

# Information sheet

## “Glass and acrylic glass”

This information sheet is jointly  
agreed upon by

Deutsche Messe AG Hannover  
KölnMesse GmbH  
Leipziger Messe GmbH  
Messe Berlin GmbH  
Messe Dusseldorf GmbH  
Messe Frankfurt GmbH  
Messe München GmbH  
NürnbergMesse GmbH

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# Information sheet

## “Glass and acrylic glass” (continued)

### 1. Area of applicability

This information sheet discusses the regulations concerning the use of glass in stand construction and design inside trade fair halls. It does not apply to stand construction and design outside trade fair halls.

Glass construction which has received general construction approval (including the European Technical Approval ETA) may be used in all cases in exhibition halls in accordance with the wording of the approval. This information sheet does not impose restrictions on its use.

### 2. Definitions and clarifications

#### 2.1 Types of supports

- Glazing secured by linear supports: secured by linear supports on at least two opposite-facing sides over the full length of a side.
- Glazing secured at individual points: glazing anchored through drilled holes or with clamps.

#### 2.2 Types of glass and acrylic glass

Types of glass granted statutory construction approval in Building Regulation List A:

- Polished plate glass (PPG) according to DIN 1249, ENV 9575: Also known as float glass or flat glass. It is characterised by relatively low flexural tensile strength and when destroyed fragments into large sharp-edged shards. Its use as singlesheet glazing in trade fair construction is prohibited.
- Wired glass manufactured from cast glass according to DIN 1249: Cast glass is manufactured by rolling and exhibits corresponding structural characteristics on the surface.
- Tempered safety glass (TSG) according to DIN 1249: TSG is a fully thermally pre-stressed type of glass. It exhibits residual stress characteristics: core tensile stress and surface compression stress. It has high flexural tensile strength and when destroyed leaves crumb-like fragments.

#### - Laminated safety glass (LSG):

LSG consists of at least two PPG, TSG or HSG glass layers, whose individual thicknesses may deviate by a maximum factor of 1.5 from each other. These layers are laminated using a PVB interlayer. If a sheet is destroyed then the foil prevents the fragments from scattering, thus ensuring residual load-bearing capabilities and reducing the risk of injury from cuts.

#### - Heat-strengthened glass (HSG):

HSG is a type of glass that is only partially thermally prestressed. Its flexural tensile strength is lower than that of TSG (tempered safety glass). When destroyed HSG fragments are larger than those left by broken TSG. Thus LSG sheets manufactured from HSG exhibit higher residual load-bearing capabilities than in LSG sheets manufactured from TSG. HSG is currently not included in Building Regulation List A. If used – including in LSG sheets – then either general construction approval or individual construction approval will be required, or alternatively a procedure has to be carried out in accordance with Section 4.

Types of glass for which no statutory construction approval exists:

#### - Acrylic glass:

Acrylic glass is a transparent thermoplast product marketed under the brand names *Plexiglas®* or *Plexiglas®*. At present no recognised technical regulations are available for the use of acrylic glass.

#### - Polycarbonate products:

e.g. Makrolon

Acrylic glass and polycarbonate may only be used for not load-bearing, infill or decorative components.

#### 2.3 Material properties of glass products

Glass products have a bulk density of 25 kN/m<sup>3</sup>, a thermal expansion coefficient of  $8.4 \cdot 10^{-6}/K$  and Young's modulus is equal to 70,000 N/mm<sup>2</sup>. For testing purposes the flexural strength limits listed in Table 1 apply.

Table 1: Flexural strength limits for various types of glass in N/mm<sup>2</sup> (for allowable stress design concept at SLS level without load factors)

	SSG (polished plate glass)	enamelled glass SSG HSG	HSG	HSG (polished plate glass)	polished plate glass	wired glass
Overhead glazing	50	30 18	29	15	12	8
Vertical glazing	50	30 18	29	22,5	18	10

The interlayers used in LSG must be made out of PVB material, with an ultimate tensile strength of at least 20 N/mm<sup>2</sup>.

### 3. Stand construction and design

#### 3.1 Non-accident proof vertical glazing

##### 3.1.1 Vertical glazing $h \leq 4$ metres above hall floor level

In order to use glazing secured by linear supports no proof of structural characteristics in accordance with the Technical Regulations for the Use of Glazing with Linear Supports [*Technische Regeln für die Verwendung von linienförmig gelagerten Verglasungen*] (TRLV) is required, nor is it necessary to submit documentation of testing. In this case the exhibitor alone is responsible for ensuring that the construction/design is technically safe for general use and that it meets current and accepted technical standards. Table A provides an overview of the types of construction that are possible.

- Either TSG or LSG must be used.
- Sheets may be secured by linear supports or at individual points.
- Glass walls tilting at an angle in excess of 10° from the vertical are considered to be overhead glazing for which the provisions of Section 3.3.1 shall apply.
- Additional measures may be required to ensure protection of neighbouring walkways, or to afford resistance against leaning loads or against human impact.

##### 3.1.2 Vertical glazing $> 4$ metres above hall floor level

Non-accident proof vertical glazing whose uppermost edges are higher than 4 metres above hall floor level does not require construction approval on an individual basis on condition that the type of glass and the type of supports securing the glass correspond to TRLV specifications.

- Verified structural calculations and relevant construction plans must be submitted.

- In addition to the load of its own weight, the material must be capable of resisting forces equivalent to a light wind, i.e. a dynamic pressure corresponding to at least 0.125 kN/m<sup>2</sup>. Flexing should be limited to 1/100 of the length of the free edge. In the case of 4-sided linear support and a glass insert depth in excess of 5 mm under load the flexural restriction may be dispensed with (see Item 5).

- Wherever there is a high risk of impact – e.g. a ramp descending towards the glazing – additional measures are required.
- Proof of structural characteristics is not required if the individual area of a sheet is less than 1.6 m<sup>2</sup>, if TSG thickness is at least 4 mm, and the sheet is secured on four sides by linear supports.

Point-mounted glazing may be installed without requiring further proofs if

- general construction approval has already been granted for the point-mounting combination
- the structural specifications and glass thicknesses as stated in TRAV (6.3.3) or Table B are observed.

TRAV 6.3.3 and Table B are included because the accident-proof glazing barriers to which they refer are of course also suitable for non-barrier type glass panels.

Construction approval is required in individual cases for all other designs.

In order to use TSG glazing a heat soak test certificate must be submitted.

Table A provides an overview of possible designs and the necessary proofs.

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## “Glass and acrylic glass” (continued)

### 3.2 Accident-proof vertical glazing

In all three of the following categories, A, B and C, are the following two proofs for parapet construction are required:

- proof of the stability of the glass and subconstruction. The loads to be applied here are that of the capping and the wind pressure (0.125 kN/m<sup>2</sup>, from the wind load stressing) Flexing should be restricted to 1/100 of the free length of the edge. In the case of 4-sided linear support and glass support depth in excess of 5 mm under load the flexural limitation may be dispensed with (see Item 5).
- Proof of load-bearing capacity when subject to sudden impact. This proof can be provided in the form of a pendulum impact test in accordance with prEN 12600 or by adherence to the design specifications and the dimensions and thickness of the glass in accordance with TRAV or in accordance with Table B of this information sheet.

Table B provides an overview of possible designs and the proofs required.

**Pendulum impact tests must be carried out by the test centres named in Item 4 well in advance of the fair and outside the exhibition halls.**

#### 3.2.1 Category A – vertical glass wall

Definition: Linearly supported vertical glazing that does not contain any load-bearing bars at capping height, are not protected by capping making them suitable for the direct imposition of loads on the capping, i.e. glazing of room height.

If protection is required against accident impact from a height exceeding 1 metre, then it will be necessary to refer to the Technical Regulations for the Use of Accident-Proof Glazing [*Technische Regeln für die Verwendung von absturzsichernden Verglasungen (TRAV)*].

- Only LSG shall be used.
- Verified 1proof of structural characteristics and a pendulum impact test (Test prEN 12 600; exception: TRAV, Table 2) are required.
- Apendulum impact test is not required for glass with linear support on all sides, provided that the appropriate dimensions and thickness of the glass as shown in Table B (or. TRAV 6.3. and Tabelle 2) are adhered to.
- The glazing supports must provide adequate protection to the edges of the glass surface.

<sup>1</sup> Depending on the relevant trade fair company's regulations, it may be possible to submit proof omitting verification. The trade fair company will then task its own inspection engineers to carry out verification at the applicant's expense.

#### 3.2.2 Category B – clamped glass balustrade with continuous handrail

Definition: Load-bearing glass balustrades held by linear supports secured by clamp-type base mountings. The individual glazing elements are connected by a continuous, load-bearing, inserted handrail (see example in Item 6.1).

- Only LSG shall be used.
- Proofs of stability testing <sup>1</sup> and a pendulum impact test (testing in accordance with prEN 12 600) are required.
- When using LSG made with 2 x 10 mm SSG (or 2 x 10 mm HSG) no pendulum impact test is required, provided that the dimensions as stated in Table B are adhered to (design details in accordance with TRAV Appendix B).
- The PVB interlayer must be at least 1.52 mm thick.
- The securing clamps must be at least 100 mm above floor level.

Calculations must prove that in the event of a glass sheet being destroyed that loads are distributed via the capping to neighbouring glass sheets. Tension in the neighbouring glass sheets may then increase to 50% above permissible limits. The destroyed glass sheet must be replaced immediately.

#### 3.2.3 Category C – railing cladding and glass wall with projecting load-distributing capping

Definition: Accident-proof glazing not serving to distribute capping loads, whose design specifications fall into one of the following groups:

- C1: Railing cladding secured by linear supports on at least two opposite-facing sides and/or at individual points.
- C2: Vertical glazing beneath a 90-degree load-distributing spanning member located at cap-ping level and secured by linear supports on at least two opposite-facing sides.
- C3: Category A type glazing with a load-distributing projecting capping.

- For category C1 and C2 type glazing, if sheets are secured on all sides by linear supports then the use of TSG is permissible. For all other types of supports and for Category C3, if no statutory construction approval exists then only LSG may be used.
- Table B provides an overview of possible designs and the proofs required.
- The pendulum impact test is not required if the relevant design specifications, and the dimensions and thickness of the glass as stated in Table B or TRAV (6.3. and Tables 2 and 3) are adhered to.

#### 3.2.4 Alternative measures/protection against glass debris

If in the case of accident-proof glazing no construction permission on an individual basis is obtained, then accident-proofing can be achieved by installing a sufficient number of horizontal stays or steel cables with a minimum diameter of 5 mm underneath the railing, spaced approximately 30 cm apart in height, and located at sufficient distance in front of the sheets.

Measures affording protection from scattering glass debris, alternatively LSG, should always be installed above and along the length of public walkways.

### 3.3 Horizontal glazing

#### 3.3.1 Overhead glazing

Glass walls tilting at an angle in excess of 10° from the vertical are considered to be overhead glazing. Table C provides an overview of possible designs and the proofs required.

Only the following glass products may be used:

- LSG manufactured from polished plate glass
- LSG manufactured from HSG
- wired glass

In addition to submitting certification of load-bearing capabilities, experimental proof of residual load-bearing capabilities must be provided, alternatively an underslung safety net must be installed. If TRLV structural requirements are met, then no proof of residual load-bearing capabilities need be given.

In addition to the load of its own weight, the material must be capable of resisting a force of at least  $q = 0.125 \text{ kN/m}^2$ . The sheets must be secured in such a way as to properly safeguard against persons slipping and protect against falling loads.

The use of glazing secured at individual points and HSG glazing requires general construction approval or construction approval in individual cases.

If for cleaning purposes overhead glazing periodically has to support human loads, then such additional loads must be taken into consideration, and experimental proof of residual load-bearing capabilities must be provided [7]. In this case construction approval on an individual basis is always required.

- LSG sheets with an effective span exceeding 1.20 m must be supported on all sides. The ratio between length and width may not exceed 3 to 1. The overall thickness of the PVB interlayers must be at least 0.76 mm. If a sheet is supported on all sides, then a thickness of 0.38 mm is permissible, on condition that the length to width ratio is not greater than 3 to 1 and that the effective span in the direction bearing the main load is not greater than 0.8 m.
- The effective span of a wired glass sheet may not exceed 0.7 m, and the glass supporting depth must be at least 15 mm.
- It is not permitted to drill holes through or cut sections out of the glass.
- The maximum permissible curvature may not exceed 1/100 of the effective span of the shorter side of the sheet.

#### 3.3.2 Glazing designed to sustain human loads

Examples of glazing designed to support human loads are stairways, podiums or catwalks. Construction approval on an individual basis is always required.

Proof of impact resistance and residual load-bearing capabilities as a result of component tests must be submitted. The requisite requirements are listed under Section [7].

Glazing designed to support human loads may be secured by linear supports or at individual points. It must be manufactured from LSG, consisting of at least three layers of TSG and/or HSG. The uppermost layer may not be used for measuring curvature, as this surface is designed to gradually wear. From the point of view of impact resistance it is recommended to use TSG as the uppermost layer. This surface must possess non-slip characteristics in accordance with DIN 51097. Glazing, mountings and substructure must be measured and tested to withstand the load of their own combined weight as well as sustained human loads in accordance with DIN 1055. Tests to establish the sustainability of constant human loads must take into account a wear rate of  $P = 3.5 \text{ kN/m}^2$  or  $5 \text{ kN/m}^2$ . The glazing should also be tested for an individual load of  $1.5 \text{ kN}$  at  $p = 3.5 \text{ kN/m}^2$  or  $2.0 \text{ kN}$  at  $p = 5 \text{ kN/m}^2$  over a contact area of  $100 \times 100 \text{ mm}$  in circumstances where loads are positioned in an adverse manner.

Stairways should be tested to sustain  $5 \text{ kN/m}^2$ , or an individual load of  $2.0 \text{ kN}$ .

In the case of stairways the construction/design must guarantee sufficient distribution of loads. When sustaining test loads the maximum curvature of the glazing may not exceed  $1/200$  of the effective span. For glazing, proof must also be supplied of positive experimental results for the destruction of the uppermost LSG sheet. In this case the maximum curvature of the glazing may not exceed  $1/100$  of the effective span.

#### 4. Approval procedures

##### 4.1 Bases

If a glass component and its glass products conform to the technical building regulations under Section 7, and to generally accepted technical principles, then it shall be sufficient to submit the verified structural calculations and the verified plans, following which construction approval will be granted. A subsequent inspection of construction work will be carried out.

If additional components are installed for which statutory construction approval, a statutory construction test report or type approval are required, then they are to be submitted together with the structural calculations.

If a glass component or its glass products do not conform to the construction engineering regulations and generally accepted technical principles under Section 7, nor is it possible to submit a statutory construction approval or statutory construction test report, then **individual construction approval** shall be required. Where the use of glass is concerned and within the limitations afforded by this information sheet, alternatively a **construction approval on an individual basis** may be granted.

##### 4.2 Construction approval on an individual Basis

This approval procedure is similar to the procedure for obtaining individual construction approval. If individual construction approval has been granted once for a particular construction/design, then the trade fair companies in question will recognise this for an identical design serving an identical purpose. Applications for construction approval and construction work inspection must be renewed in each case. The test report, all certificates and approvals, design details, as well as glass measurements and thicknesses must be submitted.

The glass components requiring approval with the necessary proof 3 are shown in column 14 of the Tables A, B and C.

Individual construction approvals cannot be obtained at short notice but require a considerable period of time for processing. Applications should therefore be submitted at least 6 weeks before the commencement of construction.

Prior to conducting component tests, it is advisable to contact the relevant trade fair company in time so as to coordinate procedures and intended testing methods. In general, component testing requirements stipulate inclusion of parts of the glass component's actual substructure in order to simulate realistic loads.

The procedure for obtaining

**Construction approval on an Individual Basis** from the relevant trade fair company is as follows:

- Testing of structural calculations and inspection of the required glass manufacturer/processing company's certificates confirming the identity of the product(s) must be carried out by a recognised structural building engineer and tester possessing expert knowledge in the field of glass construction and design.

- He must confirm that no objections exist in respect of the design's suitability for use. It is his responsibility to take any decisions concerning the need for additional testing of materials, impact resistance, and whether proof must be obtained of residual load-bearing capabilities. The test report must be submitted to the trade fair company along with the other application documents requesting granting of construction approval and subsequent construction work approval.

- Final approval will be granted on location following an inspection to confirm that the construction/design conforms to the previously inspected documents. The engineer carrying out the inspection acts on behalf of the trade fair company.

#### Recognised institutes for testing components used in glass construction/design:

MFGPA Leipzig

Richard-Lehmann-Straße 19, D-04275 Leipzig

Institut für Massivbau

Prof. Lierse, TU Hannover

Nienburger Straße 3, D-30167 Hannover

MPA Nordrhein-Westfalen

Marsbruchstraße 186, D-44287 Dortmund

TU Darmstadt

Institut für Statik, Prof. Dr.-Ing. Wörner

Alexanderstraße 7, D-64283 Darmstadt

Friedmann & Kirchner

Gesellschaft für Material- und Bauteilprüfung

Große Ahlmühle 7, D-76865 Rohrbach

Institut für Fenstertechnik e.V.

Theodor-Griehl-Straße 7-9, D-83025 Rosenheim

Materialprüfungsamt des Landes Brandenburg

Muggelseedamm 109, D-12587 Berlin

Materialprüfanstalt für das Bauwesen Hannover

Nienburger Straße 3, D-30167 Hannover

RWTH Aachen

Lehrstuhl für Stahlbau, Prof. Dr.-Ing. Sedlack

Mies-van-der-Rohe-Straße 1, D-52074 Aachen

FMPA Baden-Württemberg

Abteilung 2, Dr.-Ing. Völkel

Pfaffenwaldring 4, D-70569 Stuttgart

FH München

FB 02 – Bauingenieurwesen und Stahlbau, Prof. Dr.-Ing. Bucak

Karlstraße 6, D-80333 München

Institut für Baukonstruktionen

Prof. Dr.-Ing. Weller, Technische Universität Dresden, Beyer-Bau

George-Bähr-Straße 1, D-01069 Dresden

TU Hamburg – Harburg

Stahlbau und Holzbau, Prof. Dr.-Ing. Maier

Denickestraße 7, D-21073 Hamburg

LMPA Sachsen-Anhalt

Große Steinernetischstraße 4, D-39104 Magdeburg

MPA Darmstadt

Grafenstraße 2, D-64283 Darmstadt

Universität Karlsruhe

Versuchsanstalt für Stahl, Holz und Steine, Prof. Dr.-Ing. Saal

Kaiserstraße 12, D-76131 Karlsruhe

TU München

Lehrstuhl für Stahlbau

Arcisstraße 21, D-80333 München

#### 5. Advice about designs and calculations

- Glass is a brittle material, any failure of which will occur spontaneously and without warning

- Glass is sensitive to blows with hard, pointed objects.

Taking into account these properties, for construction purposes it follows that:

- Proofs of the load-bearing capacity of load-bearing glass cover not only the consideration of unbroken glass but always includes an additional investigation into the broken or partially broken glass (proof of residual safety).

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## “Glass and acrylic glass” (continued)

- The supports used must ensure that glass sheets are not secured under pressure.
- Taking into account the effects of loads and temperature fluctuations, contact between glass and other hard materials (e.g. other glass, metal) may not occur at any time.
- The sections used to support glass sheets must be sufficiently stiff. Maximum permissible deformation:

Section:  
 $f \leq l_{\text{section}}/200$   
 $f \leq 15 \text{ mm}$

Sheet:  
 $f \leq l_{\text{sheet}}/100$  (l = length of main direction of load)

- Minimum supporting depths of glass sheets on their respective sections must be adhered to.
- After glazing has been installed it must be possible to identify the individual type of glass sheet used (e.g. TSG, HSG) at all times. In the case of LSG glazing, for inspection purposes (number of glass sheets, thickness, interlayer) an area on the edge must be left free until after construction work has been approved. If required a manufacturer's certificate should be submitted.
- The edges of glass sheets must be fashioned or protected in such a way as to exclude any possibility of injuries occurring.
- In the case of TSG, HSG, or LSG glazing manufactured from sheets of TSG or HSG, subsequent reworking of the finished product such as cutting out sections or drilling holes is not possible.
- Sheets designed to sustain human loads must safeguard against persons slipping at all times.

Prior to submission of a standard for glass measurements by the building inspectorate the stability proofs for unbroken glass should be carried out according to the following basic rules

- Effects are applied without using partial security co-efficients, proof of load-bearing capacity takes the form of a proof of the maximum main ensile stress against the permitted stresses in accordance with Table 1.
- When considering the stability effect on LSG its compound nature is ignored. The contribution towards the overall effect made by each individual sheet of glass is measured.
- In the case of glass which is intended to support human loads the uppermost layer is regarded as the one subjected to wear and is not included in the proofs.
- Material tests should be used to substantiate proof concepts for point-supported glass.
- The notes and references to literature in Appendix E to TRAV should be taken into consideration (see 9. Literature, [9] [10])
- For examples of proofs see [11]

### 6. Examples of accident-proof designs

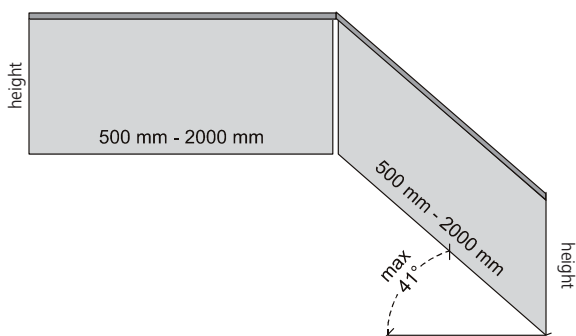
All possible dimensions, types of glass, thicknesses and the necessary proofs are summarised in Table B.

#### 6.1 Category B



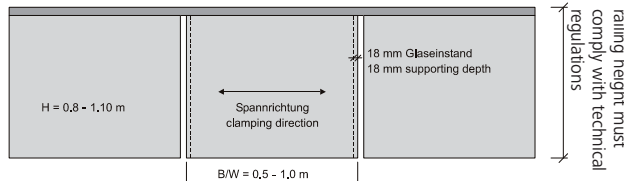
Note: When using LSG made from 10 mm SSG + 1.52 mm PVB + 10 mm SSG

LSG made from 10 mm HSG + 1.52 mm PVB + 10 mm HSG in the dimensions stated in Table B only a stability proof is required. In accordance with Appendix D of TRAV 2003 this also applies to parallelogram-shaped parapets:



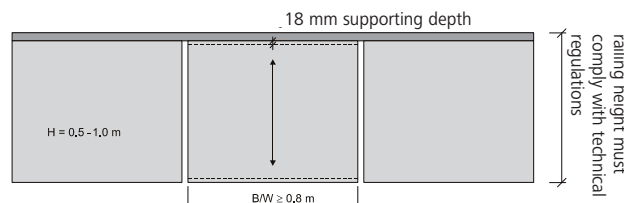
#### 6.2 Category C1

##### 6.2.1 Railing cladding vertically secured on 2 sides



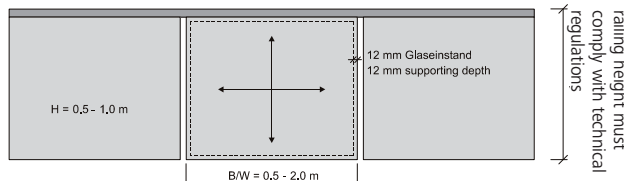
Note: When using LSG made from 100 mm SSG + 0.76 mm PVB + 6 mm SSG or 8 mm SPG + 1.52 mm PVB + 8 mm SPG or 8 mm HSG + 1.52 mm PVB + 8 mm HSG in the dimensions as stated in Appendix B only a stability proof is required.

##### 6.2.2 Railing cladding horizontally secured on 2 sides



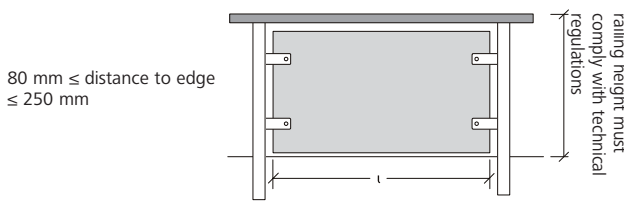
Note: When using LSG made from 5 mm SSG + 0.76 mm PVB + 5 mm SSG or 8 mm SPG + 1.52 mm PVB + 8 mm SPG or 8 mm HSG + 1.52 mm PVB + 8 mm HSG in the dimensions as stated in Appendix B only a stability proof is required.

##### 6.2.3 Railing cladding secured on 4 sides



Note: When using LSG made from 5 mm SPG + 0.76 mm PVB + 5 mm SPG or 5 mm HSG + 0.76 mm PVB + 5 mm HSG in the dimensions as stated in Appendix B only a stability proof is required.

##### 6.2.4 Glazing secured at individual points through drilled anchorage points (design specifications in accordance with TRAV, Table 3 and Item 6.3)



Note: When LSG glass and dimensions in accordance with Table B are used only a stability proof is required:

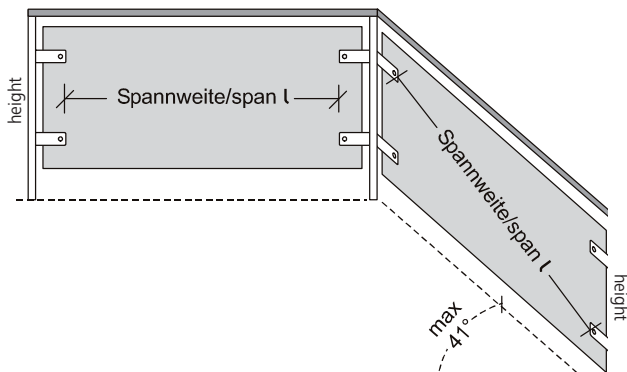
L < 1,200 mm: 6 mm SSG + 1.52 mm PVB + 6 mm SSG for plate diameter of 50 mm

L < 1,600 mm: 8 mm SSG + 1.52 mm PVB + 8 mm SSG for plate diameter of 70 mm or

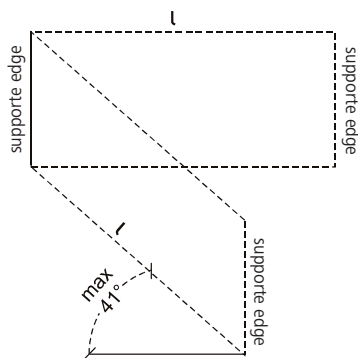
L < 1,600 mm: 10 mm HSG + 1.52 mm PVB + 10 mm HSG for plate diameter 70 mm

The rules for Categories C1 and C2 also apply to parallelogram-shaped parapets, in accordance with Appendix D of TRAV 2003:

### Category C1



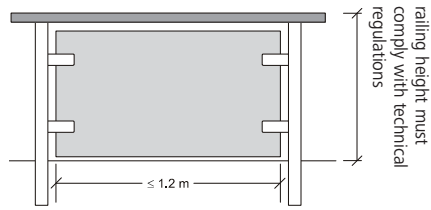
### Category C2



#### 6.2.5 Point mounting with lateral clamps and anti-slip device

- Systems granted general building approval should be used in accordance with the details contained in the approval
- for all systems that have not been granted general building approval a pendulum impact test is required. Minimum requirement:

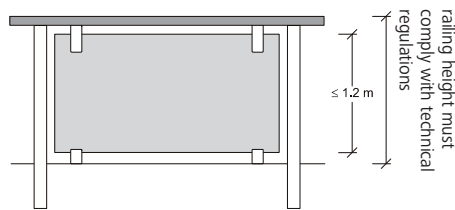
one LSG comprising 6 mm SSG + 1.52 mm PVB + 6 mm SSG or 6 mm TVG + 1.52 mm PVB + 6 mm HSG.



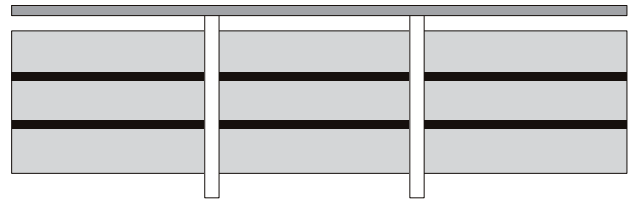
#### 6.2.6 Point mounting with clamps at top and bottom

- Systems granted general building approval should be used in accordance with the details contained in the approval
- for all systems that have not been granted general building approval a pendulum impact test is required. Minimum requirement:

one LSG comprising 6 mm SSG + 1.52 mm PVB + 6 mm SSG or 6 mm TVG + 1.52 mm PVB + 6 mm HSG.



### 6.3 Balustrade with horizontal stays



The choice of the type of glass is to be made in accordance with the Table A for glass that is not required to offer protection against falling, taking into consideration Item 3.2.4. Clearance between horizontal bars should not exceed approx. 30 cm. For additional specifications see Item 3.2.4.

### 7. Construction engineering regulations and generally accepted technical principles

- Types of glass granted statutory construction approval in the Building Regulation List
  - Source: Communications (Mitteilungen) of DIBt, ERNST & SOHN Verlag GmbH,
  - available at: <http://www.dibt.de>
- Generally accepted technical regulations:
  - Technical Regulations for the Use of Glazing with Linear Supports [*Technische Regeln für die Verwendung von linienförmig gelagerten Verglasungen*] (TRLV, DIBT 6/1998) Download at: <http://www.lgabw.de/lfb/>
  - Technical Regulations for the Use of Accident-Proof Glazing [*Technische Regeln für die Verwendung von absturzsichernden Verglasungen*] (TRAV, drafted in January 2003) Download at: <http://www.glaserhandwerk.de/seite129.htm> Download at: <http://www.lgabw.de/lfb/>
- Technical information sheet published by the building authorities in individual Federal States, e.g.:
  - Baden-Württemberg: information sheets G1 – G5 Download at: <http://www.lgabw.de/lfb/>
  - Bavaria: information sheets on obtaining construction permission on an individual basis Download at: <http://www2.stmi.bayern.de/bauen/baurecht>
- VPI checklist: <http://www.bvpi.de>

### 8. Literature

- [1] Wörner J.-D., Schneider J., Fink A.: title “Glasbau: Grundlagen, Berechnung, Konstruktion”, published by Springer-Verlag, Berlin Heidelberg; 2001
- [2] Kuhlmann U.: Stahlbau Kalender. Published by Ernst & Sohn Verlag für Architektur und technische Wissenschaften GmbH, Berlin, 1999
- [3] Sedlacek S., Blank K., Laufs W., Güsgen J.: title “Glas im Konstruktiven Ingenieurbau”. (1st edition), published by Ernst & Sohn Verlag für Architektur und technische Wissenschaften GmbH, Berlin, 1999
- [4] Siebert G.: title “Entwurf und Bemessung von tragenden Bauteilen aus Glas”. Published by Ernst & Sohn Verlag für Architektur und technische Wissenschaften GmbH, Berlin, 2001
- [5] Bavarian Interior Ministry/Bayerisches Staatsministerium des Inneren: Ministerial General Information Sheet/Allgemeines Ministerblatt no.6/2000, Enclosure 6, Technical Regulations for the Use of Glazing Secured by Linear Supports /*Technische Regeln für die Verwendung von linienförmig gelagerten Verglasungen* (TRLV) (version dated September 1998), München
- [6] DIBT Notices 2/2003: Technical rules for the use of safety glazing (TRAV) (January 2003)
- [7] State Trade Authority of Baden-Württemberg, State Construction Engineering Bureau/Landesgewerbeamt Baden-Württemberg, Landesstelle für Bautechnik, information sheet (Merkblatt) G2, a summary of principle requirements for vertical glazing requiring approval/Zusammenfassung der wesentlichen Anforderungen an zustimmungspflichtige Vertikalverglasungen (version dated 28 July 1999)
- [8] Communications (Mitteilungen) of DIBt no. 2/2001: Requirements for glazing designed to sustain human loads/Anforderungen an begehbare Verglasungen; Recommendations in connection with the approval procedure/Empfehlungen für das Zustimmungsverfahren – dated March 2000 –, Berlin
- [9] Wörner, J.-D; Schneider J.: Closing report on experiments and calculations to determine the dynamic stresses on glass as a result of a light impact, Fraunhofer IRB Verlag Stuttgart 2000, Booklet T 2935
- [10] Völkel, G.E. ; Rück R.: Investigation into panes with linear support on 4 sides when subjected to impact, Fraunhofer IRB Verlag Stuttgart 2000, Booklet T 2915
- [11] Hess, R., Weller, B: Practical examples of glass construction, design and calculations, Bauwerk-Verlag 2005

# Information sheet

## “Glass and acrylic glass” (continued)

Table A, Vertical glazing, non accident-proof

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Structural design					approved	Thickness	Thickness of	Width in mm		Height in mm		Min. support	Proof	Tech. building			
Method	Description	Construction	Mounting	Type of glass	yes/no	in mm	PVB interlayer	min.	max.	min.	max.	depth in mm	required	regulations			
Vertical glazing	non accident-proof	Glass panel ≤ 4.0 m above top of floor level	2-sided linear support	S&S	yes								1				
				LSG-double	yes									1			
				Wired	yes										1		
			4-sided linear support	Acrylic	yes											1	
				S&S	yes											1	
				LSG-double	yes											1	
			Point mounting	Wired	yes											1	
				Acrylic	yes											1	
				S&S	yes											1	
			Glass panel > 4.0 m above top of floor level	2-sided linear support	LSG-double	yes										1	
					Wired	yes										2.5	A
					Acrylic	yes										2	A
		4-sided linear support		Acrylic	yes											2	A
				S&S	yes											1	
				LSG-double	yes											2 <sup>1)</sup>	A
		Point mounting		Wired	yes											2 <sup>1)</sup>	A
				Acrylic	yes											2 <sup>1)</sup>	A
				S&S	yes											1	
		Railing infill with capping and accident-proof cross-beams at knee height. The glass itself does not serve any protective function.		2-sided linear support	LSG-double	yes										2, 3, 5	C
					Wired	yes										2, 3	C
					Acrylic	yes										1	
			4-sided linear support	Wired	no											1	
				S&S	yes											1.5	A
				LSG-double	yes											1	A
Point mounting	Wired		yes											1	A		
	Acrylic		yes											1	A		
	S&S		yes											1	A		
Point mounting	LSG-double		yes											1	A		
	Wired		no											1	A		
	Acrylic		yes											1.5	C		
												1					

Type of proof: Tech. building regs.: As of: 01.07.2005

- 1: Without proof
  - 2: Tested stab. calculation
  - 3: Installation approval in preparatio
  - 4: Pendulum impact test
  - 5: Hot storage test
  - 6: Resid. load-bearing test
  - 7: Impact test
- A: TRLV
  - B: TRAV
  - C: LfB Baden Württemberg Information Sheet G1 - G5

1) Proof 2 (examined stability calculation) not required for glass areas A ≤ 1,6 m² and d ≥ 4 mm

# Information sheet

## "Glass and acrylic glass" (continued)

**Table B, Vertical glazing, accident-proof**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Structural design																
Method	Description	Construction	Mounting	Type of glass	approved yes/no	Thickness in mm	Thickness of PVB interlayer	Width in mm		Height in mm		Min. support depth in mm	Proof required	Tech. building regulations		
								min.	max.	min.	max.					
Vertical glazing	accident-proof (Dh > 1 m)	Glass panel (Cat. A according to TRAV)	2-sided linear support	SSG	no <sup>2)</sup>											
			LSG-double	yes		0.76						18	2,4	A, B		
			SSG	no <sup>2)</sup>												
			4-sided linear support	LSG-double	yes		2 x 6 SPG	0.76	500	1200	1000	2000				
							2 x 8 SPG	0.76	500	1500	1000	2500	12	2	A, B	
							2 x 10 SPG	0.76	1200	2100	1000	3000				
							2 x 6 SPG	0.76	500	2000	1000	1200	12	2	A, B	
							2 x 8 SPG	0.76	500	2500	1000	1500	12	2	A, B	
							2 x 10 SPG	0.76	1000	3000	1200	2100	12	2	A, B	
							2 x 6 SPG	0.76	300	500	500	3000	12	2	A, B	
				Point mounting	SSG	no <sup>2)</sup>										
					LSG-double	yes		0.76							2, 3, 4	C
				Parapet tensioned at base, with handrail (cat B according to TRAV)	1-sided linear support	SSG	no									
						LSG-double	yes	2 x 10 SSG	1.52	500	2000	900	1100	100	2	A, B
								2 x 10 TVG	1.52	500	2000	900	1100	100	2	A, B
						SSG	no <sup>2)</sup>									
				Railing infill (cat. C1 and C2 according to TRAV)	Top and bottom linear support	LSG-double	yes	2 x 6 SPG	0.76	1000			800			
								2 x 5 SSG	0.76	800	bel.	500	1000	18	2	A, B
								2 x 8 SPG	1.52	800			1000			
					Left and right linear support	SSG	no <sup>2)</sup>									
				LSG-double	yes	2 x 6 SPG	0.76	500	800	1000						
						2 x 6 SSG	0.76		1000	800	1100	18	2	A, B		
						2 x 8 SPG	1.52		1000	800						
			4-sided linear support	SSG	yes							12	2,4			
				LSG-double	yes	2 x 5 SPG	0.76	500	2000	500	1000	12	2	A, B		
				SSG	no <sup>2)</sup>											
		Railing infill (only cat. C1 according to TRAV)	Point mounting	LSG-double	yes	2 x 6 SSG	1.52		1200		1000	10	2	B		
						2 x 8 SSG	1.52		1600		1000	10	2	B		
						2 x 10 TVG	1.52		1600		1000	10	2	B		
				SSG	no <sup>2)</sup>											
		Glass panel with projecting, load-bearing handrail (cat. C3 according to TRAV)	2-sided linear support	LSG-double	yes							18	2,4	A, B		
			4-sided linear support	SSG	no <sup>2)</sup>											
				LSG-double	yes	2 x 5 SPG	0.76	500	1500	1000	3000	12	2	A, B		
				SSG	no <sup>2)</sup>											
			Point mounting	LSG-double	yes								2, 3, 4	C		

Type of proof:

- 1: Without proof
- 2: Tested stab. calculation
- 3: Installation approval in preparatio
- 4: Pendulum impact test
- 5: Hot storage test
- 6: Resid. load-bearing test
- 7: Impact test

Tech. building regs.:

- A: TRLV
- B: TRAV
- C: LfB Baden Württemberg Information Sheet G1 - G5

As of: 01.07.2005

If no pendulum impact test "4" is required in Column 14, a prerequisite for this exemption is that the limiting values in Columns 7 to 13 are observed. Construction approval is required in individual cases for designs not listed here.

2) In the cases of systems with a valid approval from the building inspectorate SSG may be used in accordance with the wording of the approval

The use of acrylic glass and wired glass is not permitted on accident-proof vertical glazing, On linearly supported panes LSG plate glass may be replaced by LSG using HSG of the same thickness.

# Information sheet

## “Glass and acrylic glass” (continued)

Table C, Horizontal glazing

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
Structural design						approved	Thickness	Thickness of	Width in mm		Height in mm		Min. support	Proof	Tech. building		
Method	Description	Construction	Mounting	Type of glass	yes/no	in mm	PVB interlayer	min.	max.	min.	max.	depth in mm	required	regulations			
Horizontal- verglasung	Overhead glazing (inclination from perpen- dicular > 10°) 3)		2-sided linear support	S5G	no												
				LSG-double	yes		0.76			1200 <sup>4)</sup>				2 <sup>5)</sup>	A		
				Wired	yes					700 <sup>4)</sup>			15	2	A		
			4-sided linear support	S5G	no												
				LSG-double	yes		0.76								2 <sup>5)</sup>	A	
				Wired	yes						700 <sup>4)</sup>			15	2	A	
	Point mounting	S5G	no														
		LSG-double	yes		1.52									2, 3, 6 <sup>6)</sup>	C		
		Wired	no														
	Glazing subjected to foot traffic	installation ht. < 20 cm	2-sided linear support	S5G	no												
				LSG-double	no												
				LSG-triple	yes									30	2 <sup>5)</sup>		
			4-sided linear support	Wired	no												
				S5G	no												
				LSG-double	no												
		Point mounting	LSG-triple	yes										30	2 <sup>5)</sup>		
			Wired	no													
			S5G	no													
installation ht. > 20 cm		2-sided linear support	LSG-double	no													
			LSG-triple	yes									30	2, 3, 6, 7	A, C		
			Wired	no													
	4-sided linear support	S5G	no														
		LSG-double	no														
		LSG-triple	yes									30	2, 3, 6, 7	A, C			
Point mounting	Wired	no															
	S5G	no															
	LSG-double	no															
			Point mounting	LSG-triple	yes								2, 3, 6, 7	C			
				Wired	no												

- |  |  |   |
|--|--|---|
| Type of proof:                         | Tech. building regs.:                              | As of: 01.07.2005   |
| 1: Without proof                       | A: TRLV  | 3) Overhead glazing that must bear the weight of cleaning operatives is subject to a separate approval process  |
| 2: Tested stab. calculation            | B: TRAV  | 4) Details apply to narrower support width (load-bearing direction)   |
| 3: Installation approval in preparatio | C: LfB Baden Württemberg Information Sheet G1 - G5 | 5) When using partially tempered glass without general approval from building inspectorate an additional installation approval is required in individual cases. |
| 4: Pendulum impact test                |  | 6) No installation approval in individual cases is required for glass mounting systems that have been approved by building inspectorate                         |
| 5: Hot storage test                    |  |   |
| 6: Resid. load-bearing test            |  |   |
| 7: Impact test                         |  |   |

Use of acrylic glass in horizontal glazing is not permitted. However, exceptions are possible if the fair company does not have any reservations regarding fire safety and stability.