

***Laminated Safety Glass (LSG)
for use in building***

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Introduction and Definition

Object

This technical guide is intended to give the users in Germany (architects, planners and builders) some points of orientation for the use of LSG in the planning and design phase as well as in the actual work, and to provide them with the necessary answers to important questions.

Scope

This technical guide applies for LSG in building (use in the building shell and for finishing work in building projects and structures).

Applications

Typical applications in which LSG is specified by German building laws:

- Overhead glazing as per TRLV and TRPV rules (in future: horizontal glazing as per DIN 18008-2 and -3)
- Fall-proof glazing as per TRAV (in future: as per DIN 18008-4)
- Walk-on glazing as per TRLV and DIBt recommendations (in future: as per DIN 18008-5)

In accordance with the German workplace regulations (Arbeitsstättenverordnung) and with mandatory accident insurance/professional associations, LSG is specified for:

- all glass in traffic-frequented areas, if it is not toughened safety glass (ESG) or heat-soaked toughened safety glass (ESG-H) or is not covered fully and correctly with adhesive shatter protection film.

Definition

Laminated safety glass is defined as a special laminated glass (EN ISO 12543-1). Laminated glass (LG) is a structure comprising a glass sheet with one or more sheets of glass and/or glazing material of plastic connected to one another by one or more intermediate layers.

Laminated safety glass (LSG) is a laminated glass where in the event of fracture the intermediate layer has the functions of holding the glass fragments in place or limiting the size of the hole, of retaining a residual load capacity, and reducing the risks of cutting injuries or injuries from glass penetrations.

Requirements

European requirements for LSG

Laminated safety glass differs from laminated glass in its behaviour under a pendulum impact test and its subsequent classification (EN ISO 12543-2). In CEN member states, laminated safety glass should according to EN 12600 be classified with at least Class 3(B)3.

The quality and conformity of LSG must be verified in accordance with EN 14449. (In the present technical guide, only films and sheets are considered as intermediate layers.) This involves, depending on the intended use (System 1 or 3 as per EN 14449, annex ZA), the following four points:

1. An initial inspection of the product by a notified body accredited in Europe.

The required verification of UV resistance (EN ISO 12543-4) can also be furnished by the film supplier.

2. Setting up of an in-house production check), comprising:

- Monitoring of specimens taken in the plant in accordance with a specified inspection schedule. This inspection schedule includes at least:
 - a) inspection at high temperature (EN ISO 12543-4)
 - b) inspection in humidity (EN ISO 12543-4)

c) visual inspection (EN ISO 12543-6)
d) additionally, one of the following tests (ball drop, pendulum impact, compression/shear test, pummel test is recommended for determining the mechanical properties (EN 14449, annex C)

- Conducting of an initial inspection of the plant and the plant's internal production check.
- Conducting of a continuous monitoring and assessment of the plant's internal production check, consisting of at least:
 - a) temperature, humidity during storage and production (assembly and laminating process)
 - b) process control.

3. External monitoring

When LSG according to System 1 is used, e.g. as bullet-resistant or blast-resistant glazing, regular external monitoring by a notified body is specified.

4. Issuing of a declaration of performance and CE identification

German building law requirements for LSG as per construction products list (BRL)

The additional requirements for LSG in Germany are described in BRL A, Part 1, Serial. No. 11.14:

the laminated safety glass (LSG) must be made from glass products as per BRL A, Part 1, annex 11.8 with films made of polyvinyl butyral (PVB) as the intermediate layer. The PVB film must have the following properties in a test as per EN ISO 527-3:

Tear strength: > 20 N/mm²

Elongation at break: > 250 %

(Test speed 50 mm/min and test temperature 23 °C)

Other intermediate layers not meeting these requirements can also be used if they have general building authority approval or approval for the individual case.

As part of the initial inspection by a recognized inspection body or by the plant's own production check, the following measures must be taken:

- Documentation of the storage conditions for the PVB rolls
- Documentation of the production parameters (e.g. temperature and pressure development in autoclave, water quality and pre-lamination parameters)
- Check of appearance of LSG as per EN ISO 12543-6
- Check of LSG at high temperature as per EN ISO 12543-2 using a laminate of 3 mm float glass/0.38 mm PVB/ 3 mm float glass
- Ball drop test on a laminate of 3 mm float glass/0.38 mm PVB/3 mm float glass as per DIN 52338

Based on the aforementioned measures, the LSG manufacturer draws up a declaration of conformity according to BRL A Part 1, Serial No. 11.14.

Nomenclature

Various designations for LSG are used. For example an LSG of 2 x 4 mm glass + 0.76 mm intermediate layer, e.g. PVB, can be designated as follows: 44.2; 8/2-2; LSG8/2; 4B4; 8.8 mm LSG; 4 (0.76) 4, LSG8-0.76.

Further possible product properties

Additional functions (e.g. P2A as per EN 356) must be ordered as appropriate. Safety properties:

- Pendulum impact (EN 12600), shock test classes 1 (B) 1 to 3 (B) 3

- Ball drop (EN 356), thrown-object resistance classes P1A to P5A
- Axe (EN 356), Break-through resistance classes P6B to P8B

- Blast resistance (EN 13541), classes ER1 to ER4.
- Sound insulation properties (EN 717)
- Partially reduced UV transmission

Attack-resistant glazing as per		Drop test with hard object (ball drop test)		Test with axe (axe test)	
EN 356	VdS 2163*	Drop height in meters	Number of ball drops	Material of bar	Number of total impacts
P1A	-	1.5	3	-	-
P2A	-	3.0			
P3A	-	6.0			
P4A	-	9.0			
-	EH 01	9.5			
P5A	-	9.0	9	-	-
-	EH 02	12.5			
P6B	-	-	-	PE	30 to 50
-	EH 1			Steel	
P7B	-			PE	51 to 70
-	EH 2			Steel	
P8B	-			PE	over 70
-	EH 3	Steel			

Table 1

*Classification of safety properties as per VdS Schadenverhütung GmbH

Further requirements

- Bullet resistance (as per EN 1063)

Resistance class	Caliber	Projectile weight [g]	Projectile speed [m/s]	Shot distance [m]
BR1-S BR1-NS	0.22 LR	2.6	360	10
BR2-S BR2-NS	9 mm Luger	8.0	400	5
BR3-S BR3-NS	0.357 Magnum	10.2	430	5
BR4-S BR4-NS	0.44 Rem. Magnum	15.6	440	5
BR5-S BR5-NS	5.56 x 45	4.0	950	10
BR6-S BR6-NS	7.62 x 51	9.5	830	10
BR7-S BR7-NS	7.62 x 51	9.8	820	10
SG1-S SG1-NS	Shotgun 12/70 (1 hit)	31.0	420	10
SG2-S SG2-NS	Shotgun 12/70 (3 hits)	31.0	420	10

Table 2

It is the responsibility of the manufacturer to ensure by a suitable in-house production check that the laminated safety glass supplied conforms to the promised performance features and that this also applies when individual components are replaced.

Directions for LSG edge

Free exposure to weather

In the event that LSG edges are freely exposed to the weather, discoloration can occur in some areas of the glass edge over time, which have however no effect on the safety properties of this glass. Discoloration of this type can be minimized by design and production measures, for example by defined drip edges. The use of cleaning agents and cleaning methods must be checked. An LSG edge can also be covered by profiles, for example, which however require selection of a design that does not collect moisture at the glass edge but instead permits rapid venting and which is compatible with the intermediate layer.

Edge contacting sealants, adhesives and plastics or similar

If avoidance of a reaction is required, the LSG edge must not come into contact with any sealant, adhesive, plastic or the like. If this is not possible for design reasons, the possible reaction should be checked and confirmed on the basis of the ift guideline DI-02/1 relating to usability of sealants, Part 2, testing of materials in contact with the edge of laminated glass and laminated safety glass.

Ordinances, rules and standards

- German "Arbeitsstättenverordnung": ordinance relating to workplaces
- Bauregelliste (BRL): construction products list A, construction products list B and list C
- DIBt recommendations: requirements for walk-on glazing: recommendations for the approval procedure
- DIN 18008, Parts 1-5: Glass in building; design and construction rules
- DIN 52338: Methods of testing flat glass for use in buildings; ball drop test on laminated glass
- EN 356: Glass in building - Security glazing - Testing and classification of resistance against manual attack

- EN 1063: Glass in building; Security glazing; Testing and classification of resistance against bullets
- EN 12600: Glass in building; Pendulum tests; Impact test method and classification for flat glass
- EN 13541: Glass in building; Security glazing; Testing and classification of resistance against explosion pressure
- EN 14449: Glass in building; Laminated glass and laminated safety glass; Evaluation of conformity/Product standard
- EN ISO 527-3: Plastics; Determination of tensile properties; Part 3: Test conditions for films and sheets
- EN ISO 717-1: Acoustics; Rating of sound insulation in buildings and of building elements; Part 1: Airborne sound insulation
- EN ISO 12543, Parts 1-6: Glass in building; Laminated glass and laminated safety glass
- TRAV: Technical rules for the use of fall-proof glazing
- TRLV: Technical rules for the use of linear supported glazing
- TRPV: Technical rules for the design and execution of glazing with punctiform supports
- VdS 2163: Guidelines for mechanical security technology; burglar-resistant glazing; requirements and test methods

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