SIKA APPLICATION GUIDE

GENERAL MARINE SEALING AND BONDING TECHNOLOGY
SIKAFLEX

Bruksområde:

Egenskaper:

Teknisk data:

QR-kode til produktdatablad
## CONTENT

<table>
<thead>
<tr>
<th>Page</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>04</td>
<td>Preface</td>
</tr>
<tr>
<td>05</td>
<td>Explanation Of Different Fixing Methods</td>
</tr>
<tr>
<td>07</td>
<td>Different Between Rigid And Elastic Adhesives</td>
</tr>
<tr>
<td>09</td>
<td>Bonding Construction Design</td>
</tr>
<tr>
<td>12</td>
<td>Cost Advantage Of Elastic Bonding</td>
</tr>
<tr>
<td>13</td>
<td>Tips And Tricks</td>
</tr>
<tr>
<td>17</td>
<td>Product Selector, Calculation Tools</td>
</tr>
<tr>
<td>18</td>
<td>Adhesie Primer Consumption</td>
</tr>
<tr>
<td>19</td>
<td>Conversions And Calculations</td>
</tr>
<tr>
<td>20</td>
<td>Quality Assurance</td>
</tr>
<tr>
<td>22</td>
<td>Product Datasheets And Safety Datasheets</td>
</tr>
<tr>
<td>24</td>
<td>Bedding And Sealing Fittings And Hardware</td>
</tr>
<tr>
<td>26</td>
<td>Bonding Of Rub Rails And Fenders</td>
</tr>
<tr>
<td>28</td>
<td>Bonding Decorative Panels And Work Surfaces</td>
</tr>
<tr>
<td>30</td>
<td>Bonding Lightweight Internal Partitions</td>
</tr>
<tr>
<td>32</td>
<td>Elastic Thick Layer Bonding</td>
</tr>
<tr>
<td>34</td>
<td>Sika Solutions For Structural Bonding</td>
</tr>
<tr>
<td>36</td>
<td>Direct Glazing</td>
</tr>
<tr>
<td>39</td>
<td>Sealing And Bonding Organic Windows</td>
</tr>
<tr>
<td>42</td>
<td>Sealing And Bonding Mineral Glazing</td>
</tr>
<tr>
<td>45</td>
<td>Flybridge Bonding</td>
</tr>
<tr>
<td>47</td>
<td>Deck And Keel To Hull Bonding</td>
</tr>
<tr>
<td>50</td>
<td>Glossary Of Terms</td>
</tr>
</tbody>
</table>
INTRODUCTION
Since the middle of the 17th century, when the industrial revolution began, the process of manufacture has changed dramatically, in methods and materials. At the time, it was state-of-the-art to assemble boats and ships using traditional methods like wood jointing, nailing and screwing. Riveting and welding followed in later years, but today, we are aware of the limitations of these old methods compared to what is currently available. New lightweight materials as well as sandwich structures need smooth, stress concentration free assembly. Today, time, weight, cost, design freedom and reliability are all greatly enhanced by using chemical bonding, sealing and damping products.

BONDING, SEALING AND DAMPING
Sealants and adhesives share a similar technology. Their functions overlap to a large extent, but as they also have a range of other benefits, the role of elastic bonding is not only to join, but also to waterproof, dampen sound, insulate and prevent galvanic corrosion; all needed to overcome the daily problems in the marine environment. Some products are specifically for bonding as they exhibit high mechanical strength (commonly known as rigid adhesives) and feature variable open time to accommodate everything from quick production rates, to the much slower large structural component assembly. Much of their usefulness in absorbing forces and shock stems from the toughness of the cured bond and this, in turn, is a major factor in the durability and reliability of the bond.

FLEXIBLE BONDING AND SEALING
Flexible bonding and sealing is distinct from bonding with high modulus adhesives. They are applied in a bondline thickness of some millimetres. These products have the high elastic characteristics of both adhesives and sealants. While it does not have the high mechanical strength of rigid bonding adhesives, it has far greater flexibility, which helps to reduce fatigue in the bonded components.

FLOORING AND ACOUSTIC DAMPING
Sub decks are not always smooth and level and besides being generally unattractive, they are responsible for the transmission of most of the noise in cabins and compartments. Modern flooring has elements that improve the marine environment:

- The deck is levelled and smoothed
- The noise level transmitted through it is reduced
- The cosmetic finish improves the appearance
- Various systems can be used that amplify one or more of these.

Sika works closely with suppliers, universities, research institutions, certification societies but primarily with our customers, to maintain the most relevant level of expertise in bonding, sealing and damping. We are continuously developing the product range as new methods, materials and designs emerge or are needed.

All processes concerning application of our products are fully tested and choreographed to ensure 100% reliability. This manual explains the processes and describes the procedures necessary to achieve the highest standards. It is therefore essential that the appropriate section is consulted and adhered to for every process undertaken.

From long experience in marine applications, it is highly recommended that Sika (Corporate or local Technical Service) is consulted at the outset of any new projects.
EXPLANATION OF DIFFERENT FIXING METHODS

SOME HISTORICAL FACTS
Traditional fixing methods are mechanical fixations. Adhesives have still the nimbus of a low seriousness due to less and/or negative experiences. Adhesive technologies are not accepted voluntary. The bonded result cannot visually be detected. The resulting prudence is also called Icarus effect. From this story from the greek mythology only the crash of Ikarus is known where Daidalos his succeeding father is less known. Nevertheless Daidalos, a blacksmith, is the “historical father” of the bonding technology as the wings he produced to escape from his prison have been feathers bonded with an adhesive (light weight construction).

Nowadays aircrafts like the Boeing 787 Dreamliner are made out of synthetic carbon fibres. Only the bonding technology can be used for joining such substrates. The bonding technology is state of the art in multiple areas including the naval industry.

Sealing on the other hand has been one of the oldest technologies in the shipbuilding. Caulking boats with cotton robes impregnated with bitumen is one of the used technologies. Nowadays modern products replace this demanding working procedure.

The differences between some mechanical fixations and the bonding technologies outline some advantages of each method.
### PRINCIPAL DIFFERENCES OF THE FIXING METHODS

<table>
<thead>
<tr>
<th>Production</th>
<th>Riveting / screwing</th>
<th>Spot weld</th>
<th>Rigid bonding</th>
<th>Elastic bonding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process speed</td>
<td>Fast</td>
<td>Fast</td>
<td>Medium to fast</td>
<td>Medium</td>
</tr>
<tr>
<td>Substrate preparation</td>
<td>Low</td>
<td>Low</td>
<td>Medium to important</td>
<td>Medium to important</td>
</tr>
<tr>
<td>Substrate deformation (heatprocess)</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>None</td>
</tr>
<tr>
<td>Tolerance gapping</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Very good</td>
</tr>
<tr>
<td>Calculation of the bondline</td>
<td>Yes</td>
<td>Yes</td>
<td>Possible</td>
<td>Possible</td>
</tr>
<tr>
<td>Industrial hygiene</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Noise emission during manufacturing</td>
<td>High to low</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Quality control</td>
<td>Easy</td>
<td>Easy</td>
<td>Needs QC</td>
<td>Needs QC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Obtained characteristics</th>
<th>Riveting / screwing</th>
<th>Spot weld</th>
<th>Rigid bonding</th>
<th>Elastic bonding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joining different materials</td>
<td>Possible / limited</td>
<td>Not possible</td>
<td>Possible</td>
<td>Possible</td>
</tr>
<tr>
<td>Sealing</td>
<td>Separate operation</td>
<td>Separate operation</td>
<td>Yes</td>
<td>Very good</td>
</tr>
<tr>
<td>Acoustical improvements</td>
<td>No</td>
<td>No</td>
<td>Limited</td>
<td>Yes</td>
</tr>
<tr>
<td>Joining of thin substrates</td>
<td>Not recommended</td>
<td>No</td>
<td>Possible</td>
<td>Ideal method</td>
</tr>
<tr>
<td>Durability</td>
<td>Danger of corrosion</td>
<td>Danger of corrosion</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>

Adhesive bonding is a modern and highly effective joining technique with a number of innovative performance characteristics, which forms a welcome addition to the standard repertoire of rigid fastening technologies. Through the selective use of these adhesives and careful attention to the specific application techniques associated with them, engineers and designers are now able to design technically sophisticated products that can be manufactured economically.

The use of this bonding technology permits to use all kind of substrates permitting an optimised construction. Just to mention some advantages:

- Freedom of styling (use of GRP / plastics / metals to optimise material cost)
- Weight savings (thinner substrates / plastics)
- Sound reduction (especially with elastic adhesives)
- Corrosion resistance (bonding on anticorrosive paints, no injury of the anticorrosive layer)

The highest economic and technical benefit of the bonding technology is based on these multiple advantage which is achieved in a single operation.

The bonding technology is a new tool for engineers and designer to realise modern and innovative solutions in the Marine Industry.
Elastic adhesives differ in their functionality to the rigid systems. Rigid (high modulus) adhesives are normally used in thin layers of about some hundred microns. In contrast elastic adhesives are used in a thickness of some millimeters. Therefore the expression of thick layer bonding has been created for such application types.

The function of these systems differs in their way to transmit forces. Rigid adhesives transmit forces directly without noticeable deformation. Elastic adhesives lower the forces by bond line deformation and uniform stress distribution over the whole bonding surface.

Both of these systems have their advantages as well as their limitation. The following article describes the principal characteristics, knowing that this classification is not complete as semi flexible products may be situated somewhere in between.

To show the difference, studies have been done at the University of Munich to demonstrate this difference.

Tensile lap shear samples of PMMA (Polymethylmetacrylate, ex. Plexiglas) have been bonded and stressed. By using polarized light, lines of different colours (stress levels) could be visualized.

The uniform stress distribution of the elastic adhesive permits to utilize the whole bonding surface for the force transmission.

Elastic thick layer bonding permits therefore to use thinner substrates, or just to bond directly on painted surfaces for better corrosion resistance, just to mention two of the multiple advantages by using this fixation method.

**DIFFERENCE BETWEEN RIGID AND ELASTIC ADHESIVES**

Test sample. Lap shear test with PMMA substrate bonded with different adhesives. One sample has been screwed.

Screwed sample. The force line indicate a direct transmission of the forces from one part of the sample through the screw to the other part of the sample.

Same sample plan view. Here stress concentration around the bolts is visible (stress peaks around the screw).
One of the most contradictory discussion concerns the definition of “Structural bonding”. Many authors use this expression in connection with a high strength or modulus of an adhesive. A more practice related definition uses this expression for bonding assemblies which are essential for the functioning to the assembled part. This seems for us a better definition as it will also take in consideration the durability aspects.

Elastic adhesive bonding is a joining technique with a number of innovative performance characteristics, which forms a welcome addition to the standard repertoire of rigid fastening technologies. Through the selective use of these adhesives and attention to the specific application techniques associated with them, engineers and designers are now able to design technically sophisticated products that can be manufactured economically.

### Differences between elastic thick layer bonding and rigid thin layer bonding

<table>
<thead>
<tr>
<th>General Characteristics</th>
<th>Rigid (high modulus) adhesives</th>
<th>Elastic adhesives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bondline dimension</strong></td>
<td>Thin adhesive layer, small overlapping</td>
<td>Thick layer of at least 2 mm. Higher force transmission may be achieved by increasing the overlap (bonding area).</td>
</tr>
<tr>
<td><strong>Temperature dependency</strong></td>
<td>Glass transition temperature has to be observed. If the bonded object is used over this temperature, mechanical resistance drops and may lead to failures</td>
<td>Elastic adhesives have a glass transition temperature at about minus 50°C. The dependency of the mechanical strength in the normal application range is minim. However the temperature resistance is limited to approx. 90°C for elastic Polyurethanes and approx. 120°C for Silicons</td>
</tr>
<tr>
<td><strong>Force transmission</strong></td>
<td>Forces resulted by mechanical stress or differences in thermal expansion coefficient have to be transmitted and result directly from the chosen parameters. In some cases parts may deform during temperature change due to a “Bimetal effect”</td>
<td>Forces applied on an elastic bond line provoke a deformation of the bondline, thus lowering the stress on the substrates</td>
</tr>
<tr>
<td><strong>Shock resistance</strong></td>
<td>Normally the shock resistance of a rigid bond line is not very high, especially in the range of the Glass Transition Temperature. However some special formulations have an excellent shock resistance</td>
<td>The shock resistance of elastic bond lines is excellent. The mechanical resistance increases with the applied speed. Under shock resistance, the mechanical resistance is high</td>
</tr>
<tr>
<td><strong>Adhesion on painted substrates</strong></td>
<td>The paint adhesion on a substrate is about 7N / mm². High modulus adhesive may lead to stress peaks and cause a break between paint and substrate</td>
<td>The modulus of elastic adhesives is lower than the one of the paint. Therefore application on painted substrate is possible. Thereby the corrosion resistance is not impaired</td>
</tr>
<tr>
<td><strong>High strength bonding</strong></td>
<td>Good solution. Rigid adhesives may be combined with mechanical fixation methods</td>
<td>Only possible with larger bonding area</td>
</tr>
</tbody>
</table>

### Differences elastic thick layer bonding / rigid thin layer bonding

| **Bonding of different metals** | Perfect in case of metals with low differences in thermal behavior, good for applications where bondline dimension (thickness /surface) is restricted. | Good compensation of thermal movements, good protection against galvanic corrosion, good tolerance gapping |
| **Bonding of metals with plastic** | Usable for bonding smaller parts, good for applications where bondline dimension (thickness /surface) is restricted. | Ideal for bonding of GRP with important tolerances, good for shock resistance and acoustical damping |
| **Bonding plastic to plastic** | Normally good technique with low surface preparation, ideal for sandwich construction with low modulus core materials | Less interesting solution. ESC has to be taken in consideration. Ideal for bonding duroomers (glass reinforced plastics) with important tolerances |
PRINCIPALS
Joining of two materials means to connect them to a unit which is capable to transmit forces resulting from dynamic, static or other stress during the use of the subject. Normal joint technologies are mechanical joining methods which are known since long times.

Glues however have been reported to be used about 3000 years before JC. Asphalt and natural resins have been used to tighten up ships and clay has been used to build houses.

However structural bonding started in the 30ties of this century. One of them is unsaturated polyester which are still in use today. The development of epoxy resins opened up a vast area of bonding applications.

Elastic adhesives or sealants started in 1964 in the USA using an elastic adhesive for windscreen bonding. This technology is state of the art in all type of windscreen bonding in all market fields.

In the 80ties elastic bonding was used in busses followed by trains and trams in 1992. Structural bonding in Marine started at the beginning of the 90ties. In the meantime, elastic bonding technology was established in other sectors of the manufacturing industry, such as for containers, refrigerators and washing machines, facades, floors, windows and many applications.

The following chapter will help to understand the bonding technology and how to design an adhesive joining case.

The strength of a joint is basically determined by the area of the bond, the inherent strength of the adhesive or the substrate and the stress distribution within the joint. A poorly designed joint can lead to high stress concentrations in the joint itself and / or in the substrates connected, which in turn can lead to premature failure. Good joint design, which takes into account the practicalities of application as well as the geometry of the joint, is essential for a long service life in a demanding Marine environment.

Peel forces are the most difficult to counter and must be avoided by changing the design of the joint.
Generally forces which in praxis occur are the following:

- Tensile (ok if force is symmetric)
- Tensile lap shear (best solution for bonding)
- Compression (ok)
- Torsion (ok)
- Asymmetric torsion (to avoid)
- Peel (to avoid)
- Asymmetric peel (to avoid)

Here an example: by changing the construction the risk of peel forces could be minimised.
Traditional mechanical joint design has to cope with the inherent strength of an adhesive.

The following examples show some of an adhesive alternative to welding.

**CALCULATION OF THE BONDING AREA**

The dimensioning of a bond line depends mainly of the forces to be transmitted, and the mechanical resistance of the substrates and adhesives.

One of the most common errors is to calculate the bond line on the bases of the data’s in the Product Datasheets. These data’s are based on static tests. In praxis a lot of factors have to be considered. Temperature influence, type and frequency of the stress, aging etc. are factors on which the bond line is subjected.

Detailed calculation procedures can be ordered from your local Sika Industry branch or in appropriated literature (Example: “Elastic bonding, the principles of adhesive technology and a guide to its cost effective use in Industry” Verlag Moderne Industrie).

In praxis a rule of thumb can be used as a first approximation. The lap shear strength has to be reduced to 3% of the Product Datasheet value.

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**Example:**

Tensile lap shear force needed is 200 kg equal to 2000 Newton.

The Product Datasheet value of a particular adhesive is 2 N / mm²

The calculation value for the applicable tensile lap shear strength is only 3% of this Product Datasheet value: 2 N / mm² x 0.03 = 0.06 N / mm²

The required bond surface is therefore: 2000 N / 0.06 N / mm² = 33’000 mm² = 330 cm²

Considering a bond line width of 15 mm, the required length of the joint is: 330 cm² / 1.5 cm = 220 cm or 2.2 m

**Note:**

For exact calculation with the FEM-Methods we recommend to consult the Technical Service Sika Industry.

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![Diagram](attachment://Diagram.png)
COST ADVANTAGE OF ELASTIC BONDING

COST COMPENSATION
Adhesives compared to riveting or spot welding result in an advantage of the mechanical fixations.

However, a cost comparison has to be done taking all factors of the realisation in consideration. As an example spot welding may increase the expenditure of the filling of a surface prior to painting, thus increasing the overall costs.

The following list gives thought provoking impulse to realise a correct cost comparison.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Benefits (manufacturing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond / seal simultaneously</td>
<td>Reduction of process steps / No additional sealant costs</td>
</tr>
<tr>
<td>Compensates for tolerances</td>
<td>Less work to prepare substrate</td>
</tr>
<tr>
<td>Application at room temperature</td>
<td>Less spatula work / Low energy costs</td>
</tr>
<tr>
<td>(no thermal deformation)</td>
<td></td>
</tr>
<tr>
<td>Curing at room temperature</td>
<td>Lower energy costs</td>
</tr>
<tr>
<td>Bonding different substrates</td>
<td>Optimised choice of materials / lightweight construction / No bimetallic plates necessary</td>
</tr>
<tr>
<td>No sink marks on thin sheets</td>
<td>Thinner sheets / savings</td>
</tr>
<tr>
<td>Less tools</td>
<td>Lower investment costs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Properties</th>
<th>Benefits (enduser)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not corrosion-prone fixing</td>
<td>Longer life expectancy</td>
</tr>
<tr>
<td>Reduced maintenance</td>
<td>Lower costs</td>
</tr>
<tr>
<td>Weight-reduction</td>
<td>Lower fuel consumption</td>
</tr>
<tr>
<td>No built-in tensions</td>
<td>Increased longevity</td>
</tr>
<tr>
<td>Design with low cw (drag coeff.)</td>
<td>Lower fuel consumption</td>
</tr>
<tr>
<td>Application and curing at room temperature</td>
<td>Simple repair</td>
</tr>
<tr>
<td>Even surfaces</td>
<td>Easy to clean</td>
</tr>
<tr>
<td>Noise reduction</td>
<td>Increased comfort</td>
</tr>
<tr>
<td>Freedom of design</td>
<td>Increased brand awareness</td>
</tr>
</tbody>
</table>
TIPS AND TRICKS

SURFACE PREPARATION

General remarks
The surface preparation is beside the material choice and the joint dimensioning the key for a long lasting bond. Therefore it is essential to execute the surface preparation very accurately.

Surface cleaning
Dirty surfaces have to be pre cleaned. For oily or fatty surfaces, steam cleaning with detergents and consecutive rinsing with clean water are recommended for large areas. Smaller areas may be pre cleaned with solvents such as Sika® Remover-208.

Dust on surfaces is best removed with a vacuum cleaner. Compressed air as alternative can be used if it is deoiled.

Rust, other oxydes or loose paints have to be eliminated mechanically. Methods are sandblasting, and grinding. In case of sandblasting the type of blasting material has to be chosen according to substrate to clean. If necessary contact an abrasive producer.

Grinding with sand paper may be done with belt grinder, excentric grinder, rotation grinder or manually. The grit to choose depends on the material to eliminate. Usually grit 40-80 is used.

After grinding the dust has to be eliminated with a vacuum cleaner.

Steam cleaner
Sandblasting
Deoiler for compressed air
SURFACE TREATMENT
The additional surface treatment may be the use of an activator or/and a primer. Detailed informations are given on the Marine Pre-Treatment Chart.

STORAGE OF THE PRODUCTS

STORAGE UNOPENED CARTRIDGE OR UNIPACK
Sikaflex® and Sikasil® products should be stored at a temperature below 25°C. The product shelf life is indicated on each packaging unit.

If the product is stored at higher temperature, viscosity of Sikaflex® rises up to a moment where it is hard to extrude and shows a slight elastic behavior. In this case do not use it as the wetting of the substrate is not ensured anymore.

Sikasil® reacts differently. After the expiry date the reactivity slows down and the physical strength is lower than indicated in the Product Datasheet. The viscosity (extrusion behavior) of the product is not changing.

STORAGE OF AN OPENED CARTRIDGE
If a cartridge is opened and not used for some days, the nozzle has to remain on the cartridge and just changed with a new one before reuse of the cartridge.

If the product will not be used for a longer period, we recommend removing the nozzle and covering the cartridge opening with an aluminum foil. Screw a new nozzle over this foil. When reused after elimination of the foil, the beginning of the extrusion needs a high force. Once the plunger starts to move, the extrusion force drops down to a normal level.

STORAGE OF ACTIVATORS AND PRIMERS
These products should be stored at lower temperatures than 25°C. Once opened bottles should be closed immediately after use. Maximum storage life after opening is 3 months.

PRODUCT APPLICATION

GENERAL ADVICE
Respect the recommendation in the actual Product Safety Sheet concerning collective and personal protection. Use only products within the best before date. Never use thinners or solvents to dilute Activators or Primers.
APPLICATION OF ACTIVATORS AND PRIMERS

Activators should be applied like a solvent. It is applied on non-porous substrates only! Wet a paper tissue sparingly with the corresponding Activator and wipe the surface in one direction. Turn the tissue to a proper side and continue cleaning. Dry the area with a dry tissue (wipe on / wipe off method). Discard the tissues when dirty according to legal legislation. Close Activator bottles immediately after use.

If you transfer the Activator in a separate can, discard the rest at the end of the day according to legal legislation to prevent inactivation of it.

Do not use an Activator which is cloudy or which show an unusual aspect. Respect the minimum and maximum waiting time until the adhesive or sealant is applied. Consult the Pre-Treatment Chart Marine.

Primers are applied like paint. Use a clean dry brush, a felt or dauber to apply a Primer.

APPLICATION OF ADHESIVES AND SEALANTS

The application is done with a good quality type of gun. Cheap guns may fail especially with higher viscous adhesives such as Sikaflex®-292i or -296. Apply the product with a triangle shaped nozzle of the appropriate dimension, holding the gun in a vertical position.

Pigmented primer like Sika® Primer-206 G+P or Sika® Primer-209 D have to be shaken until the metal ball in the can can be heard. Shake for another minute until the primer is completely homogen.

Pigmented primer like Sika® Primer-206 G+P or Sika® Primer-209 D have to be shaken until the metal ball in the can can be heard. Shake for another minute until the primer is completely homogen.

Insert spacers (see page 16) beside the adhesive bead.

Join the parts together, applying a uniform pressure until the final position of the parts is reached. Use a flat rod to press flexible parts uniformly to the desired thickness.

In case of vertical application use distance blocks or adhesive tapes to hold the part in position until the adhesive get sufficient strength.

For additional sealing operation, protect the sides with adhesive tapes. Apply the sealant watching a complete filling of the space to prevent air inclusions between adhesive and sealant. Tool the sealant with a flexible spatula. Remove the adhesive tapes as soon as the tooling has been done before skinning of the sealant occurs.
REMOVAL OF ADHESIVES AND SEALANTS

FRESH UNCURED PRODUCTS
On non-porous substrate, remove the sealant or adhesive with a spatula. Clean the left over with a tissue or rag and Sika® Remover-208.

Do not use other solvents as they can react with Sikaflex® forming a permanently sticky surface.

On porous substrate it is best to let the product cure and remove it after hardening with mechanical means.

CURED PRODUCT
Cured Sikaflex® can only be eliminated with mechanical means. Solvents do not dissolve the hardened Sikaflex® but may soften it for easier removal (use acetone or isopropyl alcohol).

Note: Never use Sika® Aktivator for cleaning.

CLEANING OF HANDS AND SKIN
Contact with Sikaflex® should be avoided. Use personal and collective protection means, such as gloves etc.

Never use solvents to clean the skin. Best is Sika® Handclean towel or other water based cleaning pastes.

Detailed information’s about the physiology of the products are available in the national Safety Datasheet, available on the Internet. www.sika.com

AUXILIARY MATERIALS

MASKING TAPE
Masking tapes are to be used to protect the substrate against soiling. Apply the masking tape about 1 mm away from the joint area (see illustration). After application and tooing of the adhesives, the masking tape should be eliminated as soon as possible before skinning of the adhesive or sealant occurs.

SPACERS
Spacers are used to assure a defined thickness of the bond line. They should be softer (shore hardness) than the cured adhesive.

Suitable materials are self-adhesive bumpers. Other possibility is to produce a small bead or sheet of the Sikaflex® adhesive in the desired thickness. After curing cut it in small parts of approx. 5x10 mm.

Fix the spacer on the substrate. If an adhesive is needed we recommend to use a small dot of Sikaflex®. Never use superglue as they exhale vapors which impair a good adhesion of the Sikaflex® adhesive on the substrate.

DISTANCE BLOCKS
Distance blocks are used to temporarily fix vertically bonded parts to prevent sliding.

They are best made of plastics or wood. Never use metals! After sufficient curing of the adhesive. They can be removed to permit the consecutive sealing (backfill) of the remaining joint.

HOW TO AVOID CORROSION
The best corrosion resistance is achieved with suitable paint systems which are designed for the marine conditions.

- Aluminum and ordinary steel have to be protected with such systems. (ISO 12499-3)
- In addition enclosed air pockets or other closed areas (example between adhesive and backfill sealant) have to be avoided. In case of cold application temperature, the viscosity can be decreased warming up the adhesive or sealant in a water bath. (Up to about 40°C)
- Interrupt the bead to allow occasionally entered water (condensed water).

Note: Sika primers give a very limited corrosion resistance and should be used only for adhesion purposes.
### PRODUCT SELECTOR, CALCULATION TOOLS

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>APPLICATIONS</strong></td>
<td></td>
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</tr>
<tr>
<td>General sealing, overpaintable</td>
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<td>●●●</td>
<td>●●</td>
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<td>-</td>
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</tr>
<tr>
<td>General sealing, weathering resistant</td>
<td>-</td>
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<td>●●●</td>
<td>●●</td>
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<td>●●●</td>
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<tr>
<td>Fire retardent sealing</td>
<td>-</td>
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<td>●●●</td>
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<tr>
<td>Organic glass bonding</td>
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<tr>
<td>Mineral glass bonding</td>
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<tr>
<td>Deck levelling</td>
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<tr>
<td>Wooden deck bonding</td>
<td>-</td>
<td>●●</td>
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<td>●●●</td>
<td>-</td>
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<tr>
<td>Caulking</td>
<td>●●●</td>
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<td>-</td>
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<tr>
<td>Bonding of coverings</td>
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<td>●●●</td>
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<tr>
<td>Sanitary sealing</td>
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<td>●●●</td>
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<td>-</td>
</tr>
</tbody>
</table>

| **SERVICE CONDITIONS** | High temperature > -40°C to 150°C | - | - | - | - | - | ●●● | ● | - | - |
|                        | Normal temperature -40°C to 90°C | - | ●●● | ●●● | ●●● | ●●● | ●●● | - | - | ●●● |

See also Pre-Treatment Chart for Marine Applications

### KEY TO SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>●●●</td>
<td>Best solution</td>
</tr>
<tr>
<td>●●</td>
<td>Good solution</td>
</tr>
<tr>
<td>●</td>
<td>Possible solution</td>
</tr>
</tbody>
</table>
ADHESIVE PRIMER CONSUMPTION

DESIGN OF ADHESIVE LAYER GEOMETRY

The elastic adhesive can only fully develop its positive properties (movement compensation, peeling and impact resistance) if the adhesive layer geometry is correct.

Above all, this means keeping to a minimum layer thickness that must be individually suited to the bond. A layer thickness of 2-3 mm has proved best for most applications. Thicker layers may be required where considerable movement is expected.

 Depths over 20 mm should be avoided with standard Sikaflex® grades because the adhesive would take too long to harden.

<table>
<thead>
<tr>
<th>Joint Width</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>5</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>62.00</td>
<td>31.00</td>
<td>20.60</td>
<td>20.00</td>
<td>10.00</td>
<td>6.60</td>
</tr>
<tr>
<td>2</td>
<td>31.00</td>
<td>15.50</td>
<td>10.30</td>
<td>10.00</td>
<td>5.00</td>
<td>3.30</td>
</tr>
<tr>
<td>3</td>
<td>20.60</td>
<td>10.30</td>
<td>6.88</td>
<td>6.60</td>
<td>3.30</td>
<td>2.20</td>
</tr>
<tr>
<td>4</td>
<td>15.50</td>
<td>7.75</td>
<td>5.15</td>
<td>5.00</td>
<td>2.50</td>
<td>1.60</td>
</tr>
<tr>
<td>5</td>
<td>12.40</td>
<td>6.20</td>
<td>4.10</td>
<td>4.00</td>
<td>2.00</td>
<td>1.30</td>
</tr>
<tr>
<td>6</td>
<td>10.30</td>
<td>5.16</td>
<td>3.44</td>
<td>3.30</td>
<td>1.60</td>
<td>1.10</td>
</tr>
<tr>
<td>7</td>
<td>8.85</td>
<td>4.40</td>
<td>2.95</td>
<td>2.80</td>
<td>1.40</td>
<td>0.90</td>
</tr>
<tr>
<td>8</td>
<td>7.75</td>
<td>3.90</td>
<td>2.60</td>
<td>2.50</td>
<td>1.20</td>
<td>0.80</td>
</tr>
<tr>
<td>9</td>
<td>6.90</td>
<td>3.50</td>
<td>2.30</td>
<td>2.20</td>
<td>1.10</td>
<td>0.70</td>
</tr>
<tr>
<td>10</td>
<td>6.20</td>
<td>3.10</td>
<td>2.00</td>
<td>2.00</td>
<td>1.00</td>
<td>0.60</td>
</tr>
</tbody>
</table>

PRIMER AND CLEANER CONSUMPTION

<table>
<thead>
<tr>
<th>Product</th>
<th>Yield per 100 mL at 20 mm Width (m)</th>
<th>Brush Application Tissue Application* (l/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sika® Aktivator / Sika® Aktivator-205</td>
<td>25-30</td>
<td>0.04*</td>
</tr>
<tr>
<td>Sika® Primer-206 G+P</td>
<td>17-22</td>
<td>0.1-0.15</td>
</tr>
<tr>
<td>Sika® Primer-209 D</td>
<td>12-15</td>
<td>0.15-0.2</td>
</tr>
<tr>
<td>Sika® MultiPrimer Marine</td>
<td>12-15</td>
<td>0.15-0.2</td>
</tr>
</tbody>
</table>

Make sure that:
- The primed areas coincide with the bonding areas
- The right primer for the material surface is used
- The primer is completely dry and cured before bonding i.e. watch the evaporation time
- Primers are shaken if necessary
CONVERSIONS AND CALCULATIONS

FORMULAE
TO ESTIMATE THE NUMBER OF LITRES REQUIRED

Normal bead application;
Quantity in litres = bead width (mm) x bead thickness (mm) x joint length (metres) / 1000
(Dimensions are for wet adhesive in rectangular cross section)

Large area bonding and laminating;
Quantity in litres = width (metres) x length (metres) x wet film adhesive thickness (mm).

TO DETERMINE THE VOLUME OF A SEMI-CIRCULAR BEAD
Quantity in litres = \(\frac{3.142 \times \text{diameter (mm)} \times \text{diameter (mm)} \times \text{length (metres)}}{8000}\)

TO DETERMINE THE VOLUME OF A TRIANGULAR BEAD
Quantity in litres = \(\frac{\text{width (mm)} \times \text{height (mm)} \times \text{length (metres)}}{2000}\)

TO CONVERT KILOGRAMS TO LITRES
Quantity in litres = weight in kilograms / density (grams / ml or kg / l)

TO CONVERT BETWEEN TEMPERATURE SCALES
Fahrenheit = \((\text{degrees celsius (°C)} \times 9) / 5 + 32\)
Celsius = \((\text{degrees fahrenheit (°F)} \times 5) / 9 - 32\)

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QUALITY ASSURANCE

PRACTICAL HINTS

This chapter examines the practical issues of quality assurance for elastic adhesive and sealant applications.

The proposals outlined here should be viewed as a general checklist to be adapted to the specific requirements of each marine manufacturing environment.

Particular attention needs to be paid to establishing an effective system of quality assurance for adhesive connections.

Testing of the adhesion, and therefore the reliability, is only possible by destructive means.

Visible inspection is only effective to a limited degree, so the quality of the bond line has to be assured by the following:

- Ensure the constancy of the surface quality of the substrates to be bonded
- Correctly prepare the surfaces to be bonded
- Select the correct adhesive (as specified by the manufacturer)
- Apply (and cure) the adhesives correctly
- Respect engineering rules such as joint dimensions, etc.

If these parameters are maintained within the prescribed limits, then the quality, strength and durability of the adhesive bond is ensured.

In addition, there is little or no need to supplement these measures with time-consuming and costly destructive testing.

The following table (Quality Assurance Programme) shows that quality assurance begins at the project stage and continues throughout construction, right up to the final rollout of the product. It outlines a typical quality management programme for adhesive applications. This model has been adopted with very satisfactory results in many areas of OEM ship building and in the subcontractor segment of the marine industry.
QUALITY ASSURANCE PROGRAMME

<table>
<thead>
<tr>
<th>PROJECT STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and construction adapted to adhesive technology and assembly methods</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONSTRUCTION OF PROTOTYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checking and specifying correct method of substrate preparation in consultation with adhesive and paint suppliers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>END OF TEST PHASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation of test phase, making any design changes that may be indicated</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SERIAL PRODUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation of a quality assurance system</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROTOTYPE</th>
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</thead>
<tbody>
<tr>
<td>Construction of prototype based on design criteria for adhesive bonding. Adhesive supplier (applications engineer) to advise where necessary</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>END OF TEST PHASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of a production and quality assurance manual for adhesive bonding applications, taking into account the key application parameters of temperature and humidity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SERIAL PRODUCTION</th>
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</thead>
<tbody>
<tr>
<td>Periodic refresher courses and further training for personnel</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SERIAL PRODUCTION</th>
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</thead>
<tbody>
<tr>
<td>Introduction of activities aimed at raising quality standards (e.g. quality awareness groups)</td>
</tr>
</tbody>
</table>

In commercial enterprises that use adhesives in serial production, the sound working knowledge of adhesive technology needed is generally confined to a few individuals in technical departments. The policy of training one technician as an in-house adhesives specialist has proven to be an effective solution to making this information available on the production floor. The trained person is also able to coordinate all aspects of adhesive usage for marine projects as a whole and acts as a neutral adviser to the individual departments concerned.

The following table highlights the main issues that need to be addressed.

<table>
<thead>
<tr>
<th>MAIN POINTS OF CONSIDERATION FOR THE INTRODUCTION OF ADHESIVE TECHNOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADHESIVE</strong></td>
</tr>
<tr>
<td><strong>SUBSTRATE</strong></td>
</tr>
<tr>
<td><strong>SURFACE PREPARATION</strong></td>
</tr>
<tr>
<td><strong>APPLICATION PARAMETERS</strong></td>
</tr>
<tr>
<td><strong>JOINT DESIGN</strong></td>
</tr>
<tr>
<td><strong>STAFF TRAINING</strong></td>
</tr>
</tbody>
</table>
The following table is a guide to the preparation of a quality assurance concept. The scope and frequency of the test regime will need to be adjusted to the scale of the project and to the availability of technical and manpower resources.

### A GUIDE TO THE PREPARATION OF A QUALITY ASSURANCE CONCEPT

<table>
<thead>
<tr>
<th>AREA OF RESPONSIBILITY</th>
<th>CHECKS AND CONTROLS</th>
<th>DEPARTMENT / PERSON RESPONSIBLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENSURING CONSISTENT QUALITY OF SUBSTRATE</strong></td>
<td>Specification (name, brand, grade, supplier, chemical composition, manufacturing processes, details on mould release systems used, etc.) Release system (open mould, infusion)</td>
<td>Design and engineering</td>
</tr>
<tr>
<td></td>
<td>Contractual agreements specifying quality and condition of substrate (duty to inform in event of changes)</td>
<td>Purchasing</td>
</tr>
<tr>
<td></td>
<td>Checks on incoming deliveries (name, brand, grade, product characteristics) with adhesion tests (see Pre-Treatment Chart)</td>
<td>Quality assurance</td>
</tr>
<tr>
<td></td>
<td>Correct storage (temperature, humidity, prevention of soiling, first-in first-out stock rotation)</td>
<td>Quality assurance / Logistics</td>
</tr>
<tr>
<td><strong>PREPARATION OF SUBSTRATE</strong></td>
<td>Specification (mechanical surface preparation, chemical products, type of application, processing schedule)</td>
<td>Design and engineering / Adhesives technician / Adhesive supplier</td>
</tr>
<tr>
<td></td>
<td>Checks on incoming deliveries (name, brand, grade, visual inspection of packaging, labelling, product characteristics)</td>
<td>Quality assurance</td>
</tr>
<tr>
<td></td>
<td>Correct storage (temperature, humidity, prevention of soiling, use of stock by expiry date)</td>
<td>Quality assurance / Logistics</td>
</tr>
<tr>
<td></td>
<td>Subjective checks for visible defects in primers, etc. (E.g. cloudiness, sedimentation, thickening, smell), plus checks on expiry date</td>
<td>Quality assurance / Foreman</td>
</tr>
<tr>
<td></td>
<td>Periodic checks on the correct application procedures (method of application, observation of recommended drying times, correct handling of primed components prior to assembly, etc.)</td>
<td>Quality assurance / Adhesive technician Adhesive specialist</td>
</tr>
<tr>
<td><strong>APPLICATION OF ADHESIVE</strong></td>
<td>Checks on incoming deliveries (name, brand, grade product characteristics, visual inspection of packaging, labelling, periodic adhesion tests&lt;sup&gt;1&lt;/sup&gt;)</td>
<td>Quality assurance</td>
</tr>
<tr>
<td></td>
<td>Correct storage (temperature, humidity, conditioning of stock to room temperature, use of stock by expiry date)</td>
<td>Quality assurance / Logistics</td>
</tr>
<tr>
<td></td>
<td>Subjective checks for visible defects in adhesives (changes in consistency, flow behaviour, etc.), plus checks on expiry date</td>
<td>Quality assurance / Foreman</td>
</tr>
<tr>
<td></td>
<td>Periodic checks on correct application procedures (method of application, observance of specified open times, correct joint assembly sequence, waiting times prior to further processing, etc.)</td>
<td>Quality assurance / Adhesive technician Adhesive specialist</td>
</tr>
</tbody>
</table>

<sup>1</sup> Adhesion tests are based on DIN 54457
PRODUCT DATASHEETS (PDS)

The Product Datasheet describes the product characteristics as well as information about the area of application, advantages and application descriptions.

Before using Sikaflex® or other Marine products we recommend to download the actual Product Datasheets from the Internet.

As the legal part depends on the country of application, the Product Datasheet has to be downloaded from the national internet site. Choose worldwide and click on the respective country.

SAFETY DATASHEETS (SDS)

The Safety Datasheet helps to work safely with chemical products. This document has to be available to everyone which is in direct and indirect contact with chemical products.

The content of the SDS
- Identification
- Composition
- Hazards
- First-aid measures
- Fire-fighting measures
- Accidental release measures
- Handling and storage
- Exposure controls
- Personal protection
- Physical / chemical properties
- Stability and reactivity
- Toxicological information
- Ecological information
- Disposal considerations
- Transport regulatory information

Most up-to-date Safety Datasheet are available through the local sales organisation, or on www.sika.com.

DISCLAIMER

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GENERAL DESCRIPTION

All kinds of deck fittings and hardware need to be securely fixed and totally watertight. Some of these fittings can be subject to very high forces, such as tensile, torsion, and shear stresses. Poorly sealed joints can suffer serious damage such as metal corrosion, osmosis, and water leaks which can cause damage to interior furnishings and fittings.

**Bedding and sealing of fittings subject to high mechanical stresses**
Deck fittings such as chain plates, winches, and guide rollers must absorb very high dynamic stresses.

For this purpose a high-performance product, such as Sikaflex®-292i, should be used in conjunction with additional mechanical fixings.

**Bedding and sealing of fittings subject to minimal mechanical stresses**
Deck fittings, such as ventilators and cover strips, need to be waterproofed, but are not subject to high tensile or torsion stresses.

These fittings can be effectively bedded and sealed with only Sikaflex®-291i or if the joint remains visible and is exposed to weathering, the use of Sikaflex®-295 UV is recommended.
BEDDING AND SEALING  
FITTINGS AND  
HARDWARE  

SUBSTRATE PREPARATION  

TIMBER DECKS  

- Abrade the contact area on the deck with a sanding pad (80 / 100 grit)  
- Remove the dust with a vacuum cleaner  
- Apply a thin, continuous coat of Sika MultiPrimer Marine using a clean brush or a roller felt applicator.  
- Drying times: Sika MultiPrimer Marine 30 minutes (min) to 24 hours (max)

PAINTED DECKS  

- Pre-treat the substrate with Sika Aktivator-100, using a clean, lint-free rag or a paper towel. Change the rag frequently!  
- Flash-off: 10 minutes (min) to 2 hours (max)

BRONZE, BRASS OR STAINLESS STEEL FITTINGS  

- Slightly abrade the contact area with a very fine sanding paper or abrasive pad  
- Pre-treat the substrate with Sika Aktivator-100, using a clean, lint-free rag or a 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 a felt applicator  
- Drying time: 30 minutes (min) to 24 hours (max)

APPLICATION OF Sikaflex®-291i, -292i OR -295 UV ADHESIVES  

- Mask the surrounding area before priming and sealing  
- These adhesives should be applied to the deck and to the screw fixing holes in a bead of the required thickness. The fitting should then be pressed into position  
- The fixing screws should be tightened slightly to leave about 1 mm of adhesive under the fitting  
- Use a plastic spatula to remove excess sealant squeezed out around the edges and remove the masking tape  
- After 24 hours tighten the screws

For coloured metals please use only Sikaflex®-295 UV or Sikaflex®-591.

ALUMINUM FITTINGS  

- Lightly abrade the contact area with a very fine sanding paper  
- Pre-treat the substrate with Sika Aktivator-100, using a clean, lint-free rag or a 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 a felt applicator  
- Drying time: 30 minutes (min) to 24 hours (max)

APPLICATION OF Sikaflex®-291i, -292i OR -295 UV ADHESIVES  

- Mask the surrounding area before priming and sealing  
- These adhesives should be applied to the deck and to the screw fixing holes in a bead of the required thickness. The fitting should then be pressed into position  
- The fixing screws should be tightened slightly to leave about 1 mm of adhesive under the fitting  
- Use a plastic spatula to remove excess sealant squeezed out around the edges and remove the masking tape  
- After 24 hours tighten the screws

IMPORTANT:  
For the preparation of other substrates, please refer to the Sika Pre-Treatment Charts for Marine Applications.

A selection of cleats that can be sealed or bonded using Sika adhesives

A port-hatch, both bonded and sealed using Sikaflex®

Applying Sikaflex®-292i
GENERAL DESCRIPTION

Rub rails and fenders are designed to protect the hull of a vessel against damage. These act as a bumper to absorb impacts and scrapes, and the more elastic they are, the more effectively they perform this function.

The elastic behaviour varies according to the type of material used, so the shockabsorbing performance of the rub rail can be significantly improved by the use of an elastic adhesive joint. This provides maximum protection to the hull.

Rub rails of timber, PVC or polyurethane can be securely bonded to marine hulls using Sikaflex®-292i. The resulting elastic joint helps to absorb most of the shear and tensile stresses to which they are subjected when a vessel is docking or casting off.

If rub rails are secured with screws, a similar effect can be obtained by backfilling the rail profile with Sikaflex®-291i; a highly elastic polyurethane sealant. As well as absorbing torsional stresses, this technology also seals the screw holes and prevents water or dirt from getting behind the rub rail.

IMPORTANT:
If the rub rail has a different chemical composition and is not fixed using a mechanical fixing method, please seek advice from your local Sika company.
**APPLICATION OF Sikaflex®-292i OR Sikaflex®-291i**

Apply a masking tape on the substrate.

Pre-treat the substrate with Sika® Aktivator-100, using a clean, lint-free rag or a paper towel. Change the rag frequently!

Flash-off: 10 minutes (min) to 2 hours (max)

Apply Sikaflex®-292i (or Sikaflex®-291i if rub rails are to be held using additional mechanical fixings) to the bond area using an appropriate triangular bead.

Assemble the components within 20 minutes of applying the adhesive.

Press the rub rail into place, either directly onto the face of the hull or on top of the bond area. Use clamps, etc., to hold the rub rail in position while the adhesive sets. If the rub rail is to be secured with mechanical fixings, any holes should also be filled with adhesive.

Remove excessive adhesive and the masking tape.

Uncured Sika adhesives or sealants can be removed with Sika® Remover-208.

Clamps and other fastening aids can be removed after 24 hours.

Full service strength is attained after approximately 7 days.

---

**SUBSTRATE PREPARATION**

**GRP HULLS**

Heavily soiled surfaces should first be cleaned off with a pure solvent, like Sika® Remover-208, to remove the worst of the soiling.

Lightly abrade the contact area with a very fine sanding pad.

Remove the dust with a vacuum cleaner.

Pre-treat the substrate with Sika® Aktivator-100, using a clean, lint-free rag or a 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 a felt applicator.

Drying time: 30 minutes (min) to 24 hours (max).

---

**TIMBER RUB RAILS**

Abrate the contact area of the hull with a sanding pad (80 / 100 grit).

Remove the dust with a vacuum cleaner.

Apply a thin, continuous coat of Sika® MultiPrimer Marine using a clean brush or a felt applicator.

Drying times:

- Sika® MultiPrimer Marine: 30 minutes (min) to 24 hours (max).

---

**MOULDED PVC OR POLYURETHANE RUB RAILS**

The bond face of the rub rails must be free from mould release agents or other chemical contaminants. All traces of such substances must be removed before proceeding with Sika® Remover-208.

Abrate the bond face of the rub rail with coarse sand paper (60 / 80 grit) to key the surface.

Pre-treat the substrate with Sika® Aktivator-205 using a lint-free rag or paper towel. Change rag frequently.

Flash-off min. 10 min to max 2h.

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).
GENERAL DESCRIPTION

The interiors of many boats are based on a variety of traditional and modern materials including mirrored glass. These panels can be used functionally as working surfaces (galley worktops, etc.) or cosmetically. Either way, elastic bonding provides an easy, durable method of fixing without visible and unsightly mechanical fixings.

As the variety of materials used for panels, surfaces and supporting substrates is so vast, please consult the local Technical Service of Sika Industry or proceed to preliminary trials.
APPLICATION OF Sikaflex® ADHESIVE TO VERTICAL PANELS

Prepare the substrate according to the Pre-Treatment Chart for Marine Application

Place spacers in position (thickness 2 mm, approximately 50 Shore A hardness). These can be pressed into the adhesive once applied

Apply appropriate beads of Sikaflex®-292i in an 8 mm x 10 mm triangular profile

Assemble the components within 20 minutes of applying the adhesive

Apply pressure with fastening aids to compress the adhesive to the height of the spacers

Wait at least 24 hours before walking on the bonded plates

Uncured Sika adhesives or sealants can be removed with Sika® Remover-208

APPLICATION OF Sikaflex® ADHESIVE TO HORIZONTAL PANELS

Horizontal surfaces: Sikaflex®-298

Inclined surfaces: Sikaflex®-291i

Slightly abrade the surface with a very fine abrasive pad

Pre-treat the surface with Sika® Aktivator-205 using a lint-free rag or paper towel. Change the rag frequently!

Flash-off time min. 10 min to max. 2 h

Apply adhesive to the previously prepared surface and spread over the area to be covered, using a spreader with 4 mm triangular notches. The bed thickness may vary depending on the thickness of any gaps that needs to be filled (normally 1–2 mm)

If vapour-tight substrates are used, spray a fine mist of water (1 g / m²) onto the Sikaflex®-298 surface for faster curing

The deck panel must be positioned accurately within the tack free time of the adhesive and pressed firmly into place to avoid air-entrapment

Clamps, weights or screws (removable once the adhesive has set) can be used to secure the panel while the adhesive sets. After about 24 hours the panels can carry their full service load and the temporary fastenings can be removed

IMPORTANT:
Always refer to the current Sika Product Datasheets and Safety Datasheets obtainable through your local Sika company
GENERAL DESCRIPTION

These lightweight panels are usually constructed of wood sandwiches with internal polyurethane foam or honeycomb core. They are particularly suited as partitions for cabins and technical rooms as they are of lighter weight than wood filled panels and have good soundproofing properties.

However, bonding with Sikaflex®-292i is an ideal replacement fixing method that also possesses the flexibility to respond to the movements and stresses of the assembly.

The uniform stress distribution prevents damages which may be result of stress concentration (example screw).

This process is also endorsed by the manufacturers of the lightweight panels.
BONDING LIGHTWEIGHT INTERNAL PARTITIONS

SUBSTRATE PREPARATION
Please refer to the Sika Pre-Treatment Chart for Marine Applications.

APPLICATION OF Sikaflex®-292i ADHESIVE

- Dry fit the panels to ensure an accurate fit and correct dimensioning.
- Prepare the surface accordingly.
- Place the spacers in position (thickness typically 3 mm, approximately 50 Shore A hardness).
- Apply Sikaflex®-292i to the appropriate bond face using an appropriate bead.
- Assemble the components within 20 minutes of applying the adhesive.
- Uncured Sika adhesives or sealants may be removed with Sika® Remover-208.
- Panels can be held in place during cure by clamps or support brackets.
- Clamps and other fastening aids can be removed after 24 hours.

Lightweight panels being fitted to an open hull.

Sikaflex®-292i applied to a lightweight panel prior to fitting.

High-quality lightweight panels finished in traditional high-gloss wood veneer and bonded using Sikaflex®-292i.
ELASTIC THICK LAYER BONDING

INTRODUCTION

From the earliest of times, boat construction has relied upon the available technology. Structural members needed to be attached to one another and everything would depend on the reliability of the bond.

Trial and error would have exposed the weaknesses in design and construction and one of the costs would have been the loss of the vessel, if not of lives.

As knowledge and experience was shared, so technology improved and in a symbiotic advancement, boat building and other industries benefited.

Today, significant advances in adhesive technology have spurred a revolution in assembly techniques across all of industry. But none reap the benefits more than the marine industry.

APPLICATION DESCRIPTION

Elastic thick layer bonding in respect of this manual refers to the method of joining the main structural components or components that contribute to the strength and stability of the structure of the vessel.

Elastic thick layer bonding is responsible for a completely different approach to vessel design. Whereas earlier techniques worked from a rigid skeleton that had to be strong enough to support the deck, hull, superstructure, windows, and fittings, the new approach uses all of these major components as the primary structural members and uses the old skeletal parts in a lighter form to provide stiffening to the structure.

Each time that a screw was used to hold a major component to the skeleton, it introduced weaknesses in every part it passed through and became a focal point for stresses.

Marine architects had to take this into consideration during the design phase and ensure that there were sufficient fixings placed evenly along the joint lines in order to distribute the stresses. The location, size and type of every screw had to be specified, drawn onto the plans, bought in and stored.

The laminating method (taping) provides a far better alternative to this approach in most applications, with fewer components, a simplified design and better stress distribution. But this method is highly labour intensive and comes with numerous health and safety issues.

Elastic thick layer bonding from Sika is relatively simple to design, tolerant of dissimilar materials, very strong and durable, and besides having few health and safety requirements, takes a fraction of the time of other techniques to assemble.

In service, the inherent flexibility of the Sika structural adhesives evenly distributes the stresses and the lightweight construction techniques result in a major weight saving and corresponding buoyancy and performance increase in the vessel.

For every structural application, national and international rules, regulations and approvals must be observed.
Vi tar forbehold om trykkfeil, informasjon angående våre salgs og leveringsbetingelser se www.sika.no
SIKA SOLUTIONS FOR STRUCTURAL BONDING

MATERIALS AND TECHNOLOGIES

The main property of elastic bonding adhesives is that they are capable to support high mechanical stresses.

This single detail gives rise to concerns regarding the finished vessel in service, where, despite the improved assembly benefits, there can still be localized stress issues and a greater possibility of joint fracture due to impact or crushing forces.

Following extensive research, Sika has found that by introducing a degree of flexibility, these problems are greatly improved.

The Sikaflex® elastic adhesives for structural bonding are:
- Sikaflex®-292i
- Sikaflex®-296
- Sikaflex®-295 UV

Sikaflex®-292i is used to bond flybridges and keels as each of these can be subject to far greater local forces than other main components. The greater flexibility in these cases means that there will be greater ‘give’ in the first instance. The members would be more likely to be pulled off the vessel whole, without ripping pieces from the hull or superstructure. This also means that there is every chance that the components can be refitted without needing to be replaced.

Sikaflex®-295 UV and -296 are each used for glazing, as windows are increasingly used as structural members. Sikaflex®-295 UV is used for organic glazing and backfilling and Sikaflex®-296 is used for mineral glazing. In both cases the greater flexibility is to prevent forces being transmitted to the glazing that would otherwise damage it.

The following examples show the capability of the Sikaflex® Marine adhesives. However the custom tailored characteristics gives naval engineers and constructors the possibility of economic and sustainable new realisations. Sika will be happy to support you in the development and testing of new applications.
<table>
<thead>
<tr>
<th>MANUFACTURING</th>
<th>MECHANICAL FIXING</th>
<th>LAMINATING TAPING</th>
<th>ELASTIC BONDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time consumption</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
</tr>
<tr>
<td>Material cost</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
</tr>
<tr>
<td>Process complexity</td>
<td>✰✰✰ / ✰✰✰</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
</tr>
<tr>
<td>Health / safety / environment</td>
<td>✰✰✰ / ✰✰✰</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
</tr>
<tr>
<td>Tolerance gapping</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
</tr>
<tr>
<td>Assembling different (lightweight)</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
</tr>
<tr>
<td>materials</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
</tr>
<tr>
<td>FINAL PERFORMANCE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Durability / fatigue resistance</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
</tr>
<tr>
<td>Durability / corrosion resistance</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
</tr>
<tr>
<td>Weight reduction</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
</tr>
<tr>
<td>Comfort (acoustics)</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
<td>✰✰✰</td>
</tr>
</tbody>
</table>

- ✰ Very good
- ✰✰ Good
- ✰✰✰ Neutral
- ✰✰✰ Poor
- ✰✰✰✰ Very poor
DIRECT GLAZING

DESCRIPTION

Traditional glazing methods have evolved as they had 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.
**DESIGN DIRECTIVES**

Direct glazing represents a straightforward 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

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 page 39 for organic glass and page 42 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.

**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. Procedure for organic and for mineral glass are described on the following pages. 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.

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

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:

<table>
<thead>
<tr>
<th>Bonding System</th>
<th>Cleaner</th>
<th>Primer</th>
<th>Adhesive</th>
<th>Sealant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sika® Aktivator-100</td>
<td>Sika® Primer-206 G+P</td>
<td>Sikasil® SG-20</td>
<td>Sikasil® WS-605 S</td>
</tr>
<tr>
<td></td>
<td>Sika® Aktivator-100</td>
<td>Sika® Primer-206 G+P</td>
<td>Sikasil® SG-20</td>
<td>Sikasil® WS-605 S</td>
</tr>
<tr>
<td>PC/PMM</td>
<td>Abrasive pad very fine</td>
<td>Sika® Primer-209 D</td>
<td>Sikaflex®-295 UV</td>
<td>Sikaflex®-295 UV</td>
</tr>
<tr>
<td>PC/PMM</td>
<td>Abrasive pad very fine</td>
<td>Sika® Primer-209 D</td>
<td>Sikasil® SG-20</td>
<td>Sikasil® WS-605 S</td>
</tr>
</tbody>
</table>

Sika® Primer-206 G+P can be eliminated if proper UV-protection of the bond line is ensured.

The definition of backfill width
SEALING AND BONDING ORGANIC WINDOWS

APPLICATION DESCRIPTION

Most of the organic glazing materials used in boat building are 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.
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/m², ∆T = 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!
- 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)

ALUMINUM 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!
- 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)

ALUMINUM OR TIMBER FRAME COATED WITH TWO-PART LACQUER

- Mask off any areas that need it
- Pre-treat the substrate with Sika® Aktivator-100, using a clean, lint-free rag or paper towel. Change the rag frequently!
- Flash-off: 10 minutes (min) to 2 hours (max)
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 16). Shore A hardness of the spacer approximately 30 or less.
- Avoid interruption of the bead by the spacers.
- 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 16).
- 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. 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.
- Uncured Sika adhesives or sealants may be removed with Sika® Remover-208.

Example:
If D = 8 mm, the overlap should be at least 16 mm.

SIKA RULE

O = 2 x D

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 9 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 Safety Datasheet obtainable through your local Sika company.

PMMA / PC GLAZING PANELS

- If required, apply an acryl paint or a profile opaque to cover the bond line in accordance with the Sikaflex®-295 UV.
- Abrade the bond area with abrasive paper or very fine abrasive pad. Abrade the bonding perimeter with 80 grit sand-paper 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.
- 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%).

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.
SEALING AND BONDING MINERAL GLAZING

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.
**BONDING AND SEALING MINERAL GLASS 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.

Basis of calculation substrate aluminum-glass, wind load 2.4 kN/m², $\Delta T = 40^\circ$ C

**DETERMINATION OF THE ADHESIVE WIDTH (BITE)**

![Diagram showing adhesive bite width](image)

**ADHESIVE THICKNESS**

<table>
<thead>
<tr>
<th>Joint thickness</th>
<th>Biggest window dimension [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
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<tr>
<td>4</td>
<td>2</td>
</tr>
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<td>6</td>
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<td>7</td>
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<td>16</td>
<td>8</td>
</tr>
<tr>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

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

**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-100, 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® Primer-206 G+P, using a clean brush or felt applicator.
- Drying time: 30 minutes (min) to 24 hours (max).

**IMPORTANT:**

At all times recommendations from classification societies must be respected.
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.

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 16).

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 16).

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. 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.

Uncured Sika adhesives or sealants can be removed with Sika® Remover-208.

Pre-treatment of the ceramic ink area with Sika® Aktivator-100.

Adhesive is applied to the window frame.

The window is fitted.
FLYBRIDGE BONDING

APPLICATION DESCRIPTION

Many modern motor yachts have flybridges. Conventional fixing methods such as mechanical fixings or rigid adhesives have concentrations of peak stresses which lead to breaching of the substrate allowing access to moisture.

Bonding of flybridges using flexible adhesive systems evens the distribution of stresses and optimises resistance to impact and fatigue effects.

In service, flybridges are subjected to substantial stress on the joints at high speeds. The main reason that makes Sikaflex®-292i perfect for this application is the high modulus characteristic that ensure the integrity of the joint under stress.

A perfect cosmetic finish is obtained with the weather resistance Sikaflex®-295 UV in white colour.
**FLYBRIDGE BONDING PROCEDURE**

**PREPARING THE SUBSTRATE**

- Heavily soiled surfaces should first be cleaned off with a pure solvent, like Sika® Remover-208, to remove the worst of the soiling.
- Lightly abrade the contact area with a very fine sanding pad.
- Remove the dust with a vacuum cleaner.
- Pre-treat the substrate with Sika® Aktivator-205, using a clean, lint-free rag or a 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 a felt applicator.
- Drying time: 30 minutes (min) to 24 hours (max).

**APPLICATION OF Sikaflex®-292i ADHESIVE**

- Place 3 mm deep elastic spacers, of about 50 Shore A hardness, into position.
- Apply Sikaflex®-292i in an appropriate profile around the entire periphery of the flybridge. An additional bead may be required for heavier loads.
- Assemble the components within 20 minutes of applying adhesive.
- Apply pressure with clamps or other fastening aids to compress the adhesive to the height of the spacers.
- Uncured Sika adhesives or sealants should be removed with Sika® Remover-208.
- For open joints, cover Sikaflex®-292i with a layer of Sikaflex®-295 UV.
- Clamps and other fastening aids can be removed after 12 hours. Full service strength is attained after about 7 days.

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

Sealing with Sikaflex®-295 UV
DECK AND KEEL TO HULL BONDING

APPLICATION DESCRIPTION

Arguably the most crucial joint on the vessel is that between the deck and the hull where Sika’s resilient, one-component polyurethane adhesives have many benefits to the designer and boat builder alike.

The naval architect can be confident that a deck and a hull that have been built separately of differing materials can be brought together to form a single unit that is both strong and durable. The tolerances in alignment between the two parts need not be quite as close, because minor discrepancies can be taken up by the gap filling property of the adhesives.

The strength of the adhesives makes mechanical fixings redundant and the resilience absorbs much of the stresses and strains from temperature changes, impact shocks and torsion forces.

All of these factors reduce the design and source costs of the build and remove many design obstacles.

To the boat builder, the assembly techniques are simplified and streamlined.

Applying an adhesive around the joint between deck and hull is far quicker, simpler and easier than laborious GRP laminated joints.

And providing the Sika guidelines are followed ensures a reliable watertight joint, as is not the case with taping methods.

With no mechanical fixings, there is no need to drill holes in the joint area, no need for gaskets, no need to spend the time aligning the holes and no need to insert and tighten the fixings.

For information regarding bondline dimensions, please contact Sika’s Technical Service department, who can also provide appropriate values for FEM calculations.

Also, the critical joint between keel and hull is subjected to very high stresses when a boat is under sail and needs to be very strong if it runs aground. So it must be designed and built with great care in order to withstand these stresses.

This particular joint is prone to leaks, which identify themselves by rust streaking and staining on the keel when the boat is out of the water.
DECK TO HULL BONDING PROCEDURES WITH Sikaflex®-292I

PREPARING THE SUBSTRATE FOR ALUMINUM

- Heavily soiled surfaces should first be cleaned off with a pure solvent, like Sika® Remover-208, to remove the worst of the soiling
- Lightly abrade the contact area with a very fine sanding pad
- Remove the dust with a vacuum cleaner
- Pre-treat the substrate with Sika® Aktivator-205, using a clean, lint-free rag or a 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 a felt applicator
- Drying time: 30 minutes (min) to 24 hours (max)

APPLICATION OF Sikaflex®-292I

- Place spacers of at least 4 mm deep and about 50 shore A hardness, in position. Alternatively, these can be pressed into the adhesive once applied
- Apply Sikaflex®-292I onto the entire periphery of the hull. A continuous zig-zag bead Sikaflex®-292I should be used; the amount applied will depend on the width of the bond face. The adhesive bead must be carried continuously around any cut-outs or clearance holes (e.g. for deck stanchions, pipes, chain plates) to maintain the integrity of the watertight joint
- Assemble the components within 20 minutes of applying the adhesive
- Apply pressure with clamps or other fastening aids to compress the adhesive to the height of the spacers
- Clamps and other fastening aids can be removed after 24 hours. Full service strength is attained after approximately 7 days
- Uncured Sika® adhesives or sealants must be removed with Sika® Remover-208

IMPORTANT: Do not use Sika® Aktivator or any other cleaning agent or solvent for cleaning purposes

OTHER SUBSTRATE

Refer to the actual Sika Pre-Treatment Chart for Marine Applications.

PREPARING THE SUBSTRATE FOR GRP

- Heavily soiled surfaces should first be cleaned off with Sika® Remover-208, to remove the worst of the soiling
- Lightly abrade the contact area with a very fine sanding pad
- Remove the dust with a vacuum cleaner
- Pre-treat the substrate with Sika® Aktivator-205, using a clean, lint-free rag or a 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 a felt applicator
- Drying time: 30 minutes (min) to 24 hours (max)

IMPORTANT: It is vital to check the accuracy of the fit before applying the adhesive so that the parts do not need to be separated again once they have been brought together

Hull and deck are brought together
A locating pin ensures perfect alignment
### KEEL TO HULL BONDING

#### PREPARING THE SUBSTRATE

**ALUMINUM HULLS (PAINTED WITH 2C PAINT)**

- Heavily soiled surfaces should first be cleaned off with Sika® Remover-208, to remove the worst of the soiling.
- Pre-treat the substrate with Sika® Aktivator-100, using a clean, lint-free rag or a paper towel. Change the rag frequently!
- Flash-off: 10 minutes (min) to 2 hours (max)

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**FOR GRP**

- Heavily soiled surfaces should first be cleaned off with Sika® Remover-208, to remove the worst of the soiling.
- Lightly abrade the contact area with a very fine sanding pad.
- Remove the dust with a vacuum cleaner.
- Pre-treat the substrate with Sika® Aktivator-205, using a clean, lint-free rag or a paper towel. Change the rag frequently!
- Flash-off: 10 minutes (min) to 2 hours (max)

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**STEEL HULLS AND KEELS, COATED WITH TWO-PART CORROSION PROTECTION PAINTS**

- Apply a thin, continuous coat of Sika® MultiPrimer Marine, using a clean brush or a felt-applicator.
- Drying time: 30 minutes (min) to 24 hours (max)

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#### APPLICATION OF Sikaflex®-292i ADHESIVE

- Place elastic spacers of about 10 mm thick and 50 Shore A hardness into position.
- Apply Sikaflex®-292i in sufficient quantity. Each bead must form a continuous, closed ring, with no gaps. The same applies to the beads around the bolt holes.
- The keel must then be lifted into position, carefully observing the open time of Sikaflex®-292i. Then the keel bolts must be tightened as far as the spacer blocks. Any adhesive that is squeezed out of the joint can be tooled to a finish.
- Remove Sika adhesives or sealants with Sika® Remover-208.
- After three or four days, the keel bolts can be tightened to their full torque rating. The additional pressure exerted on the adhesive, gives the joint between keel and hull the required degree of torsional stiffness. When the adhesive has fully hardened, the sealed joint can be over-painted in the normal way with any good quality anti-fouling paint. The sealed joint absorbs the dynamic stresses generated in this area and forms a totally watertight bond between keel and hull.

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**IMPORTANT:** With lead keels, the contact area must also be given a coating with a two-part epoxy-resin based protective paint.

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For the preparation of other substrates, please refer to the Pre-Treatment Chart for Sika Marine Applications.
GLOSSARY OF TERMS

**Activator**
Solvent containing adhesion promoters that increase the adhesion of an adhesive on a substrate.

**Adhesion**
Adherence of an adhesive to a substrate.

**Adhesive joint (bond-line)**
Gap between two components that must be filled with adhesive.

**Aging**
Behaviour of the adhesive layer under the influence of time, temperature and environmental conditions.

**Balanced moisture content**
Moisture content of a material (specially wood) when allowed to stabilize relative to ambient levels of atmospheric temperature and air humidity.

**Bonding joint**
Gap between two bonding surfaces filled with adhesive.

**Bondline**
Contact area between adhesive and substrate.

**Breaking stress**
Stress required to produce failure or fracture in a material.

**Clamping**
Temporary securing of components in the desired position by mechanical means, with or without the application of pressure, while the adhesive is setting.

**Cleaner**
Chemical agent used to clean surfaces prior to bonding.

**Coefficient of thermal expansion**
A factor that expresses the dimensional changes in a component as a function of temperature change.

**Cohesion**
Inherent strength of a material.

**Contact adhesive**
Laminating adhesive, applied to both surfaces of the joint. Once ready, the adhesive surface is not tacky and the bonding force results only on contact of the two adhesives surfaces.

**Cross-linking**
Creation of a three-dimensional network through the formation of chemical bonds between molecular chains.

**Curing / Setting**
Setting or hardening of an adhesive due to physical or chemical reaction.

**Curing conditions**
Factors that influence the curing of adhesives, e.g. temperature, relative humidity.

**Dew point**
Temperature at which a condensation of the air humidity occurs (depending on environmental temperature and relative humidity).

**Diffusion**
Migration of gases or liquids through materials. The hardening process of one-component PUR and silicones is limited by the speed of diffusion of water through the hardened skin or layer of the adhesive.

**Drying time**
Duration required for a primer to reach a state that will safely allow the process that follows it to be started (e.g. adhesive application).

**Duromer**
Crosslinked, mostly unmeltable plastics.

**Elastomers**
Elastomers are macromolecules with an open network structure which do not undergo plastic flow even at high temperatures approaching the point of chemical decomposition, but undergo reversible elastic deformation instead.

**Elongation at break**
Elongation that takes place before a material fails or fractures.

**ESC**
Environmental stress cracking. Cracking of thermoplastics under internal or external stress and chemicals.

**Final strength**
Strength of an adhesive joint when the adhesive has attained full cure.

**Fillers**
Additives (mostly inorganic) to improve the properties of the adhesive.

**Flash-off time**
Duration required for a primer, solvent, cleaner or activator to reach a state that cure on exposure to moisture.

**Fracture energy**
Energy that is required to cause a material to fail or fracture.

**Galvanic corrosion**
Corrosion due to the electrical contact of metals with different electrochemical potential (e.g. aluminum, steel). The use of nonconductive adhesives can stop this effect.

**Handling strength**
Strength level development at which the bonded assembly can be handled and passed on to the next stage of processing.

**Heat resistance**
The ability of a material to withstand heat without altering its state as a result of exposure to a specified temperature over a fixed period of time.

**Hygric movement**
Movement as a result of humidity content in the material. Particularly applies to wood but also affects other materials like PA (brand name Nylon). The values from wood depend on the type and the orientation of the grain (radial, tangential).

**Joint assembly**
Process of bringing the substrates together under light pressure so that the adhesive is compressed to form the adhesive bond.

**Impact resistance**
Resistance against abrupt forces (crash).

**Modulus of elasticity**
Modulus of elasticity describes the ratio of stress to strain in a rod under tension whose sides are unconstrained.

**Non-sag properties**
Resistance of an adhesive to collapse or slump when extruded as a bead.

**One-component polyurethane adhesive**
Adhesive containing isocyanate groups that cure on exposure to moisture.

**Open or working time**
Maximum period of time that may elapse between application of the adhesive and assembly of the joint.
Organic window
Transparent plastic such as PMMA and PC (e.g. Brand names; Plexiglas / Lexan). Thermoplastics which are prone to ESC.

Pot-life
Period of time during which multi-component adhesives can be processed after their components have been mixed. Pot-life depends on the ambient temperature and the quantity of batch mixed. It decreases with higher temperature and increased batch quantities.

Primer
A special paint coating designed to improve adhesion between adhesive and substrate. They may also have additional functions such as UV-protection of the bond line, reinforcing the substrate and some corrosion protection.

QA
Quality assurance. Reactive adhesives Adhesives that cure or set when exposed to heat, moisture, radiation, etc.

Resistance
Behaviour of an adhesive under changed environmental conditions. Sag resistance (see Viscosity)

Sealant
Substance that separates a joint from any medium to which it is exposed.

Setting
Solidification of adhesive through physical and / or chemical process.

Shear modulus
Defined as the ratio of the shear stress to the shear strain in a body that undergoes simple angular deformation.

Shelf life
Period of time that can elapse between the manufacture of an adhesive and its use, subject to storage of the product under controlled conditions.

Solvent
Organic liquid that dissolves the base materials and other soluble adhesive constituents without changing their chemistry.

Solids content
Nonvolatile portion of components.

Spacers
Elastic parts, mostly self-adhesive, used to control the thickness of the adhesive. The shore hardness of the spacer should be equal to or lower than that of the adhesive.

Substrates
The base materials to be bonded, e.g. fabric, steel, wood, GRP.

Tack-free or skinning time
Time between the application of a one-component adhesive and the formation of a skin on its surface, after which point bonding can no longer take place.

Tensile lap-shear strength
Breaking strength of the adhesive bond joining two parallel surfaces in a single lap joint when the joint is subjected to a shearing stress by applying a tensile load centrally to the two lapped substrates.

Tensile strength
Breaking stress of a material under tension.

Thermoplastic adhesive
Plastics that soften under the application of heat (e.g. PVC, PMMA, ABS).

Thermosetting resins
Closely cross-linked macromolecules that do not undergo plastic deformation, even at high temperatures (e.g. Polyester, Epoxy).

Thick-layer elastic bonding
Elastic bonding application where the thickness of the adhesive layer exceeds 3 mm.

Tie-coating
An industry specific term used to indicate a bonding coat or layer applied to a material to facilitate ready adhesion with other media.

Transmission
Ratio of the intensity of a beam of light passing through a body, related to its original intensity. Measured in the UV (organic glazing) and visible range (mineral glazing). Sika stipulates limits for primerless glass bonding.

TV-value
Maximum workplace concentration or highest admissible concentration of evaporating solvent at a workplace. Two-part polyurethane adhesive Adhesive formed by the addition reaction of two components: main component and hardener.

UV-radiation
High energy part of sunlight, mainly responsible for surface degradation of organic materials like paint, sealants, etc.

Viscosity
Resistance to flow exhibited by fluids or paste-like substances as a result of internal friction.

White spirit
Petroleum spirit solvent, common used for thinning and cleaning.

Wetting
Ability of liquids to disperse themselves uniformly over solid materials.

Wet bonding
Method of bonding whereby the adhesive is applied by wetting.

Disclaimer
The information, and, in particular, the recommendations relating to the application and end-use of Sika products, are given in good faith based on Sika’s current knowledge and experience of the products when properly stored, handled and applied under normal conditions.

In practice, the differences in materials, substrates and actual site conditions are such that no warranty in respect of merchantability or of fitness for a particular purpose, nor any liability arising out of any legal relationship whatsoever, can be inferred either from this information, or from any written recommendations, or from any other advice offered.

The proprietary rights of third parties must be observed. All orders are accepted subject to our current terms of sale and delivery. Users should always refer to the most recent issue of the Sika Product Datasheet for the product concerned, copies of which will be supplied on request.
WHO WE ARE
Sika is a specialty chemicals company with a leading position in the
development and production of systems and products for bonding, sealing,
damping, reinforcing and protecting in the building sector and the motor
vehicle industry. Sika has subsidiaries in 94 countries around the world
and manufactures in over 170 factories. Its more than 17,000 employees
generated annual sales of CHF 5.49 billion in 2015.