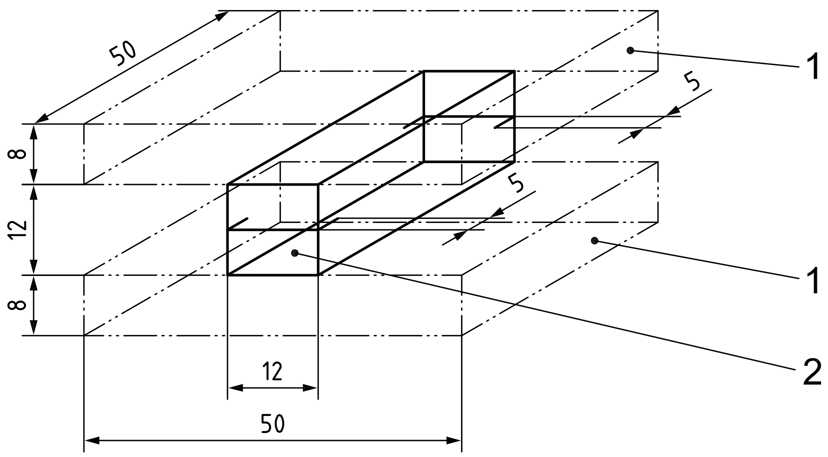
— without insertion in the structural seal:

  at least 0,50 times the average value as measured by B.2.3.3 at 23 °C: $\Delta\bar{x} \geq 0{,}50$

Rupture shall be at least 90 % cohesive,

where $\Delta\bar{x} = \bar{x}_{\text{tear}}/\bar{x}_{23\ °\text{C}}$.

Dimensions in millimetres



Key

1 float glass

2 sealant with 5 mm deep incisions at the extremes

Figure B.2 — Test specimen for the tear strength test

Alternative 2:

Alternative 2 has the same test requirements as Alternative 1 above except that the strength of the specimens must be greater than 75 % of 345 kPa (239 kPa).

B.2.3.7 Mechanical cyclic load

The purpose of this test is to evaluate the effect of fatigue stresses on the residual mechanical strength of the sealant bond.

Test specimens are subjected to repetitive tensile loads with a cycle time of 8 s (see Figure B.3):

— 100 times from $0{,}1\sigma_{des}$ to the design stress, σ_{des};

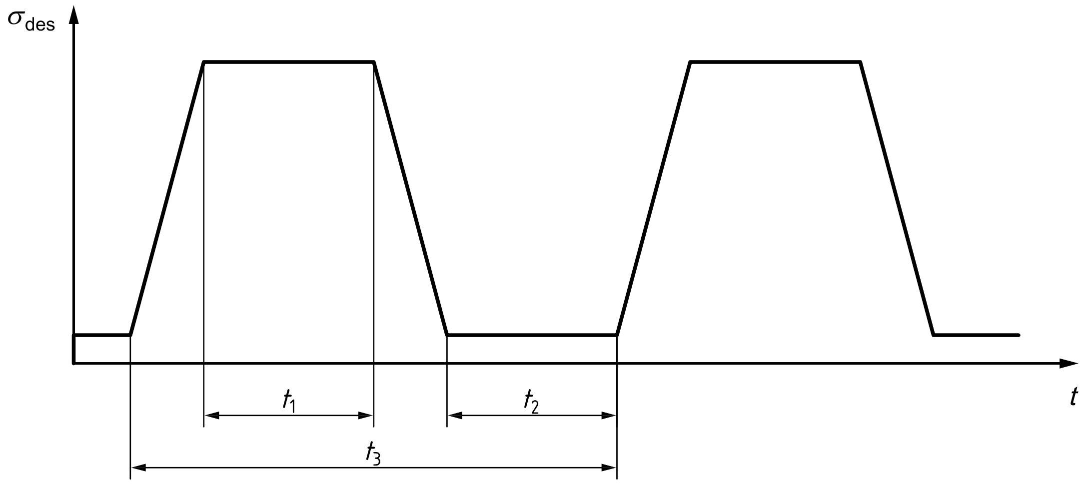
— 250 times from $0{,}1\sigma_{des}$ to $0{,}8 \times$ the design stress, σ_{des};

— 5 000 times from $0{,}1\sigma_{des}$ to $0{,}6 \times$ the design stress, σ_{des};

where $\sigma_{des} = \dfrac{R_{u,5}}{6}$ for Alternative 1 or σ_{des} = 140 kPa for Alternative 2. (B.1)

After 24 h conditioning at (23 ± 2) °C and (50 ± 5) % RH and after visual inspection of the sealing, the test specimen shall be subjected to a tensile test.

Number of test specimens: 10.



Key

t_1 duration of the peak load ≥ 2 s

t_2 rest time ≥ 2 s

t_3 cycle period time ≤ 8 s

Figure B.3 — Stress cycle for fatigue test

Alternative 1:

Evaluation:

- Sealant for structural purposes:
  - After the cycles, test specimens are pulled at rupture according to B.2.3.3 at 23° C.
  - Criteria: $\Delta\bar{x}$ ≥ 0,75 or, if Alternative 2 is used, $\Delta\bar{x}$ ≥ 259 kPa.
  - Rupture shall be ≥ 90 % cohesive.
- Outer seal of the IGU without structural function:
  - For strength and elongation criteria, refer to EN 1279-4.

Alternative 2:

Evaluation:

- Sealant for structural purposes:
  - After the cycles, test specimens are pulled at rupture according to B.2.3.3 at 23° C.
  - Criteria: $\Delta\bar{x}$ ≥ 345 kPa.

B.2.3.8 Displacement under permanent shear load (creep test)

B.2.3.8.1 Purpose of the test

This test is applicable to sealant intended for structural purposes and under permanent shear load.

B.2.3.8.2 Creep factor — Definition and requirements

Alternative 1:

Factor γ_c by which the shear design stress under dynamic load Γ_{des} shall be divided to obtain a permanent shear design stress Γ_∞ for which no creep is measurable, or

$$\Gamma_\infty = \frac{\Gamma_{des}}{\gamma_c} \text{ with } \gamma_c \geq 10 \text{ for Alternative 1 and } \Gamma_{des} = 140 \text{ kPa for Alternative 2} \tag{B.2}$$

The value of Γ_∞ declared by the manufacturer.

The value of $\Gamma_{des} = R_{u,5}/6$.

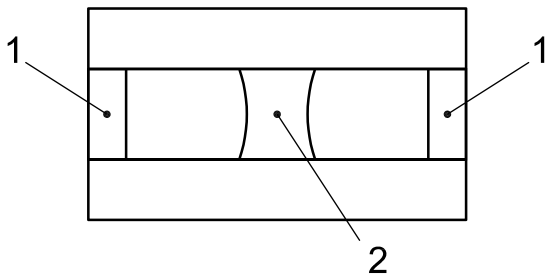
The value of $R_{u,5}$ declared by the manufacturer and verified in accordance with B.2.3.3.

Alternative 2:

When tested according to Alternative 2, the value of Γ_∞ shall be no more than 7 kPa.

B.2.3.8.3 Test specimen

The test specimen shall conform with Figure B.4. The sealant height, h, shall be declared by the sealant manufacturer for the test, with a minimum value of 12 mm for the outer seal of an IGU with structural function.



Key

1 spacer to maintain the extension

2 structural sealant (height, h, to be declared by the sealant manufacturer)

NOTE Glass thickness is 8 mm and glass size is 20 mm× 20 mm.

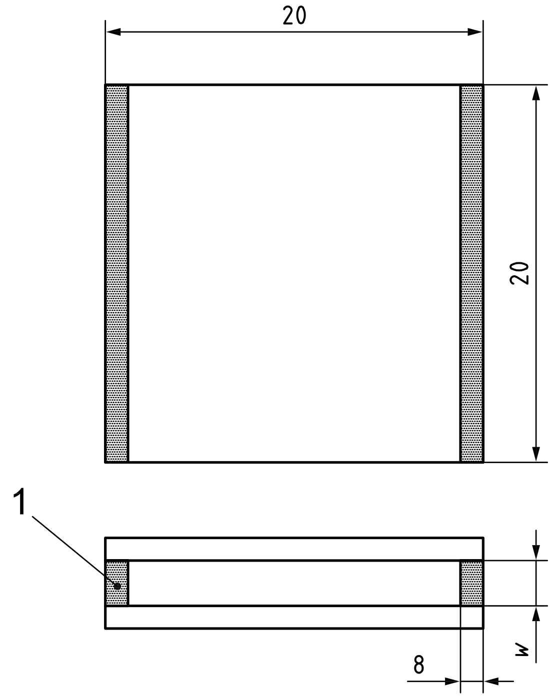
Figure B.4 — Creep test specimens for structural purposes

B.2.3.8.4 Test procedure

Manufacture enough test specimens to select three for the test and keep some for spares, and store them all for 28 days at a temperature of (23 ± 2) °C.

Install three test specimens in the creep installation and place it in a climatic chamber with a temperature of (23 ± 2) °C and a relative humidity of (50 ± 5) %.

Dimensions in millimetres



Key

1 structural sealant

NOTE 1 Glass thickness is 8 mm and glass size is 20 × 20 mm.

NOTE 2 Structural sealant height, h, to be declared by sealant manufacturer.

Figure B.5 — Load arrangement for creep measurement

The validity of the test result is valid up to the tested value w.

The creep installation (see Figure B.5) subjects the test specimens for 91 days simultaneously to:

— a tensile loading of: $F_{t,i} = 2\,400 P_{t,i}$

where

$P_{t,i} = 0{,}3 \times \sigma_{des}$ for 91 days;

$$\sigma_{des} = \frac{R_{u,5}}{6} \text{ for Alternative 1 or } \sigma_{des} = 140 \text{ kPa for Alternative 2} \quad \text{(B.3)}$$

$R_{u,5}$ is determined for structural purposes in accordance with B.2.3.4 at 23°C;

— a permanent shear loading of: $F_s = 2\,400 \Gamma_\infty$

With Γ_∞, stress given by the manufacturer, taking into account a minimum creep factor of 10, or in the case of Alternative 2, the value of Γ_∞ shall be no more than 7 kPa.

Evaluation:

— creep evolution at 1 day, 3 days, 7 days, 10 days and then every 7 days after loading;

— deformation after 91 days before unloading;

— residual deformation 24 h after unloading.

The sealant shall be gradated in accordance with Table B.2.

Grade C1 is applicable for the value of height of the seal declared for the test and for inferior values.

Table B.2 — Vertical displacement under permanent shear load (creep) gradation of sealant

Grade C1	Grade: C2
For all test specimens: — after 91 days loading, the vertical displacement shall be stabilized at $u \leq 1$ mm — after 24 h unloading, the maximum vertical displacement is $u \leq 0,1$ mm	For all sealants that are not grade C1

B.2.3.9 Elastic modulus of the sealant

The aim of this test is to determine the calculation of the modulus E_o.

The test shall be carried out in conformity with ISO 527-3 with all the test pieces having a thickness of 2,2 mm ± 0,2 mm.

The manufacturer shall specify the modulus type to be introduced into the calculation, either tangent or secant to the origin. In the latter case, the boundaries of the curve [deformation, stress (ε_1, σ_1), (ε_2, σ_2)].

Number of test pieces: 5.

Speed of the traction: 5 mm/min.

The maximum relative elongation allowed in the calculation shall be that corresponding to the upper boundary used to determine the calculation modulus.

The test report shall contain the graphs (deformation, stress) for each sample tested.

B.2.3.10 Formation of bubbles

The aim of this test is to check the eventual formation of bubbles during and after the curing of the sealant. The test is conducted in conformity with Annex G.

Recording and evaluation: The test specimen is checked visually every week for three weeks for the possible appearance of bubbles. The generation of gas bubbles and their rate of growth shall be recorded.

Evaluation: no bubbles occurred.

B.2.4 Environmental influences

B.2.4.1 General

Alternative 1:

The method in EN 15434:2006, 5.4 shall be applied to silicone-based sealants.

The performance as a function of the environmental influences is independent of the production equipment used, provided that a factory production control in accordance with Annex E is used.

The test pieces shall be prepared as described in B.2.3.2.

B.2.4.2 Determination of cohesion/adhesion properties after exposure to artificial light through glass and water

Alternative 1:

Purpose and principle of the test

The purpose of this test is to evaluate the sensitivity of the structural sealant to artificial ageing, combining the effects of the ultraviolet radiation and exposure to water, by measuring the residual mechanical strength of the structural sealant.

Test specimens are prepared in which the sealant to be tested adheres to two parallel glass surfaces. After submitting the test specimens to a permanent artificial light at elevated temperature and to water, the test specimens are extended at rupture.

Description of test specimen

The test pieces are prepared as defined in B.2.3.2, with the following changes:

— at least one substrate of the test piece used as a standard glass substrate complies with 6.1.1;

— the thickness of the float glass exposed to UV radiation is nominal 6 mm;

— when the test piece is made with two different substrates (including float glass nominal 6 mm), the upper part of the test piece exposed to UV is the float glass substrate.

Number of test pieces: 10 for initial conditioning and 10 for conventional conditioning.

Conditioning:

— Initial conditioning:

  The test specimens shall be conditioned for 28 days at (23 ± 2) °C and (50 ± 5) % RH, or in conformity with the specification of the sealant manufacturer;

— Conventional conditioning:

  After initial conditioning, test specimens shall be immersed in demineralised water (resistance shall be less than 10 MΩ < 30 µS) at a controlled temperature of (45 ± 1) °C.

The upper glass surface shall be flush with the water level.

During the total time of the immersion (1 008 h), the test specimens are exposed to the radiation from Osram Vitalux[1] lamps. The intensity of the radiation on the upper side of the test specimen shall be (50 ± 5) W/m^2 for the wavelength range from 300 nm to 400 nm.

After the 1 008 h of exposure, the test specimens shall be conditioned at (23 ± 3) °C during (24 ± 2) h, followed by destructive tensile testing.

Tensile testing

The 20 test pieces are submitted to a destructive tensile testing at a speed of (5,5 ± 0,5) mm/min.

1) Osram Vitalux is a trade name. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Record the following:

- stress at breaking point;
- elongation at breaking point;
- type of rupture.

Specifications:

- Sealant for structural purposes:
  - The stress at the breaking point as measured in accordance with B.2.3.3 at +23 °C: $\Delta\overline{x} \geq 0{,}75$.
  - The secant stiffness (or rigidity modulus) must be as follows: $0{,}5 \leq K_y/K_x \leq 1{,}10$ (with $0 \leq x\ \% \leq 12{,}5$ of the deformation/stress curve). See C.2.
  - Rupture ≥ 90 % cohesive.
- Sealant for use for non-structural IGU seals (if relevant):
  - For strength and elongation criteria, refer to the requirements in EN 1279-4.

Alternative 2:

5 000 hrs accelerated aging in accordance with ASTM C 1442.

Test method and requirements in accordance with ASTM C 1184-00:2000, 8.6.2.5 and Table 1 or ASTM C1369-07:2007 8.1.6 and Table 1.

B.2.4.3 Salt spray

Conditioning of the test pieces is carried out in accordance with ISO 9227:2006 or ASTM B 117.

Atmosphere NSS is maintained for 480 h for uncoated glass and glass coated on face 4 (and other substrates), and for 240 h for glass coated on faces 2 and 3.

Number of test specimens: 5.

Evaluation:

Alternative 1:

- Sealant for structural purposes:
  - the stress at the breaking point as measured in accordance with B.2.3.3 at +23 °C: $\Delta\overline{x} \geq 0{,}75$;
  - rupture ≥ 90 % cohesive.

Alternative 2:

- Sealant for structural purposes:
  - the stress at the breaking point as measured in accordance with B.2.3.3 at +23 °C: $\Delta\overline{x} \geq 345$ kPa.

B.2.4.4 SO_2 atmosphere

The conditioning of the test pieces is carried out in accordance with ISO 3231:1993.

Corrosion test in artificial atmosphere — Salt spray test:

— atmosphere 0,20 l of SO_2;

— 20 cycles for uncoated glass, glass coated on face 4 and other supports, and 10 cycles for glass coated on faces 2 and 3.

Number of test pieces: 5.

Evaluation:

— Sealant for structural purposes:

 — the stress at the breaking point as measured in accordance with B.2.3.3 at +23 °C: $\Delta\bar{x} \geq 0{,}75$;

 — rupture ≥ 90 % cohesive.

B.2.4.5 Ozone

Conditioning and dimensioning of the test pieces is carried out in accordance with B.2.3.1 above.

Specimens are exposed to an atmosphere of ozone, maintained at 40 °C and 50 MPa pressure for 72 h, according to 9.9.1 and 9.1.3 in ASTM D 1149:2007. Specimens are allowed to equilibrate at 23 °C for 7 days before subject to testing.

Number of test specimens: 5.

Evaluation:

Alternative 1:

— Sealant for structural purposes:

 — the stress at the breaking point as measured in accordance with B.2.3.3 at +23 °C: $\Delta\bar{x} \geq 0{,}75$;

 — rupture ≥ 90 % cohesive.

Alternative 2:

— Sealant for structural purposes:

 — the stress at the breaking point as measured in accordance with B.2.3.3 at +23 °C: $\Delta\bar{x} \geq 345$ kPa.

B.2.4.6 Façade cleaning products

The test is applicable for sealant intended for structural purposes.

Immerse five test pieces for 21 days in the cleaning product(s), as recommended by the façade supplier and/or used in practice, at (45 ± 2) °C.

After immersion, remove the cleaning product with water and store the test pieces for (24 ± 4) h at a temperature of (23 ± 2) °C and (50 ± 5) % RH.

Subject the test pieces to the tensile test in accordance with EN 28339 at (23 ± 2) °C.

Evaluation:

Sealant for structural purposes:

- stress at the breaking point as measured in accordance with B.2.3.3 at +23 °C: $\Delta\bar{x} \geq 0{,}75$;
- rupture ≥ 90 % cohesive.

B.2.5 Stress at the breaking point

The stress at the breaking point shall be measured in accordance with B.2.3.3 at +23 °C: $\Delta\bar{x} \geq 345$ kPa.

B.2.6 Water vapour transmission and gas transmission

For sealant intended to be used for IGU edge seals, this information can be made available. For the determination of these properties, refer to ISO 20492-4.

B.2.7 Outer seal of IGU — Category differentiation

The category differentiation is applicable for the outer sealant of IGUs without structural function, as in Clause 5 Situation 1.

The category differentiation is based on:

- function: non-structural;
- conformity to the specifications associated with the three levels of UV exposure, A, B and C, described in the test method.

Refer to Annex F for:

- test description;
- specification;
- category differentiation.

B.3 Sealing and bonding

Sealing means that there is no structural function and exposure to UV and bonding means that there is structural function and exposure to UV.

Exposure to the UV is dependant on the situation.

Refer to Annex H for illustrations.

When the bonding of sealant is tested on a substrate that is not a glass material (i.e. a metallic coating on glass), the non-glass substrate (in this case the metal coating), its treatment and its preparations for bonding, as applied or to be applied for the work, shall be used in testing.

For details of bonding of sealant to non-glass substrates, see Annex I.

Annex C
(normative)

Evaluation of tests results

C.1 Evaluation of the characteristic values, $R_{u,5}$

For stability, the characteristic values, $R_{u,5}$, are to be determined. The following formula shall be used:

$$R_{u,5} = \bar{x} - \tau_{\alpha\beta} \cdot s$$

For 5 test specimens (n = 5) $R_{u,5} = \bar{x} - 2{,}46 \times s$ (C.1)

For 10 test specimens (n = 10) $R_{u,5} = \bar{x} - 2{,}10 \times s$ (C.2)

$$\Delta\bar{x} = \bar{x}_c \,..\, \bar{x}_o \quad \text{(C.3)}$$

where

$R_{u,5}$ is the characteristic breaking stress giving 75 % confidence that 95 % of the test results will be higher than this value;

$\bar{x}$ is the average breaking stress, under either tension or shear;

$\bar{x}_o$ is the average breaking stress, under either tension or shear in the initial state;

$\bar{x}_c$ is the average breaking stress, under either tension or shear after conditioning or ageing;

$\tau_{\alpha\beta}$ is the eccentricity of 5 % with 75 % confidence (see Table C.1);

s is the standard deviation of the series under consideration;

$$s = \left\{ \frac{1}{n-1} \sum_{i=1}^{n} \left(X_i - \bar{x} \right)^2 \right\}^{1/2} \quad \text{(C.4)}$$

where

X_i is the value of the breaking stress of the test piece i, under either tension or shear.

Table C.1 — The variable $\tau_{\alpha\beta}$ as a function of the number of test pieces (see ISO 16269-6)

Number of pieces	5	6	7	8	9	10	15	30	∞
Variable $\tau_{\alpha\beta}$	2,46	2,33	2,25	2,19	2,14	2,10	1,99	1,87	1,64

C.2 Stiffness

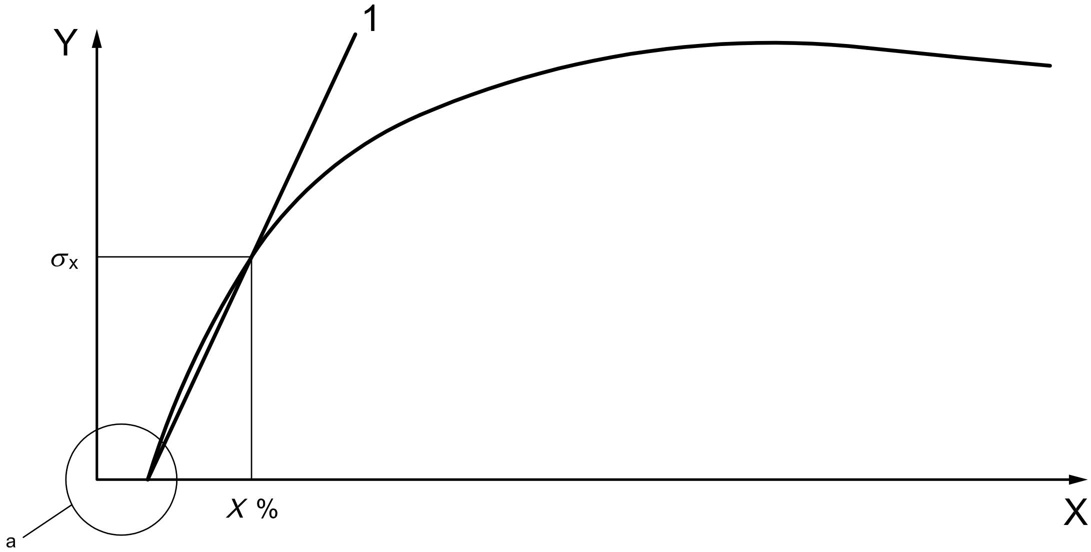
This annex describes the method of linearization for the tensile curves. It can be used for the elastic area of the material and for materials with a Poisson's ratio of approximately 0,5 (normal for sealant used in SSG). The advantages of this method are:

— higher accuracy for the modulus with a reduced number of test samples;

— verification of the relationship between the tensile, compressive and shear stiffness of the same material;

— higher reliability of the application of the calculation models.

A typical curve of deformation under tension is shown in Figure C.1. This curve shows irregularities. Given the application of a certain amount of pre-stressing, the determination of the zero point can give rise to difficulties and affect the precision of the stiffness at different elongations. An improvement can be gained by linearising the curve in the elastic area of the structural sealant.



Key

X deformation u/L_o

Y stress

1 secant stiffness

a Irregularity.

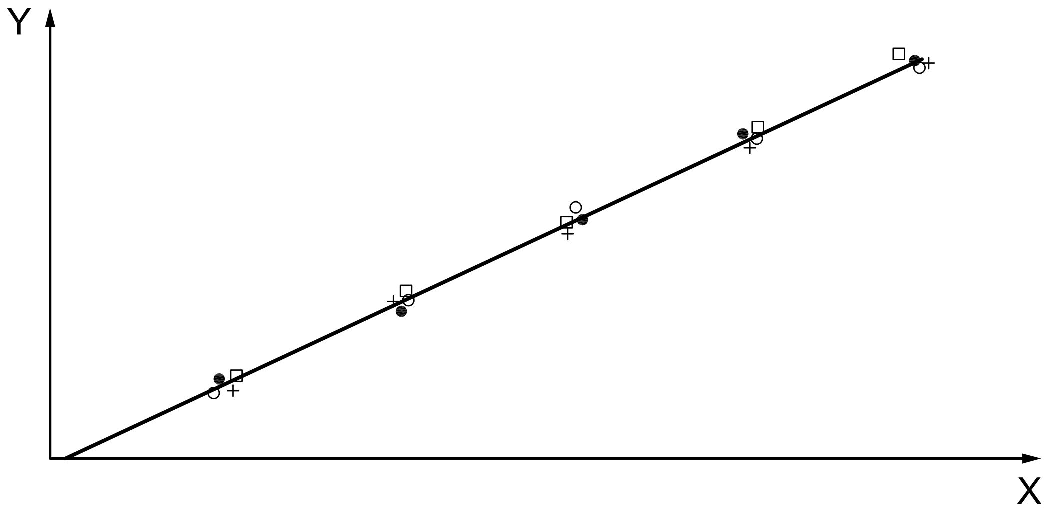
Figure C.1 — Secant stiffness

The linearization is produced by a conversion of the deformation. For an initial length (L_o) of the test piece and the length of the loaded test piece (L, where $L = L_o +$ deformation), the scale for the deformation is expressed as:

$$\frac{u_c}{L_o} = \frac{\dfrac{s_{min} - 1}{s_{min}^2}}{3} \tag{C.5}$$

where $s_{min} = L/L_o$.

When this technique is applied to several points of the curve, a converted line of regression stress/deformation is obtained, the slope of which represents the tangent stiffness (K_o) at the origin.



Key

X deformation u_c/L_o

Y stress

NOTE 4 test pieces, 5 observations per test piece.

Figure C.2 — Stress/deformation converted line of regression

K_o can be calculated directly from the measured points as follows:

$$K_o = \sum_j^m \sum_l^r \frac{K_{ij}}{m \times n} \text{ with } K_{ij} = s_{\min_{ij}} - \frac{3 \times \sigma_{ij}}{1/s_{\min}{}^2{}_{ij}}; s_{\min_{ij}} = \frac{e_i + u_{ij}}{e_i} \tag{C.6}$$

where

m is the number of observations per test piece;

n is the number of test pieces per test for the temperature concerned;

u_{ij} is the displacement under tension or compression ($e_i + u_{ij}$ represents L);

e_i is the initial thickness per test piece representing L_o;

σ_{ij} is the tensile stress at the tensile displacement u_{ij}.

The relationships between the tangent stiffness at the origin on the one hand and the secant stiffness on the other are defined and given in Table C.2.

Table C.2

Conversion of the elongation relating to tension or of the displacement relating to compression (u/L_o) to values of converted deformation (u_c/L_o)	
u/L_o values	u_c/L_o values = $\dfrac{\dfrac{s_{min}-1}{2}}{\dfrac{s_{min}}{3}}$ ($s_{min} = L/L_o$)
0	0
0,05	0,048
0,10	0,091
0,125	0,112
0,15	0,131
0,20	0,169
0,25	0,203
0,30	0,236
0,35	0,267
0,40	0,297
0,45	0,325
0,50	0,352
0,55	0,378
0,60	0,403
0,65	0,428
0,70	0,451
0,75	0,474
0,80	0,497
0,85	0,519
0,90	0,541
0,95	0,562
1,00	0,583

The relationship between the secant stiffness and the tangent stiffness at the origin is:

$$K_{sec} = K_o \, x \, (u_c / L_o) / (u / L_o)$$

Annex D
(normative)

Shear at 23 °C — Test method

Test specimens are prepared in accordance with B.2.3.2.

The pulling system is made of a static part and a mobile part which are connected to the sample holder.

This system allows for:

— the centralization (alignment) of a sample on the testing machine and maintains it throughout the duration of the test;

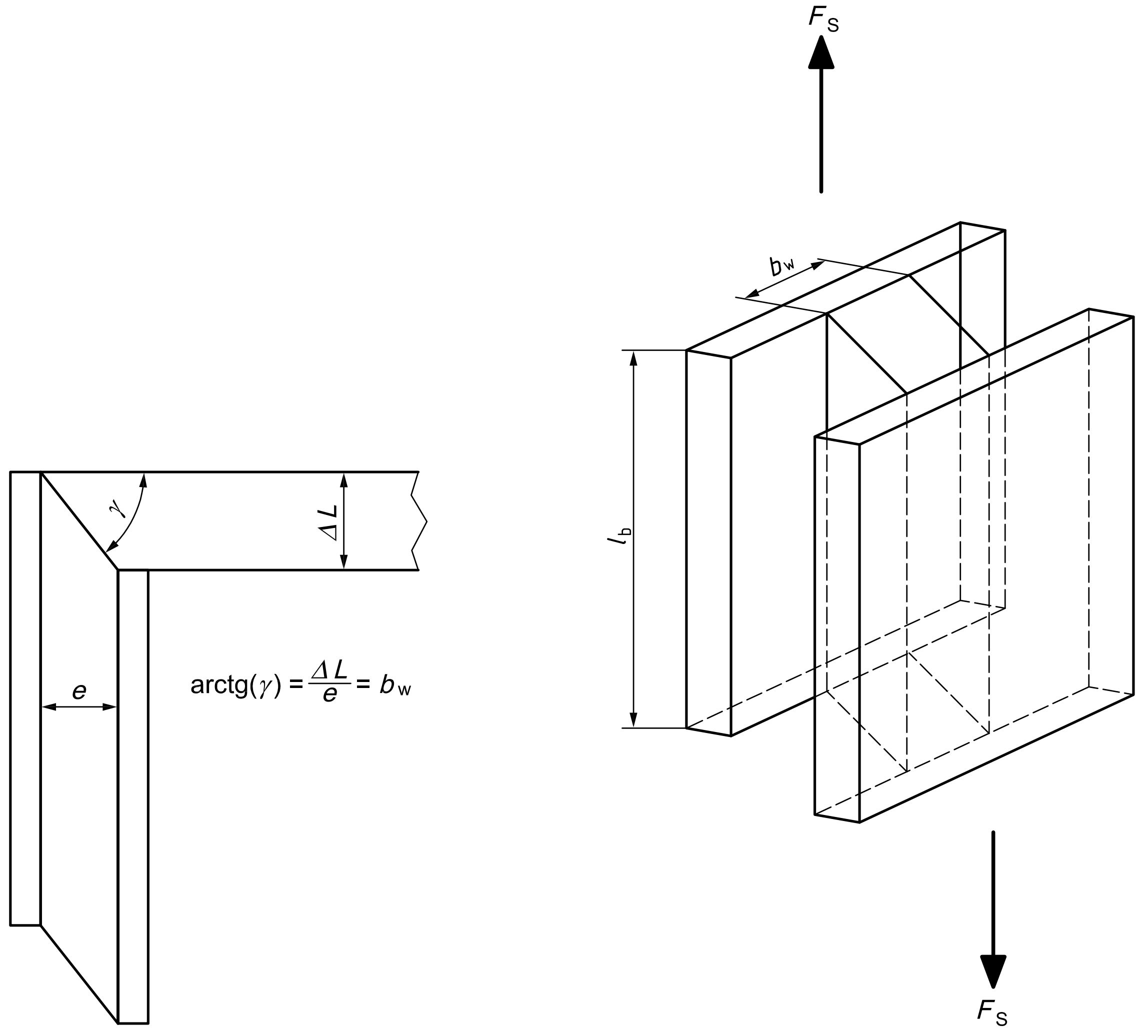
— the displacement at a constant speed of (5,5 ± 0,5) mm/min of the mobile part versus the static part;

— the accurate measurement of the force to within ±1 %;

— the accurate measurement of the relative displacement of the two parts of the testing machine to the nearest 0,1 mm;

— the recording of a stress-strain curve.

An example of such a system is shown in Figure D.1.



Key

F_s shear force

b_w width of the bead

l_b length of the bead

Figure D.1 — The pulling system — Static and mobile parts connected to a sample holder

$$\tau = \frac{F_S}{b_w \times l_b} \tag{D.1}$$

The testing method shall be such that the surfaces of the two beads stay parallel and equidistant.

Annex E
(normative)

Factory production control (FPC) requirements for sealants

E.1 General

The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results (raw and other) to control incoming materials or components, equipment, the production process and the product.

Testing shall be carried out on the clear glass substrate.

Only sealants with one or two components are taken into consideration.

NOTE An FPC system conforming to ISO 9001 and made specific to the requirements of this part of ISO 28278 is deemed to satisfy the requirements of this part of ISO 28278.

E.1.1 Organization

E.1.1.1 Responsibility and authority

The responsibility, authority and interrelation of all personnel who manage, perform and verify work affecting conformity shall be defined, particularly for personnel who have the organizational freedom and authority to:

a) initiate action to prevent the occurrence of product non-conformity;

b) identify and record any product non-conformances.

E.1.1.2 Management representative for factory production control

The manufacturer shall appoint a management representative who, irrespective of other responsibilities, shall have defined authority and responsibility for ensuring that the requirements of this part of ISO 28278 are implemented and maintained.

E.1.1.3 Management review

The production control system shall be reviewed by the manufacturer's management at appropriate intervals in accordance with the manufacturer's control system in order to ensure its continuing suitability and effectiveness. Records of such reviews shall be maintained for a minimum period of five years.

E.1.2 Control system

E.1.2.1

E.1.2.2 General

The manufacturer shall establish and maintain a documented system as a means of ensuring that the product conforms to ISO 20492-2 (or EN 13022-2) as appropriate. The following requirements shall be fulfilled.

E.1.2.3 Personnel

The manufacturer shall use appropriately trained personnel for the operation and inspection of all production and inspection equipment (see E.1.2.3).

The manufacturer's documentation and procedures shall be relevant to the production and process control of the soda lime silicate glass products, and shall be adequately described in a manual which shall include the following:

a) the organizational structure, responsibilities and authorities of management with regard to product conformity;

b) the procedures for specifying and verifying the incoming materials;

c) the manufacturing, production control and other techniques, processes and systematic actions that will be used;

d) the inspections and tests that will be carried out before, during and after production, and the frequency at which they will be carried out;

e) required records of the inspections, test and assessments;

f) non-conformity situations requiring corrective action and the action taken.

Unless otherwise indicated in national regulations, records shall be kept for a minimum of one year after manufacturing the product.

E.1.2.4 Test equipment

Calibration of test equipment necessary for factory production control shall be documented.

NOTE The precision of calibration required is implied by the accuracy of the test method and tolerances specified.

E.1.2.5 Inspection and testing

The inspections and tests are designated in Table E.1. The requirements and records shall be normative.

Frequencies shall be regarded as a minimum frequency.

E.2 Inspection and testing tables of sealant production

E.2.1 Information on Table E.1

This table consists of three sections:

— Section 1: Raw material control;

— Section 2: Production control;

— Section 3: Control on non-cured finished product.

When a manufacturing process is such that one or more of the listed inspections or tests are not applicable or physically not practical, the inspection or test concerned may be ignored. The inspections and/or tests on incoming materials shall be carried out before use.

In the case of non-conforming materials, action shall be taken in order that:

a) non-conforming raw materials cannot be used;

b) non-conforming products cannot be delivered.

The required records in Table E.1 may be any document, e.g. order documents, production documents, logbook, etc., as described in the FPC procedures and associated documentation.

For those criteria where no record is required, this situation shall apply only until a complaint regarding that criteria is received. Records shall subsequently be kept to show that corrective action has been successful.

The machinery and equipment used for manufacturing the products shall be checked at periods consistent with the manufacturer's documented process control, against defined parameters, maintained and adjusted for optimal results.

E.2.2 Use of proxy testing

A manufacturer may employ a test method/method of evaluation other than those referred to in Table E.1. However, it shall be the manufacturer's responsibility to prepare suitable documentation describing such tests and their correlation with the recommended method in order to ensure that the appropriate characteristic is as declared.

Table E.1 — Inspection and test table for UV-resistant sealant and structural sealant

Section 1: Raw material control					
Ref.	**Material, inspection or test**	**Recommended method** (decision to be made by manufacturer)	**Requirement**	**Recommended frequency** (decision to be made by manufacturer)	**Record and samples**
E.1.1	**Raw materials**				
E.1.1.1	Identification, including packaging and labelling, sampling, and testing if relevant In conformity with the quality assurance manual relating to the incoming raw material	Identification, including packaging and labelling, sampling, and testing if relevant In conformity with the quality assurance manual relating to the incoming raw material			
Section 2: Production control					
Ref.		**Recommended method** (decision to be made by manufacturer)	**Requirement**	**Recommended frequency** (decision to be made by manufacturer)	**Record**
E.2.1	**Process control**				
	In conformity with the quality assurance manual	In conformity with the quality assurance manual			
E.2.2	**Products: Part A (and B if relevant)**				
	In conformity with the quality assurance manual, e.g.:			At least 1 measurement per batch	Yes
E.2.2.1	Particle size of Part A (Basis)				
E.2.2.2	Viscosity of Part A				
E.2.2.3	Viscosity of Part B (Catalyst)				
E.2.2.4	Dispersion, de-aeration (Part A)				
E.2.2.5	Appearance, colour (Part A)				

Table E.1 (*continued*)

Section 3: Control on non-cured finished product					
Ref.	**Material, inspection or test**	**Recommended method** (decision to be made by manufacturer)	**Requirement**	**Recommended frequency** (decision to be made by manufacturer)	**Record and samples**
E.3.1	**Product Part A (and B if relevant)**				
E.3.1.1	Packaging and labelling		See purchase requirement		
E.3.1.2	Measurement in conformity with the quality assurance manual	In conformity with the quality assurance manual			
E.3.2	**Part A (Basis)**			At least 1 measurement per batch	Yes
E.3.2.1	Viscosity or pressure flow test			At least 1 measurement per batch	Yes
E.3.2.2	Specific gravity Part A	5.2.3 of EN 13022-2:2006	Initial test results	At least 1 measurement every 6 months	Yes
E.3.3	**Part B (Catalyst) if relevant**			At least 1 measurement per batch	Yes
E.3.3.1	Reactivity NCO content (for PU)	Manufacturer	Manufacturer	At least 1 measurement per batch	Yes
E.3.3.2	Viscosity	Manufacturer	Manufacturer	At least 1 measurement per batch	Yes
E.3.3.3	Specific gravity Part B	5.2.3 of EN 13022-2:2006	Initial test results	At least 1 measurement every 6 months	Yes
E.3.4	**Part A (and B if relevant)**			At least 1 measurement per batch	Yes
E.3.4.1	Work life	Manufacturer	Manufacturer	At least 1 measurement per batch	Yes
E.3.4.2	Sagging (Part A and/or mixed sealant)	ISO 7390		At least 1 measurement per batch	Yes
E.3.4.3	Hardness after 4 h (Shore A) if relevant	ISO 868		At least 1 measurement per batch	Yes
E.3.4.4	Hardness after 24 h (Shore A)	ISO 868		At least 1 measurement per batch	Yes
E.3.4.5	Tack free time and/or snap time and/or skin time	Manufacturer	Manufacturer	At least 1 measurement per batch	Yes
E.3.4.6	Initial adhesion	EN 28339		At least 1 measurement per batch	Yes
E.3.4.7	Tensile test	5.3.3 of EN 15434	Initial test results	At least 1 measurement every 10 batches or 2 production weeks	Yes
E.3.4.8	Specific gravity Part A+B (if relevant)	5.2.3 of EN 15434	Initial test results	At least 1 measurement every 6 production months	Yes

Annex F
(normative)

Outer seal of an IGU — Category differentiation

F.1 General

The purpose of this test is to evaluate the resistance of the outer seal of insulating glass **without structural function to UV exposure**, corresponding to Situation 1 of Clause 5, and to classify the sealant into three categories.

Test specimens are prepared in which the sealant to be tested adheres to two parallel glass surfaces. After submitting the test specimens to a permanent artificial light at elevated temperature and to water, the test specimens are extended at rupture.

This test is a comparative test in order to perform a category differentiation. The test specimen will be conditioned and submitted to a shear test before and after ageing. The mechanical resistance and the type of failure, after one, two or three cycles (weeks) of ageing are compared with the values of the initial shear test, allowing the classification of sealants into three categories: A, B and C.

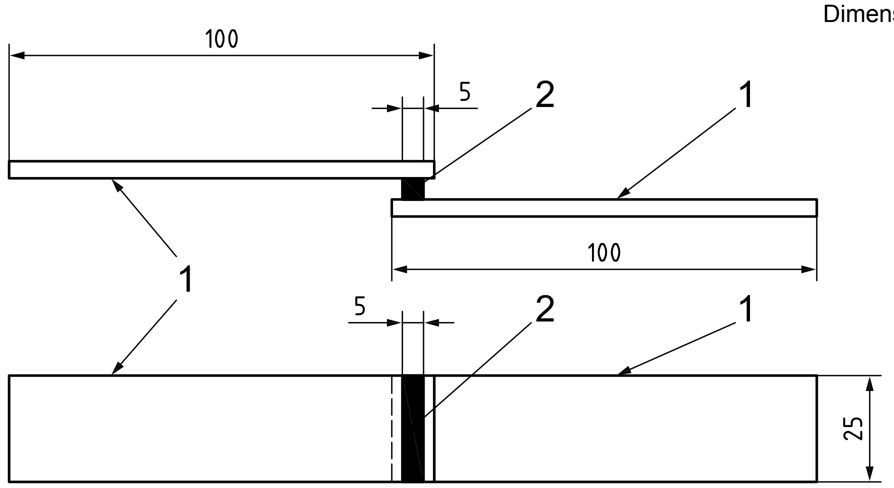
Organic-based outer sealants conforming to the specifications of level A, B or C can be used in applications with a corresponding level of **low or medium** exposure to UV.

Silicone based outer sealants conforming to the specifications of level A, B or C can be used in applications with a corresponding level of **low, medium or high** exposure to UV.

F.2 Test specimens and test samples

F.2.1 Test specimen description (see Figure F.1):

Dimensions in millimetres



Key

1 glass: 100 × 25 × 4 mm

2 sealant: 25 × 5 × 5 mm

Figure F.1 — Shear test specimen — Dimensions

F.2.2 Number of test specimens

The number of test specimens shall be as follows:

- six for the initial conditioning;
- six for each level of conditioning.

F.2.3 Conditioning

F.2.3.1 Initial

The test specimens shall be conditioned for 28 days at (23 ± 2) °C and (50 ± 5) % RH, or in conformity with the specification of the sealant manufacturer.

F.2.3.2 Conventional conditioning

After initial conditioning, test specimens conforming to F.2.1 shall be immersed in demineralized water (resistance shall be less than 10 MΩ, <30 μS) at a controlled temperature of (55 ± 2) °C.

The upper glass surface shall be flush with the water level.

During the total time of immersion, the test specimens are exposed to radiation from Osram Vitalux lamps. The intensity of the radiation on the upper side of the test specimen shall be (50 ± 5) W/m^2 for the wavelength range from 300 nm to 400 nm.

Variable times for immersion and solar radiation (one, two or three cycles/weeks) can be applied according to the intended use declared by the sealant manufacturer.

F.3 Dynamic shear testing

After one, two or three weeks of immersion and UV exposure, the test specimens shall be conditioned at (23 ± 3) °C for at least (24 ± 2) h, followed by destructive shear testing at a speed of (5,5 ± 0,5) mm/min.

F.4 Record

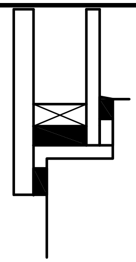
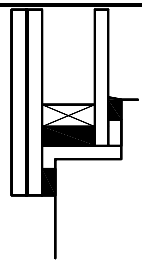
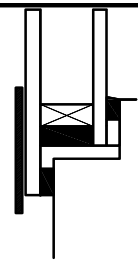
The following information shall be recorded:

- the initial shear stress and elongation at the breaking point at the initial stage and after ageing (one, two or three cycles/weeks);
- the type of failure.

F.5 Specifications and category differentiation

The specifications are given in Table F.1.

Table F.1 — Specification corresponding to levels A, B and C and category differentiation

	Outer seal			
Bonding with structural function	**Yes**	**No**		
Description	**Any kind**	 No specific protection with respect to direct UV exposure	 The type of glass product reduces the direct UV transmission	 The outer seal is protected from direct exposure to UV[b]
UV exposure	**Any**	High Amount of UV[a]: > 5 %	Medium Amount of UV[a]: 1 % to 5 %	Low Amount of UV[a]: ≤ 1 %
Type of polymer	**Silicone polymer-based sealant**		**Silicone and organic polymer-based sealants**	
Adhesion test: Alternative 1 of B.2.4.2: 1 008 h UV exposure (Xenon lamp), immersion in water at 45°C **Or Alternative 2: ASTM C 1184:2005, 8.6.2.5**	**Yes**	**No**		
Heat exposure test	**According to 5.1.3.2 of ISO 20492-4, amended: temperature raised to (100 ± 2) °C instead of (60 ± 2) °C**			
Annex F	**No**	**Yes** **Level C** **Lamp Osram** **Immersion in water at 55 °C** **504 h exposure** Specifications:[c] 1) Shear stress at break ≥ 0,30 MPa 2) Ratio (R) of stress values after/before ageing at rupture: R ≥ 50 % 3) Type of rupture: RC ≥ 80 % 4) Minimum elongation: 20 %	**YES** **Level B** **Lamp Osram** **Immersion in water at 55 °C** **336 h exposure** Specifications:[c] 1) Shear stress at break ≥ 0,20 MPa 2) Ratio (R) stress values after/before ageing at rupture: R ≥ 50 % 3) Type of rupture: RC ≥ 80 % 4) Minimum elongation: 20 % For hot-melt sealants, type of rupture: RC ≥ 90 %.	**YES** **Level A** **Lamp Osram** **Immersion in water at 55 °C** **168 h exposure** Specifications:[c] 1) Shear stress at break ≥ 0,20 MPa 2) Ratio (R) of stress values after/before ageing at rupture: R ≥ 50 % 3) Type of rupture : RC ≥ 80 % 4) Minimum elongation: 20 % For hot-melt sealants, type of rupture: RC ≥ 90 %.

[a] UV coefficient transmission according to EN 410 (UVA + UVB).

[b] Height of the UV protection coverage above the outer seal at least two times the thickness of the outer glass pane.

[c] A test report following test Alternative 1 or 2 of B.2.4.2 can be substituted for the Annex F test levels A, B and C.

Annex G
(normative)

Formation of bubbles

G.1 Purpose of the test

Check eventual formation of bubbles during and after curing of the sealant.

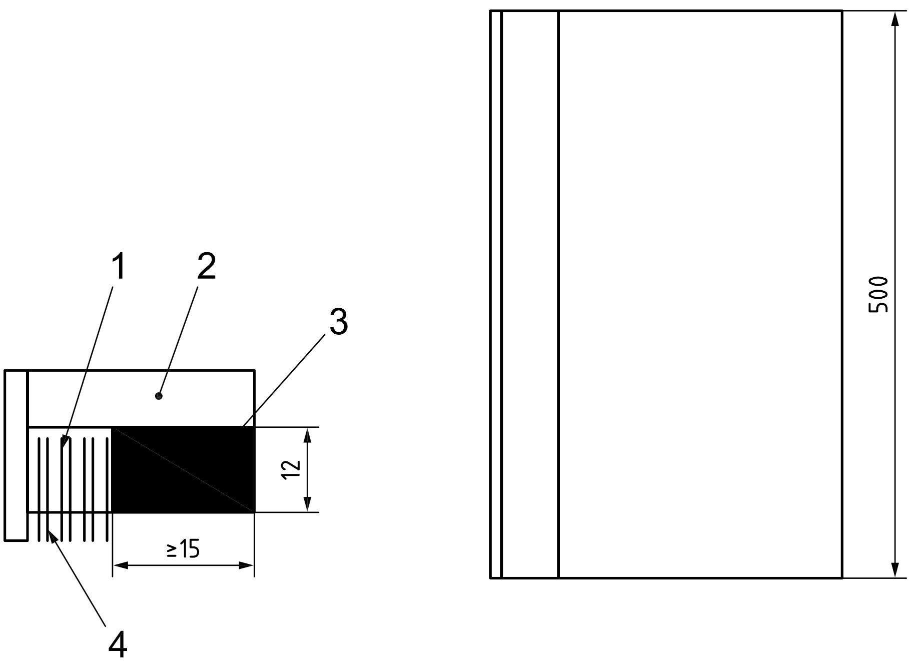
G.2 Test specimen description and conditioning

The test specimen shall be prepared as shown in Figure G.1.

One test specimen with a float glass upper face shall be prepared in accordance with the structural sealant manufacturer's specifications. The structural sealant shall fill, completely and without any air pockets, the space created between the glass and the aluminium.

The test specimen shall be stored at a temperature of (23 ± 2) °C and at a relative humidity of (50 ± 5) % for 21 days during at least 3 weeks.

Dimensions in millimetres



Key

1 spacer

2 clear glass

3 structural sealant

4 aluminium section

Figure G.1 — Sample for gas inclusion test

Annex H
(informative)

Schematic illustrations of sealing, structural bonding and UV resistance

NOTE 1 See Annex F for UV exposure.

NOTE 2 The following figures are given as examples.

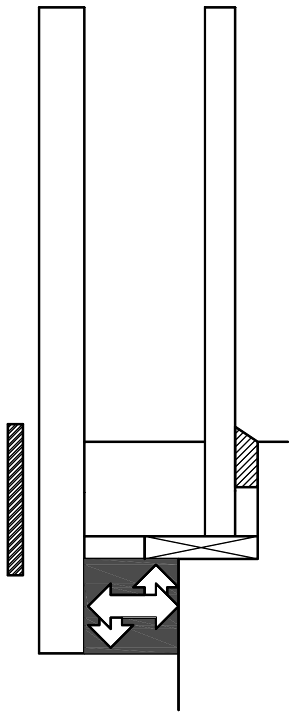


Figure H.1 — Outer seal of IGU without structural function but with UV protection with respect to UV exposure from a low level of UV loading

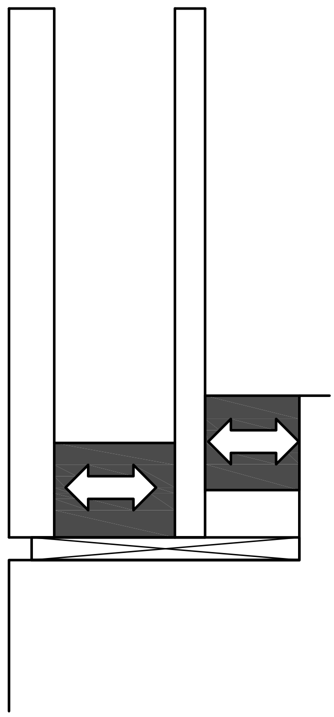


Figure H.2 — Insulating glass edge seal and bonding with structural functions — High level of UV exposure

NOTE 3 Glass that is not supported requires sealant that is resistant to permanent shear loads.

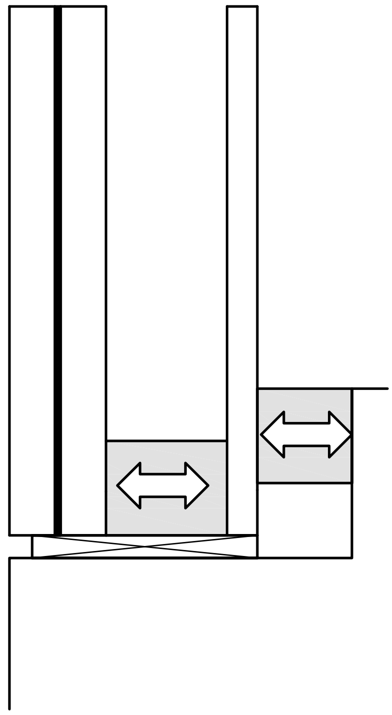


Figure H.3 — Insulating glass edge seal and bonding with structural functions — Medium-level UV loading due to presence of a UV-absorbing glass pane

NOTE 4 Glass that is not supported requires a creep-resistant sealant.

NOTE 5 Refer to Level B of Table F.1.

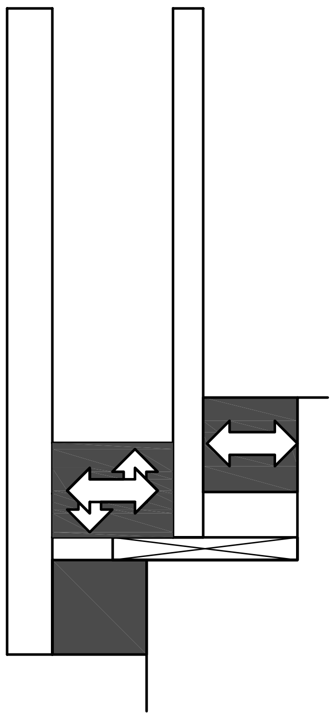


Figure H.4 — Stepped IGU — Insulating glass edge seal and inside pane bonding with structural functions — High-level UV loading

NOTE 6 Glass that is not supported requires a creep-resistant sealant.

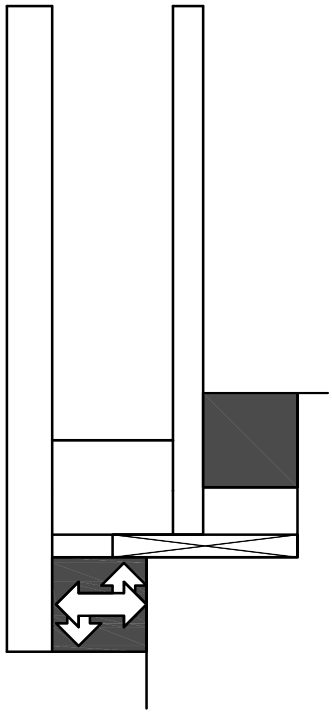
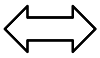
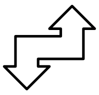


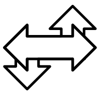
Figure H.5 — Stepped IGU — Outside pane bonding with structural function — High-level UV loading

NOTE 7 Glass that is not supported requires a creep-resistant sealant.

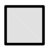
Key

 Structural function (bonding)

 Permanent shear load resistant

 Structural function structural bonding and permanent shear resistant

 Low-level ultraviolet resistance

 Medium-level ultraviolet resistance

 High-level ultraviolet resistance

Annex I
(normative)

Initial testing of the bonding of sealant to a non-glass substrate

I.1 Bonding to the coated surfaces of coated glass

For sealing or bonding on coated glass see 5.2.3 of EN 13022-1:2006.

I.2 Metals

The following is valid for anodized aluminium, coated aluminium and stainless steel. The tests are in principle the same as for the bonding of sealant to glass, but the shear test in B.2.3.4 is not requested.

I.3 Test specimens

Test specimens shall conform to Figure B.1. However, one glass substrate of the test samples shall be replaced by the relevant metal substrate, i.e. the metal, its treatment and its preparations for bonding as applied or to be applied for the work.

When the metal substrate does not have the correct dimensions or shape, other dimensions and shapes are allowed as long as the sealant dimensions are ensured. When that is the case, the relevant clamp of the tensile equipment shall be adapted.

I.4 Description of the material

The material description shall contain:

— metal or metal alloy;

— surface condition or treatment;

— preparation of the surface for bonding, including cleaning process, cleaning materials, primer(s), primer process;

— type of sealant.

I.5 Mechanical strength and adhesion — Initial testing

The following initial testing shall be performed:

— water exposure in accordance with B.2.4.2. (test specimens are placed with the glass exposed to the artificial light source);

— salt spray test in accordance with B.2.4.3;

— SO_2 atmosphere test in accordance with B.2.4.4;

- façade cleaning products in accordance with B.2.4.6 (when relevant);
- high temperature test in accordance with B.2.3.3, class T3: 100 °C;
- compatibility with adjacent material in accordance with ISO 28278-2:2010, Annex E (when relevant).

I.6 Test report

The test report shall evaluate the test results in detail and summarise the results.

I.7 Initial testing of specific projects

When the type of metal for the framework is known for a specific project, and information of its surface condition and the preparation for bonding is available, that information together with the test results may be used for other works using the same metal framework, surface condition, preparation for bonding and the sealant concerned.

When no test report is available, proceed according to I.4 and I.5.

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[4] ISO 9001:2008, *Quality management systems — Requirements*

[5] ISO 9002, *Quality systems — Model for quality assurance in production, installation and servicing*

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[31] EN 28339, *Building construction — Jointing products — Sealants — Determination of tensile properties*

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[34] JIS R 3204, *Wired glass*

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