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Bundesverband
Flachglas

Compass for bonded windows

Focusing on glass, sealants and adhesives

Compass for bonded windows

Contents

Introduction

This Technical Guide has been written in cooperation and consultation with relevant industries and associations, and therefore provides a comprehensive overview of the requirements placed on the "bonded window" as an overall system. In facade construction and in the automotive or aerospace industries, bonding has been a familiar technique for many years and is today indispensable. In window construction too, glueing is receiving increasing attention. The basic principle here is to exploit the stiffness of the glass, and use a structurally effective bond between the casement and the glass (or multiple-sheet insulating glass) to stiffen the window as a combined element and to design it non-settling.

In addition to the possible benefits that bonding technology can offer, the window structures and the individual functional elements must be considered holistically. The insulating glass is one of the main components that can, in the case of bonded glazing systems, be subjected to possible additional stresses resulting from the type of window system.

The definition of bonded window systems here is that the insulating glass sheet in the closed state of the window has linear support on at least two sides, preventing the sheet from falling.

This Technical Guide deals with bonded glazing in window construction from the viewpoint of long-term functioning and suitability for use of the "window" system as a whole, focusing in particular on the insulating glass. Mechanical, static or dynamic stresses on the edge seal, compatibility aspects, edge seal structure, adhesive force of the adhesives, joint dimension, moisture effects in the rebate, glass surface protection with outside coatings etc. are just some of the factors that can affect the durability and hence the long-term functioning of the window structure.

This Technical Guide does not absolve the window manufacturer of responsibility for designing the bonded window structure holistically and in close consultation particularly with the manufacturers of insulating glass, adhesive, frame materials and fittings, with due consideration being given to existing standards and guidelines. Instead it is intended to draw his attention to a number of important aspects that need to be considered as part of this holistic design process.

1.0 System description

1.1 System supplier

The term "System" means in this context that only an agreed-upon and tested system may be used. To do so, the system supplier provides an appropriate system description, which must be complied with in respect of the following points:

- System drawing
- Sections
- Reinforcements
- Seals
- Glazing
- Blocking
- Fittings
- Connections
- Opening types
- Production directions
- Transport and storage
- Assembly
- Care and repair directions
- Traceability of components (identification)
- System changes

A check of reusability (recycling capability) is recommended.

1.2 Insulating glass structure

1.2.1 Glass

The glass can in this case absorb frame loads. To do so, it must, depending on the design in question, be sufficiently dimensioned for that purpose. Dead weight, wind loads and live loads are transmitted via the building structure. The rules of the DIBt and relevant standards for the window must be complied with (see also item 9.0). With reference to this specific system, the following points must be noted in connection with the glass / laminates:

- UV impact
- Moisture impact
- Material compatibility
- Additional mechanical loads
- Edge finishing / free glass edge
- Shear load

1.2.2 Spacers

The spacer system must be suitable for this application. Its function must be verified accordingly.

1.2.3 Primary and secondary sealants

The long-term functioning of the primary and secondary seals must be assured. Particular influences from any UV radiation, moisture or additionally occurring shear forces which might arise, and the compatibility (see literature index) of all components coming into contact, must all be taken into consideration. In mechanically unsecured systems (e.g. without glass retaining strips), the edge seal, which is subjected in these systems to higher loads from wind pressure and wind suction, must be dimensioned in accordance with the state of the art. This can for example affect the height of the rear overlap and the selection of materials.

1.3 Adhesive system

The selection of the adhesive system depends on the window system and the resultant stresses (see also 2.0). The boundary conditions in the bonded variant, with regard to temperature, UV and moisture impacts, can permanently affect durability. The selection of the bonding systems must take this into account (see also 2.0). The durability of the bonded connection must be verified in a state of the art process. The bonded joint must be dimensioned to suit the window system, the stresses occurring and the frame material.

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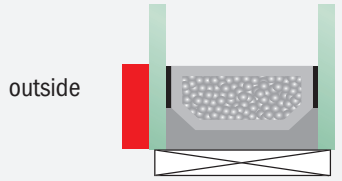
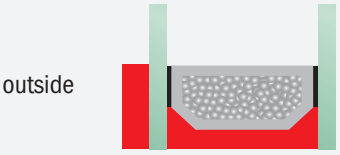
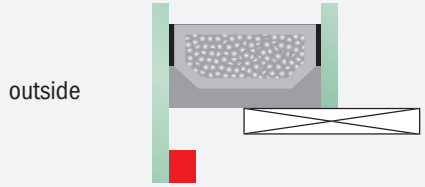
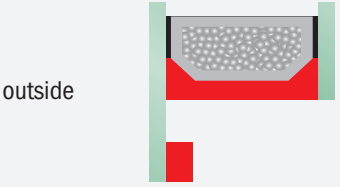
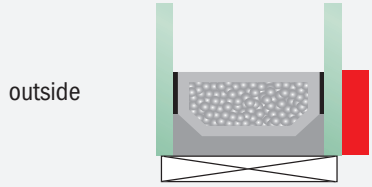
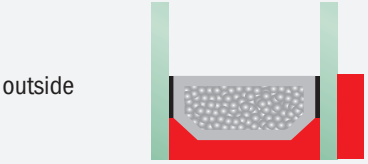
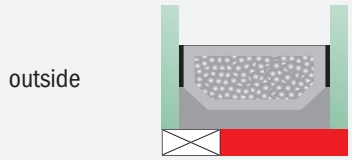
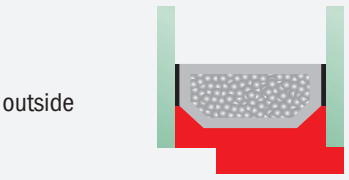
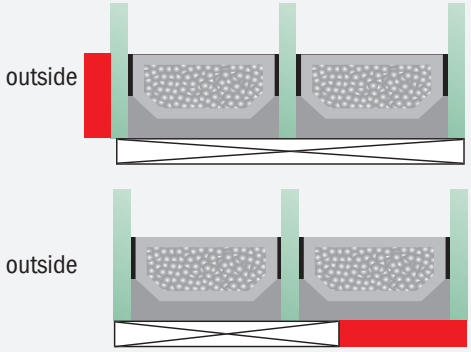
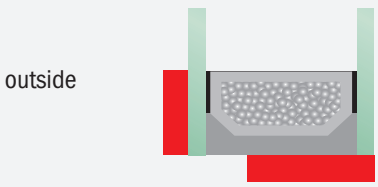
2.0 Systems

2.1 Representation of systems – Fig. 1: Permissible bonding positions and glazing systems

Bonding position	**Group K** With conventional mechanical load transfer via blocks	**Group L** Without conventional mechanical load transfer Bonding systems and sealant ensure the entire load transfer
Position 1		
Position 2		
Position 4		
Rebate bottom		
Examples for solutions with triple thermal insulation glass		
Combinations		

2.2 Vapour pressure equalization / drainage

All-round vapour pressure equalization must be permanently assured. The water drainage / vapour pressure equalization holes provided must have normal dimensions and perform their function.

2.3 Check of component suitability

The quality of the individual components must be assured by verification of their suitability.
Furthermore, the identity of the components used must be verified.

= Load-bearing connection / MIG with permanent shear load of the edge seal

= MIG without permanent shear load of the edge seal

= Glazing block

The illustrations shown on the left indicate the principles and the basic possibilities for a bonded connection. Based on the principles shown, the resultant introduced loads can be derived. With combined solutions, the resultant additional stress condition shall to be considered in addition.

3.0 General conditions

3.1 Climatic conditions

In addition to the usual and well-known climatic impacts and mechanical stresses on the insulating glass and its bonding inside the frame, the following points in particular must be kept in mind:

- Shear forces due to differing temperature-related expansions of the materials used
- Possibly higher temperature and UV impacts on the edge seal and the bonded connection
- Possible change in the isothermic development – leading to possible condensate build-up at unusual places (e.g. edge seal, bonded connection)
- Possible change in rebate design, leading to impeded vapour pressure equalization

3.2 Mechanical stress

The load assumptions must be taken into account in accordance with the known standards and regulations. Moreover, additional stresses causes by static and dynamic loads are possible and must be taken into account accordingly, such as:

- transmission of dead weight via both the edge seal of the insulating glass and the bonded connection between the glass and the frame
- distortions in the glass plane depending on its design and format
- possible creepage of the adhesives in glass types without mechanical load transfer
- point loads applied by the fittings and shear forces onto the edge seal
- loads due to use
- load transmission of wind/suction loads in the closed state via linear mounting on at least two sides
- incorrect use

The particular load effects on the glazing, the edge seal and the bonded connection must be assessed depending on the system (see also 2.0). The edge seal in insulating glass units put into service in accordance with EN 1279 must not be used for load transfer of the dead weight via individual sheets (e.g. blocks). If the insulating glass edge seal is used for bonding (e.g. rebate bottom bonding), the edge seal is subjected to additional stress. These loads must be taken into account.

3.3 Thermal insulation / sound insulation / solar control / safety / fire behaviour

The additional requirements depending on the intended application may require separate verification.

3.4 Other conditions

The edge finish or edge protector must be considered with reference to the system in question.

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4.0 Compatibility

The compatibility of materials must be verified for each application (see point 9.0), i.e. the components used must permanently perform their functions in the overall system, for example:

- frame material
- primary and secondary sealant in insulating glass
- spacers in insulating glass
- material of glazing blocks
- sealing sections / filler sections
- glazing sealants
- adhesive
- adhesive strips
- glass laminates
- coatings or films on glass

Example to illustrate a compatibility matrix

	Adhesive system	Cleaning agent	Primer	Adhesive	PVC-U	Glass laminates	Sekon-dary sealant	Primary sealant	Spacer	Sealing lip a	Sealing lip i	Section coatings	Blocks
Adhesive system													
Cleaning agent													
Primer													
Adhesive													
PVC-U													
Glass laminates													
Sekondary sealant													
Primary sealant													
Spacer													
Sealing lip a													
Sealing lip i													
Section coatings													
Blocks													

Table 1: Examples for contacts of different materials
Identification: d = direct contact, i = indirect contact, 0 = no contact
In the event of changes to the systems, compatibility must be re-verified.

5.0 Adhesion behaviour

The adhesion between the casement and the bonded connection must be permanent (see 1.0). In the case of bonding onto glass, particular attention must be paid to the adhesion when bonding is done onto coated and / or enamelled surfaces. The glass manufacturer must be consulted about this.

6.0 Quality assurance

To ensure a consistent quality standard, the preparation of inspection schedules for incoming materials, manufacturing processes and final production checks is recommended.

7.0 Repairability

The possibilities for repairs must be covered by the system description. In the event of repair, the functioning of all components and their compatibility must be assured. To do so, the traceability of the components used must be assured by appropriate identification.

8.0 Warranty

The supplier of the bonded window structure, as a rule the window installation specialist, is responsible for warranty of his work as mandated by law.

9.0 Standards and regulations

The following standards and regulations apply in their latest and comprehensive versions.

- DIN EN 356
  Glass in building – Security glazing – Testing and classification of resistance against manual attack
- DIN EN 572
  Glass in building – Basic soda lime silicate glass products
- DIN 1055
  Actions on structures
- DIN EN 1096
  Glass in building – Coated glass
- DIN EN 1279
  Glass in building – Insulating glass units
- DIN EN 1627 – 1630
  Pedestrian doorsets, windows, curtain walling, grilles and shutters – Burglar resistance
- DIN EN 1863-2
  Glass in building – Heat strengthened soda lime silicate glass
- DIN 4102
  Fire behaviour of building materials and building components
- DIN 4108
  Thermal insulation and energy economy in buildings
- DIN 4109
  Sound insulation in buildings
- DIN 5034
  Daylight in interiors
- DIN EN ISO 10077
  Thermal performance of windows, doors and shutters
- DIN EN 12150
  Glass in building – Thermally toughened soda lime silicate safety glass
- DIN EN 12412
  Thermal performance of windows, doors and shutters – Determination of thermal transmittance by hot box method
- DIN EN 12488
  Glass in building – Glazing guidelines – Glazing systems and requirements for glazing
- DIN EN ISO 12543
  Glass in building – Laminated glass and laminated safety glass
- DIN EN 12758
  Glass in building – Glazing and airborne sound insulation
- DIN EN 13022
  Glass in building – Structural sealant glazing
- DIN EN 13501
  Fire classification of construction products and building elements
- DIN EN ISO 13788
  Hygrothermal performance of building components and building elements – Internal surface temperature to avoid critical surface humidity and interstitial condensation – Calculation methods
- DIN EN 14179
  Glass in building – Heat soaked thermally toughened soda lime silicate safety glass
- DIN EN 15434
  Glass in building – Product standard for structural and / or ultra-violet resistant sealant
- DIN 18361
  German construction contract procedures (VOB) – Part C: General technical specifications in construction contracts (ATV); Glazing works
- DIN 18545
  Glazing with sealants; rebates; requirements

- Technical directive of the glazing trade No. 3, “Blocking of glazing units”
- Technical directive of the glazing trade No. 17, “Glazing with insulating glass”
- Guide of Bundesverband Flachglas “Material compatibility with insulating glass”
- Quality and inspection regulations, RAL – GZ 716/1, section III, Annex A: Bonded glazing in PVC frame structures”
- Ift Rosenheim, VE-08 / 1 Basis for assessment of bonded glazing systems
- GUV – SI 8027
  More safety when glass is broken
- VdS 2163
  Burglar-resistant glazing
- VdS 2270
  Alarm glasses
- VDI 2719
  Sound insulation of windows
- RAL - GZ 520
  Multiple-sheet insulating glass; quality assurance
- EnEV energy saving ordinance

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Beuth-Verlag GmbH (exclusive sales rights)
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Telefon +49 (030) 2601-2260
Telefax +49 (030) 2601-1260
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VdS= VdS Schadenverhütung GmbH, Cologne
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On the initiative of: Bundesverband Flachglas e.V. · Mülheimer Straße 1 · D-53840 Troisdorf

Bundesverband Flachglas e.V.
Mülheimer Straße 1
53840 Troisdorf