

# Direct Glazing in Marine



## 6.1 General Remarks for Window Bonding



### 6.1.1 Description

Traditional glazing methods have evolved as they have due to the limitations in the performance of the glass. A sturdy window frame was required to hold the glass in place and to protect it from forces that would shatter it. Also, the size of a window was limited for similar reasons and a broken window in heavy weather could compromise the safety of the vessel.

In addition marine regulations define the areas on the ship where bonding of windows is allowed and where additional mechanical fixations are necessary. It is therefore of interest to contact a Classification Society in case of vessels which are submitted to IMO and SOLAS or other national rules.

Modern glazing can be realised with mineral and organic glasses. The manufacturing techniques allow windows of superlative performance to be produced in almost any shape, size and curvature to give designers the possibility of modern realisation of ships.

The traditional role of glazing as protection against the elements whilst allowing light and vision to pass through, has been extended to include the extra benefit of structural member.

Direct glazing, using peripherally applied structural adhesive systems, has become the primary method of installing windows due to the extensive list of benefits:

- Better protection against the elements than framed windows.
- Significantly improved design and styling capabilities for the marine architect by elimination of trim, frame and screws.
- Enlarged window area permits a more imaginative styling.
- Lower weight reduces running costs and improves speed.
- Fewer materials required reduce the cost of the build with lower component cost and quicker assembly times.
- Improved torsion stiffness of the boat
- Reduction of the natural frequencies and vibrations, leading to an improved ride comfort
- Improved aerodynamics reducing wind noise in operation
- Better bridging of tolerances which has the advantages of quicker assembly and reduced adjustment costs
- Greatly reduced production times leading to quicker delivery and lower labour costs.
- Fewer glass breakages both during construction and in operation.
- Easy repair at any place due to Sika's global presence

## 6.1.2 Design directives

Direct glazing represents a straight-forward process whereby the glass is bonded directly to the body of the vessel. This must comply with all industry standards as laid down by the governing bodies, such as the classification societies, in each respective country. Specific details are described as appropriate for mineral and organic glazing later in this manual, but the general criteria are described following.

### UV Protection

The bond line material must be protected from direct UV radiation as this causes deterioration of the chemical composition leading to failure. This is normally carried out by including a light impermeable mask as part of the design of the window. This can appear in the form of:

- Ceramic coating (peripheral) for mineral glass
- UV impervious paint or ink for organic glass
- External trim

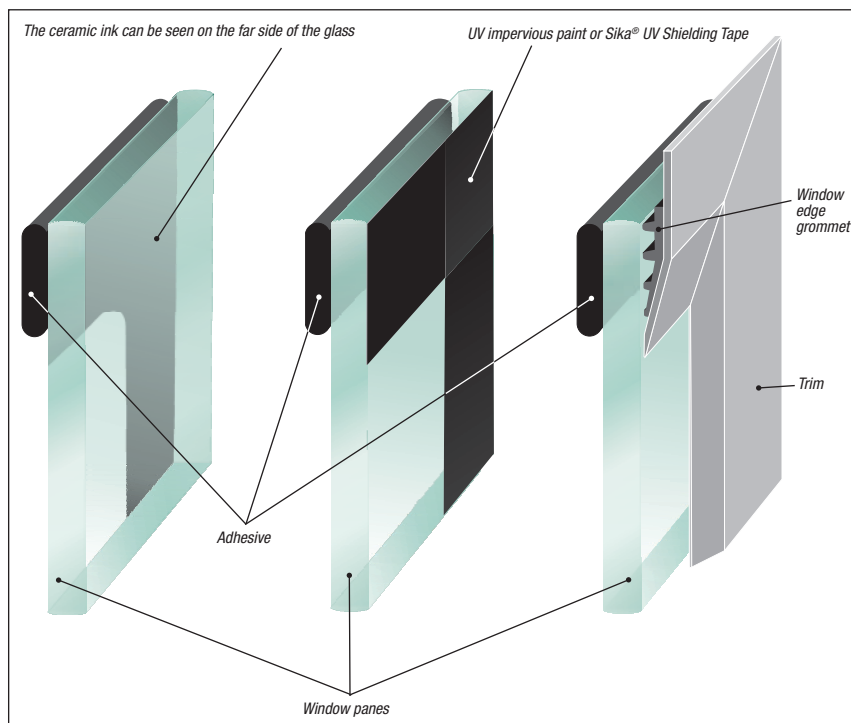


Fig. 1 Three different UV protection arrangements

The black silk screened ceramic border around the edge of the window is often feathered towards the centre of the window using various dot densities, resulting in an attractive shading effect. Adhesives can also be protected using external trim that is large enough to keep out the ultraviolet light and is also attractively designed such to enhance the appearance of the finish.

See chapter 6.2 for organic glass and 6.3 for mineral glass for dimensioning the adhesive layer.

### Fitting dimensions

Not only does the window have to fit correctly into the allotted aperture during assembly, but it must also take into account the changes that occur to the superstructure and the window under operating conditions.

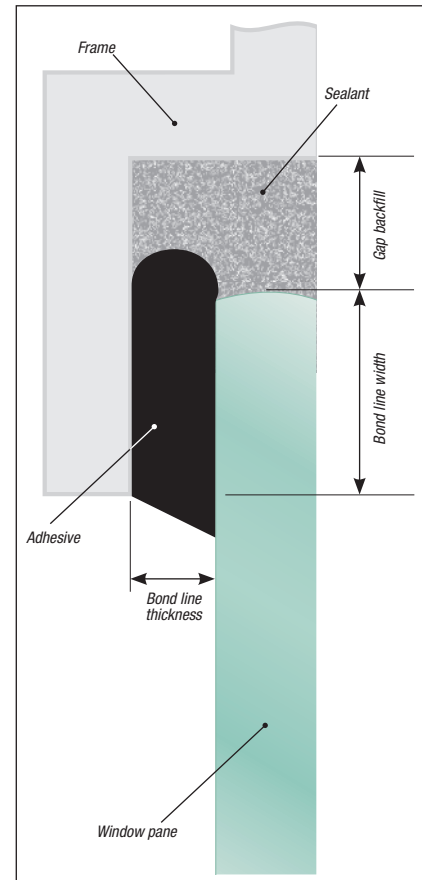


Fig. 2 Definitions of the window dimensions

### Bond line width

The overlapping area between the frame and the glazing, known as the bond line width, should be large enough to allow sufficient adhesive to bear the weight of the glazing, as well as the suction load and head pressure to which the environment exposes it. A dimensioning guide is provided adjacent to the different procedures for mineral and organic windows.

### Bond line thickness

After it has set, the adhesive remains flexible. However, if too thinly applied, the adhesive may shear due to the changes in dimension caused by differences in thermal coefficient of expansion between the glazing and the superstructure and also the natural flexing between the glazing and the window frame in the varying sea conditions. Sika's dimensioning guide provided adjacent to the appropriate procedures determines the depth of spacers required to be placed within the adhesive to keep the distance equal to or greater than the minimum depth required to ensure the reliability and longevity of the adhesive and the bond.

### Gap backfilling

Around the edge of the glazing, there should be a gap sufficient to prevent contact between the glazing and the window frame for all temperatures and under all mechanical strains. A dimensioning guide is provided adjacent to the appropriate procedures.

### Surface preparation

The adhesion properties between the glazing and the window mounting material must be verified by Sika's Technical Department to ensure that the correct materials, solutions and methods are used and followed as per the procedure described on part 6.2.2 for organic glass and 6.3.2 for mineral glass. Improperly prepared surfaces could result in failure of the bond and may put the safety of the vessel in jeopardy.

The high quality of Sika products is guaranteed and whereas Sika cannot vouch for the quality or compatibility of other manufacturer's products, only Sika primers, cleaners and adhesion promoters should be used with Sika adhesives and sealants.

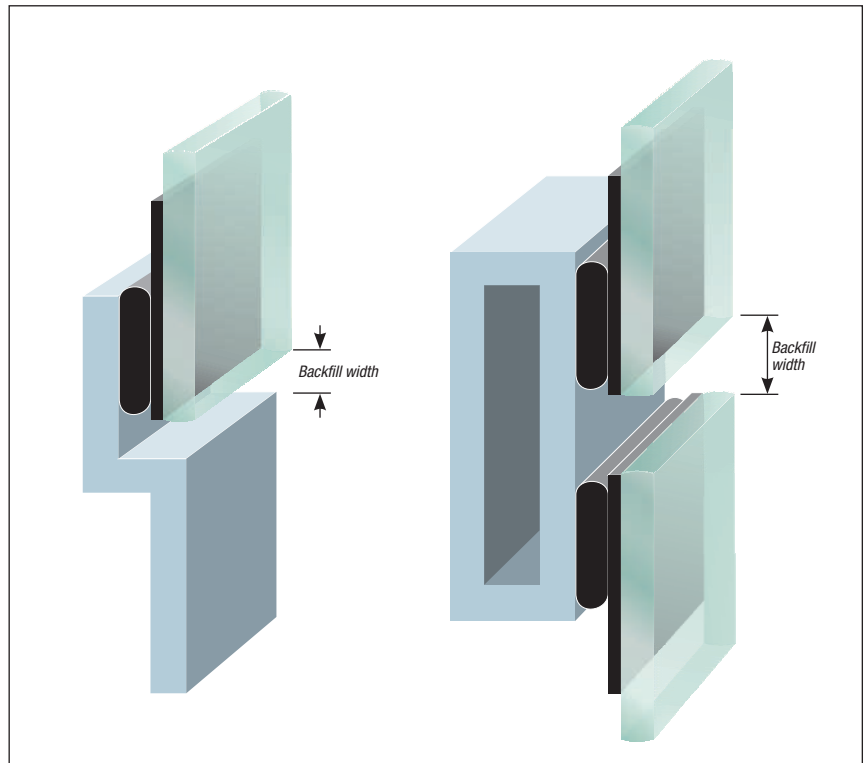


Fig. 3 The definition of backfill width

### Primers and cleaners

Flash off times for cleaners and primers must be strictly observed.

## 6.1.3 Product selection for both mineral and organic windows

Selection of the correct surface preparation system is of utmost importance; as is the selection of the correct adhesive. These both depend on the type of window to be installed. The following table shows which adhesive should be used:

	Bonding	Sealing / backfill
Mineral glazing (single glazing)	Sikaflex®-296	Sikaflex®-296
Mineral glazing (double glazing)	Sikaflex®-296	Sikasil® WS-605 S
Organic glazing	Sikaflex®-295 UV	Sikaflex®-295 UV

## 6.2 Bonding and Sealing Organic Windows



### 6.2.1 Application description

Most of the organic glazing materials used in boat building are either clear acrylic sheet (PMMA).

Plastic glazing products have a high coefficient of thermal expansion. In general, incorrectly installed plastic glazing panels are prone to environmental stress cracking (ESC). This can be aggravated by the use of the wrong adhesives or wrong dimensioned adhesive/sealant.

Plastic glazing products have a higher coefficient of thermal expansion than conventional glass. Therefore, when designing glazing installations, an expansion gap of at least 8 mm all round the periphery must be incorporated between the window rebate and the plastic glazing panel to accommodate thermal movement. In case of additional mechanical fixations any clearance holes for fixing screws must be drilled oversize; slightly larger than the diameter of the screw shank. See also plastic manufacturer recommendations.

To minimise the risk of environmental stress cracking, flat sheets of plastic glazing material should be installed completely flat; they

should not be forced to take up a curvature by the use of mechanical fastenings. When the design calls for curved glazing panels, these should be prefabricated to order and properly tempered by a specialist supplier to ensure installation with no remaining stresses.

As many varieties of organic window exist, it is recommended to ensure that the specific grade selected is suitable for use with Sikaflex®-295 UV. Please note that the extruded type of organic glazing (XT) exhibits a higher tendency to environmental stress cracking than the cast type (GS).

Please contact your local Sika company for technical advice.

## 6.2.2 Procedure for bonding and sealing with Sikaflex®-295 UV organic windows

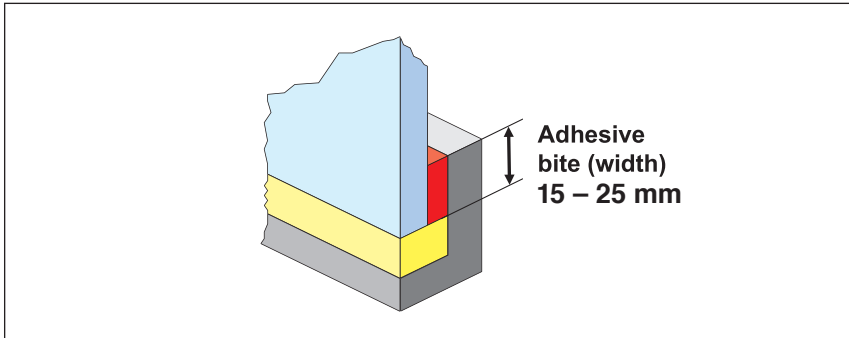
### Bondline configuration

Organic windows have a high thermal movement which creates stress in the bond line. Additionally dynamic stress due to the boat movement and the wind load have to be taken in consideration.

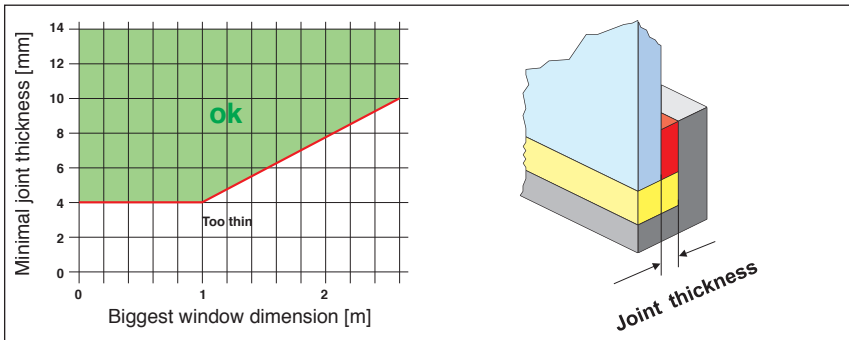
The following graphs are a result of theoretical and practical experience, considering all parameters of a boat under the conditions to which a window is subjected.

Basis of calculation are substrates MMA/GFK, wind load 2 kN/m<sup>2</sup>, ΔT = 30° C

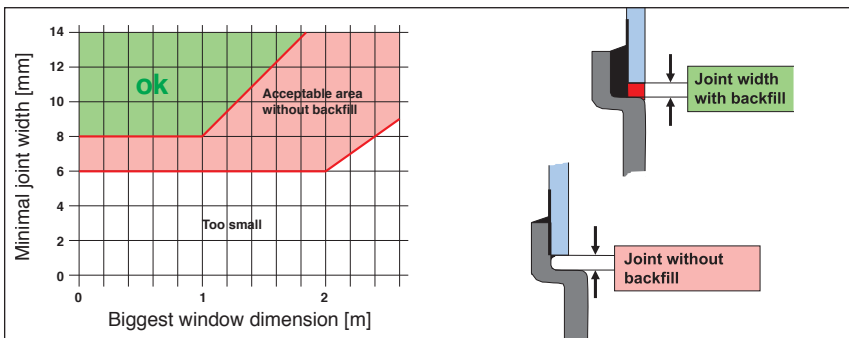
### Adhesive width (bite)



### Joint thickness










### Joint width










Note: For important projects consult Corporate Technical Service Sika Industry

## Substrate preparation




### GRP frame

-  Lightly abrade the gel coat of the contact area with a very fine sanding pad
-  Remove the dust with a vacuum cleaner
-  Mask off any areas that need it
-  Pre-treat the substrate with Sika® Aktivator-205, using a clean, lint-free rag or paper towel. Change the rag frequently!
- SA 205
-  Flash-off: 10 minutes (min) to 2 hours (max)
-  Apply a thin, continuous coat of Sika® MultiPrimer Marine, using a clean brush or felt applicator
- SMM
-  Drying time: 30 minutes (min) to 24 hours (max)

### Aluminium frame







-  Mask off any areas that need it
-  Lightly abrade the contact area with a fine sand pad
-  Remove the dust with a vacuum cleaner
-  Pre-treat with Sika® Aktivator-205, using a clean, lint-free rag or paper towel. Change the rag frequently!
- SA 205
-  Flash-off: 10 minutes (min) to 2 hours (max)
-  Apply a thin, continuous coat of Sika® MultiPrimer Marine, using a clean brush or felt applicator
- 210
-  Drying time: 30 minutes (min) to 24 hours (max)

### Aluminium or timber frame coated with two-part lacquer

-  Mask off any areas that need it
-  Pre-treat the substrate with Sika® Aktivator, using a clean, lint-free rag or paper towel. Change the rag frequently!
- Aktivator
-  Flash-off: 10 minutes (min) to 2 hours (max)

**Important:**  
For the preparation of other substrates, please refer to the Pre-Treatment Chart for Sika Marine Applications or contact the local Technical Service Sika Industry

## PMMA/PC glazing panels

 acryl paint	If required, apply an acryl paint or a profile opaque to cover the bond line in accordance with the Sika recommendations.
	Abrade the bond area with abrasive paper or very fine abrasive pad. Abrade the bonding periphery with 80 grit sandpaper if the organic glazing panel has a scratch proof coating (example Margard)
	Remove the dust with a vacuum cleaner
	Mask off any areas that need it
 209 D	Apply a continuous coat of Sika® Primer-209 D, using a clean brush or felt applicator
	Drying time: 30 minutes (min) to 24 hours (max)





## Bond line protection






As with conventional glass, plastic glazing panels generally do not protect the adhesive face from damage by UV radiation. Therefore, the bond line must be protected from direct sunlight using one of the methods recommended.

- External cover strip of appropriate dimensions
- Internal sieve printing acrylic paint (contact Technical Service Sika Industry for appropriated types)

The use of black Primer Sika® Primer-209 D as a sole UV-protection is only permitted in case of a low UV-transmission of the organic glass (UV-transmission < 0,5% )

## Application of Sikaflex®-295 UV adhesive

	Place spacers in position. Depending on the size of the glazing panel, the thickness of the spacer should be chosen accordingly (see page 2). Shore A hardness of the spacer approximately 30 or less
	Avoid interruption of the bead by the spacers
 295i UV	Apply Sikaflex®-295 UV to the frame rebate or glazing panel using a triangular nozzle with a bead width of at least 10 mm
	Assemble all components within 20 minutes of applying the adhesive

	To prevent slip down of vertical glazing panels, distance blocks (wood or plastic) must be placed in the lower rebate during installation. After curing, these must be removed. The backfill gap must be at least 8 mm (see page 2)
	Fastening aids can be removed after 24 hours. After this time, the expansion gap between glazing panel and the backfill gap should be filled and completely sealed with Sikaflex®-295 UV.
 295i UV	This sealant joint can be tooled to a smooth finish using Sika® Tooling Agent N. This must be carried out before skinning of the sealant
	After tooling remove any masking tape before the adhesive skins over
 208	Uncured Sika adhesives or sealants may be removed with Sika® Remover-208

## Window edge sealing/backfilling

Commonly, the edge of the window will be cosmetically finished with Sikaflex®-295 UV. The preparation of the surfaces must be identical to that used for bonding. Edge sealing ensures both the prevention of standing water on or near the bond and helps cosmetically finish the window. Fill up the joint completely, ensuring there is no space between the adhesive bead and the joint. The diagram on page 2 illustrates the required dimensioning of the back-fill gap for plastic window panels using Sikaflex®-295 UV.

**Important:**  
Always refer to the current Sika Product Datasheet and Material Safety Datasheet obtainable through your local Sika company

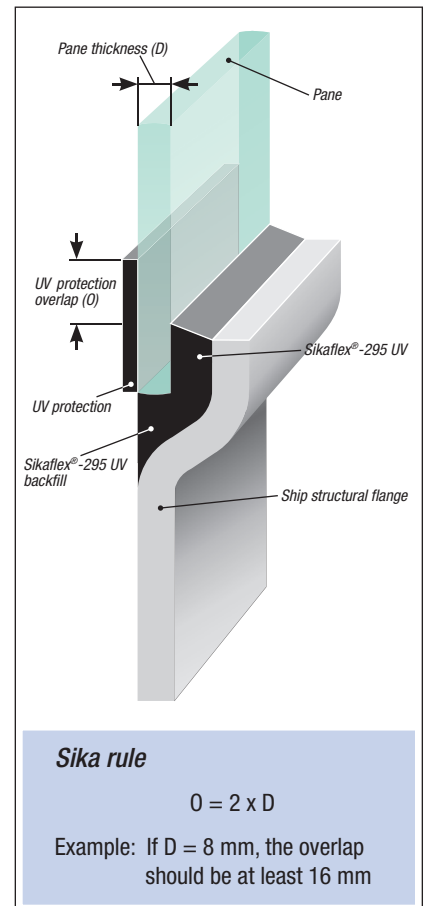


Fig. 1 Minimum recommendations for external UV bond line protection

## 6.3 Bonding and Sealing Mineral Glazing



### 6.3.1 Application description

The direct mineral glazing into frames or directly into the hull or deck, requires a full understanding of all the important principles involved.

It is essential that the glass meets all the demands and standards required for the intended application, such as IMO resolutions or other regulations as laid down by the classification societies.

In case of self cleaning glass we ask you to consult the Corporate Technical Service Sika Industry.

The adhesive bond line must be protected against UV radiation. This may be achieved using several materials and methods:

- Using a black, ceramic coated border with a light transmission of less than 0.01%.



**Important:**

*Local and international rules for maritime constructions and appropriate legislation must always be observed.*



## 6.3.2 Procedure for bonding and sealing mineral glazing with Sikaflex®-296

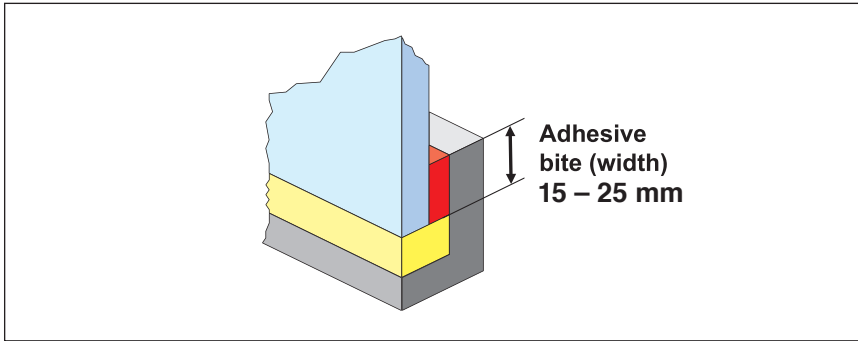
### Adhesive and sealant dimensioning

The dimensioning of the adhesive and the joint geometry must be carried out in accordance with Sika's basic rules of calculation. If deck movement is negligible the following dimensions are recommended.

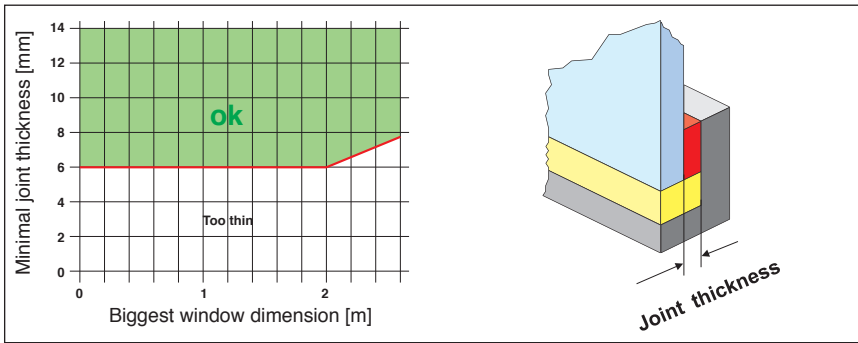
**Important:**  
At all times recommendations from classification societies must be respected

Basis of calculation substrate aluminium-glass, wind load 2,4 kN/m<sup>2</sup>, ΔT = 40° C

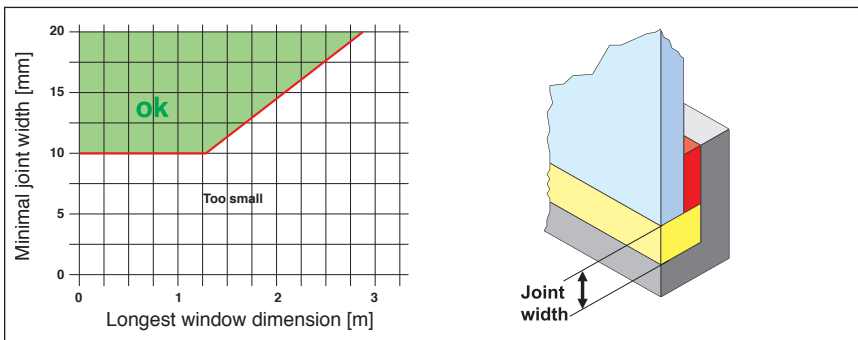
### Determination of the adhesive width (bite)



### Adhesive thickness










### Joint width



Note: For insulating glass or important projects consult Corporate Technical Service Sika Industry



## Substrate preparation

### GRP frame





-  Lightly abrade the gel coat of the contact area with a very fine sanding pad
-  Remove the dust with a vacuum cleaner
-  Mask off any areas that need it
-  Pre-treat the substrate with Sika® Aktivator-205, using a clean, lint-free rag or paper towel. Change the rag frequently!
-  Flash-off: 10 minutes (min) to 2 hours (max)
-  Apply a thin, continuous coat of Sika® MultiPrimer Marine, using a clean brush or felt applicator
-  Drying time: 30 minutes (min) to 24 hours (max)

For the preparation of other types of frames, please refer for the Pre-Treatment Chart for marine application.

### Glass with external UV protection or with black ceramic border (transmission < 0.01%)

-  Pre-treat the substrate with Sika® Aktivator, using a clean, lint-free rag or paper towel. Change the rag frequently!
-  Flash-off: 10 minutes (min) to 2 hours (max)

### Glass with black ceramic glass border (transmission > 0.01% visible light)

-  Pre-treat the substrate with Sika® Aktivator, using a clean, lint-free rag or paper towel. Change the rag frequently!
-  Flash-off: 10 minutes (min) to 2 hours (max)
-  Apply a thin, continuous coat of Sika® Primer-206 G+P, using a clean brush or felt applicator
-  Drying time: 30 minutes (min) to 24 hours (max)

## Application of Sikaflex®-296 adhesive










	Place spacers in position. Depending on the size of the glazing panel, the thickness of the spacer should be chosen accordingly. Shore A hardness of the spacer approximately 40 or less
	Avoid interruption of the bead by the spacers
 295i UV	Apply Sikaflex®-296 to the frame rebate or glazing panel using a triangular nozzle with a bead width of at least 10 mm
	Assemble all components within 20 minutes of applying the adhesive
	To prevent slip down of vertical glazing panels, distance blocks (wood or plastic) must be placed in the lower rebate during installation. After curing, these must be removed. The rebate gap must be at least 10 mm (see page 2)
	Clamps and other fastening aids can be removed after 24 hours. After this time, the expansion gap between glazing panel and the rebate should be filled and sealed with Sikaflex®-296.
 296	This sealant joint can be tooled to a smooth finish using Sika® Tooling Agent N. This must be carried out before skinning of the sealant
 N	After tooling remove any masking tape before the adhesive skins over
 208	Uncured Sika adhesives or sealants can be removed with Sika® Remover-208



Fig. 1 Cleaning (pre-treatment) of the ceramic ink area with Sika® Aktivator

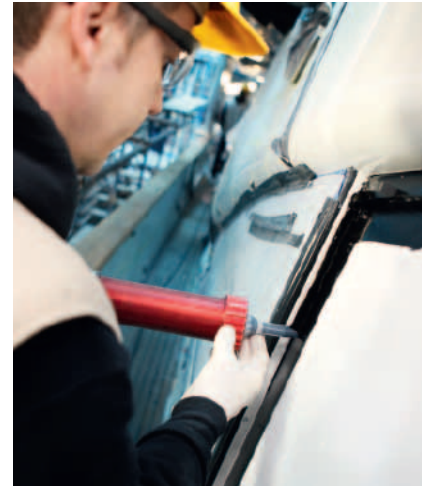


Fig. 2 Adhesive is applied to the window frame



Fig. 3 The window is fitted