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Introduction to the Bonding and Sealing Technology
1.1 Preface

1.1.1 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 in three ways:

- 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 carefully choreographed to ensure 100% reliability every time. 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.
1.2 Explanation of Different Fixing Methods

1.2.1 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 robs 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.
1.2.2 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 (heat process)</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>
</tr>
</thead>
<tbody>
<tr>
<td>Joining different materials</td>
</tr>
<tr>
<td>Sealing</td>
</tr>
<tr>
<td>Acoustical improvements</td>
</tr>
<tr>
<td>Joining of thin substrates</td>
</tr>
<tr>
<td>Durability</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 anti-corrosive paints, no injury of the anti-corrosive 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.
1.3 Difference Between Rigid and Elastic Adhesives

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.

Fig. 1 Test sample. Lap shear test with PMMA substrate bonded with different adhesives. One sample has been screwed.

Fig. 2 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.

Fig. 3 Same sample plan view. Here stress concentration around the bolts is visible (stress peaks around the screw).
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.

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 to us a better definition as it will also take in consideration the durability aspects.

### 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>Bondline dimension</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>Temperatur dependency</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 40 °C. The dependency of the mechanical strength in the normal application range is minim. However the temperature resistance is limited to 90 °C for elastic Polyurethanes and 120 °C for Silicones</td>
</tr>
<tr>
<td>Force transmission</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>Choc resistance</td>
<td>Normally the choc 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 choc resistance</td>
<td>The choc resistance of elastic bond lines is excellent. The mechanical resistance increases with the applied speed. Under choc resistance, the mechanical resistance is high</td>
</tr>
<tr>
<td>Adhesion on painted substrates</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>High strength bonding</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

<table>
<thead>
<tr>
<th>Bonding of different metals</th>
<th>Rigid thin layer bonding</th>
<th>Elastic thick layer bonding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonding of different metals</td>
<td>Perfect in case of metals with low differences in thermal behavior, good for applications where bondline dimension (thickness / surface) is restricted</td>
<td>Good compensation of thermal movements, good protection against galvanic corrosion, good tolerance gapping</td>
</tr>
<tr>
<td>Bonding of metals with plastic</td>
<td>Usable for bonding smaller parts, good for applications where bondline dimension (thickness / surface) is restricted.</td>
<td>Ideal for bonding of GRP with important tolerances, good for shock resistance and acoustical damping</td>
</tr>
<tr>
<td>Bonding plastic to plastic</td>
<td>Normally good technique with low surface preparation, ideal for sandwich construction with low modulus core materials</td>
<td>Less interesting solution. ESC has to be taken in consideration. Ideal for bonding duromers (glass reinforced plastics) with important tolerances</td>
</tr>
</tbody>
</table>
Elastic 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.

Fig. 6 Bonded windows on cruise vessel

Fig. 7 GRP parts and windows bonded on high speed ferry
1.4 Bonding Construction Design

1.4.1 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, different to glues in an industrial scale, 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.
Generally forces which in praxis occur are the following:

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

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.

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.

1.4.2 Calculation of the bonding area

The dimensioning of a bond line depends mainly on 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, ageing 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.

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
1.5 Cost Advantage of Elastic Bonding

1.5.1 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 realised 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</td>
</tr>
<tr>
<td></td>
<td>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 $c_w$ (drag coeff.)</td>
<td>Lower fuel consumption</td>
</tr>
<tr>
<td>Application and curing at room</td>
<td>Simple repair</td>
</tr>
<tr>
<td>temperature</td>
<td></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>

Sika®
## 2.1 Sika Marine Adhesives and Sealants

### Product Range Overview

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Product Name</th>
<th>Characteristics</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>SikaFlex -290 DC</td>
<td>Sikaflex® -290i</td>
<td>Deck caulking compound</td>
<td>Sealing joints in timber planking</td>
</tr>
<tr>
<td>SikaFlex -291</td>
<td>Sikaflex® -291i</td>
<td>Marine sealing compound</td>
<td>General purpose sealing</td>
</tr>
<tr>
<td>SikaFlex -292i</td>
<td>Sikaflex® -292i</td>
<td>Marine sealing compound</td>
<td>Bonding / sealing of plastic materials</td>
</tr>
<tr>
<td>SikaFlex -295 UV</td>
<td>Sikaflex® -295 UV</td>
<td>Marine sealing compound</td>
<td>Bonding and expansion jointing for use in wood, marble, etc.</td>
</tr>
<tr>
<td>SikaFlex -296</td>
<td>Sikaflex® -296</td>
<td>Direct glazing adhesive for mineral glass</td>
<td>Bonding of mineral windows</td>
</tr>
<tr>
<td>SikaFlex -298</td>
<td>Sikaflex® -298</td>
<td>Direct glazing adhesive for mineral glass</td>
<td>Bonding of mineral windows</td>
</tr>
</tbody>
</table>

### Product Characteristics

- **Chemical base**: 1 part polyurethane, 1 part silicone, neutral curing
- **Stability (non-sag rating)**: Thixotropic
- **Shore A hardness at 23 °C (ISO 868)**: 40 approx. to 20 approx.
- **Tensile strength (ISO 37)**: 3 N/mm² approx. to 1 N/mm² approx.
- **Tensile lap-shear strength (ISO 4587)**: Not applicable
- **Elongation at break (ISO 37)**: 600 % approx. to 800 % approx.
- **Application temperature**: 10 °C to 35 °C
- **Service temperature**: CQP 513-1 –40 °C to 90 °C

### Important Notes

- The rate of cure value is measured after 1 day under normal conditions (23°C, 50 % r.h.).
- More detailed information can be obtained in the Product Datasheet.
- For detailed material characteristics, refer to the current national Sika Product- and Material Safety Datasheet available through your local Sika company: www.sika.com
2.2 Tipp’s and Tricks, General Advices

2.2.1 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 a abrasive producer.

Grinding with sand paper may be done with belt grinder, eccentric 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.
### 2.2.2 Storage of the products

**Storage unopened cartridge or unipack**

Sikaflex® and Sikasil® products should be stored at a temperature under 25°C. The best of use data 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 show a slight elastic behavior. In this case do not use it anymore as the wetting of the substrate is not ensured anymore.

Sikasil® reacts different. 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 aluminium 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 Aktivators 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.

### 2.2.3 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 Aktivators 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 Aktivator 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 national legislation. 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. Sika® Multiprimer Marine may also be applied with a paper tissue.

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

Close inner cap immediately after use.

If you transfer the primer for use in a separate can, discard the rest of it at the end of the day according to national legislation. With this action inactivation or jellification will be prevented.

Respect the minimum and maximum waiting time until the adhesive or sealant is applied.

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.

Insert spacers (see page 4) 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.
2.2.4 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).

**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 about the physiology of the products are available in the national Material Safety Datasheet, available on the Internet. www.sika.com

2.2.5 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 tooling of the adhesives, the masking tape should be eliminated as soon as possible before skinnering 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.

2.2.6 How to avoid corrosion

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

- Aluminium 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.

Note: Sika® Primers give a very limited corrosion resistance and should be used only for adhesion purposes.

**Distance blocks**

Distance blocks are used to fix temporarily a vertical bonded part against sliding down. They are best made on plastics or wood. Never use metals. After sufficient curing of the adhesive (about 2 times the skinnering time in the corresponding Product Datasheet) They can be eliminated to permit the consecutive sealing (backfill) of the remaining joint.

**Fig. 15 Example of spacers**

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.
3 Quality
3.1 Quality Assurance

3.1.1 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 constance 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>
<th>Construction of prototype</th>
<th>End of test phase</th>
<th>Serial production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and construction adapted to adhesive technology and assembly methods</td>
<td>Checking and specifying correct method of substrate preparation in consultation with adhesive and paint suppliers</td>
<td>Evaluation of test phase, making any design changes that may be indicated</td>
<td>Implementation of a quality assurance system</td>
</tr>
<tr>
<td>Dimensioning and configuration of adhesive joints based on existing codes of practice and design data</td>
<td>Construction of prototype based on design criteria for adhesive bonding. Adhesive supplier (applications engineer) to advise where necessary</td>
<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>
<td>Periodic refresher courses and further training for personnel</td>
</tr>
<tr>
<td>Appointment of an in-house adhesives specialist to liaise between departments on all aspects of adhesive usage</td>
<td>Specifying type and scope of repair works</td>
<td>Training of assembly personnel in the use of adhesives</td>
<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.

Main points of consideration for the introduction of adhesive technology

<table>
<thead>
<tr>
<th>Adhesive</th>
<th>Selected to suit the requirements of the production cycle and the service stresses to which the finished assembly will be subjected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrate</td>
<td>Consistent and sound composition and surface condition</td>
</tr>
<tr>
<td>Surface preparation</td>
<td>Selected to suit the requirements of the production cycle and the service stresses to which the finished assembly will be subjected and to accommodate variances in unstable substrates (mould release in GRP, wood)</td>
</tr>
<tr>
<td>Application parameters</td>
<td>Working within the specified time limits (open time), taking account of temperature and relative humidity levels</td>
</tr>
<tr>
<td>Joint design</td>
<td>Adhesive-friendly joint design, dimensioning of joints to suit functional requirements of finished assembly in accordance with manufacturers engineering rules. Think about a possible repair solution</td>
</tr>
<tr>
<td>Staff training</td>
<td>External or internal training courses organized in conjunction with adhesive suppliers</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>
</table>
| **Ensuring consistent quality of substrate** | Specification (name, brand, grade, supplier, chemical composition, manufacturing processes, details on mould release systems used, etc.)  
Release system (open mould, infusion)  
Contractual agreements specifying quality and condition of substrate (duty to inform in event of changes)  
Checks on incoming deliveries (name, brand, grade, product characteristics) with adhesion tests (see Pre-Treatment Chart)  
Correct storage (temperature, humidity, prevention of soiling, first-in first-out stock rotation) | Design and engineering  
Purchasing  
Quality assurance  
Quality assurance / Logistics |
| **Preparation of substrate** | Specification (mechanical surface preparation, chemical products, type of application, processing schedule)  
Checks on incoming deliveries (name, brand, grade, visual inspection of packaging, labelling, product characteristics)  
Correct storage (temperature, humidity, prevention of soiling, use of stock by expiry date)  
Subjective checks for visible defects in primers, etc. (E.g. cloudiness, sedimentation, thickening, smell), plus checks on expiry date  
Periodic checks on the correct application procedures (method of application, observation of recommended drying times, correct handling of primed components prior to assembly, etc.) | Design and engineering / Adhesives technician / Adhesive supplier  
Quality assurance  
Quality assurance / Logistics  
Quality assurance / Foreman  
Quality assurance / Adhesive technician / Adhesive specialist |
| **Application of adhesive** | Checks on incoming deliveries (name, brand, grade product characteristics, visual inspection of packaging, labelling, periodic adhesion tests)  
Correct storage (temperature, humidity, conditioning of stock to room temperature, use of stock by expiry date)  
Subjective checks for visible defects in adhesives (changes in consistency, flow behaviour, etc.), plus checks on expiry date  
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.) | Quality assurance  
Quality assurance / Logistics  
Quality assurance / Foreman  
Quality assurance / Adhesive technician / Adhesive specialist |

Nowadays, bonding technology is a well accepted and proven practical assembly method. However if the correct application procedures are neglected, the bonded or sealed object will not comply with expectations. In fact the correct use of adhesives and sealants in marine applications should not be regarded any differently from other traditional industrial skills such as welding or painting. The only real difference is that applications use a wide range of different materials and subsequently this requires personnel with specialist skills and training.

This manual supplies all of the information necessary for the correct application of adhesives and sealants. However, should there be any doubt regarding materials, methods or applications, support and advice can be obtained from the Marine expert at the nearest Sika Industry organisation.

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1) Adhesion tests are based on DIN 54457
3.2 Product Datasheets and Material Safety Datasheets

3.2.1 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. Here you will find these documents as well as a contact address.

3.2.2 Material Safety Datasheets (MSDS)

The Material Safety Datasheet is a document who helps to work safely with chemical products. This document has to be available for all persons which are in direct and indirect contact with chemical products.

The content of the MSDS
- 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’s
- Ecological information
- Disposal considerations
- Transport regulatory information

The actual Material Safety Datasheet is available through the local sales organisation. Or from the national internet site www.sika.com.
4.1 Deck Coverings

4.1.1 General description

Deck coverings are of functional and esthetical importance. Since maritime conditions are harsh, the ship has to be produced not only with the best products but also in accordance with a professional workmanship.

This manual will help to produce durable bonding and sealing solutions. For project related informations we recommend to consult the corresponding national Technical Service.

Teak deck history

Teak has been used for hundreds of years as a durable deck material.

The hard wood is very durable. Natural antimicrobial and insecticide substances cause an excellent natural anti-rot and weathering resistance.

Alternatives for teak such as iroko, padouk etc. are used in some cases but needs an intensive protection work to assure a long time function. Usually they are used in workboats as thick protective floors.

Regardless of the type of wood used, all require sealants to protect the deck from water penetration that can cause severe damage. This can take the form of unsightly marks along the hull, rotting the woodwork and corroding metal components. Watertight seals are therefore absolutely essential. Also, in addition to adding structural strength to the sub-deck, a wooden deck contributes to the insulation in hot and cool climates alike.

Teak, however, is not a uniform material. Oil, fat, talc and resin-content, as well as porosity and colouration, differ depending on the source and age of the wood.

The following pages detail the correct procedures for the planning, laying, preparing and caulking of teak decks with Sika’s Totally Glued Teak Decking System.

Strict adherence to the guidelines will result in a watertight timber deck that can be enjoyed for years to come and that will resist the harsh conditions of the maritime environment.
4.1.2 Types of teak deck
The teak planks vary in dimension. Thickness range from 4 to 50 mm. The later have been used for luxury vessel decking's with mechanical fixation. Up to now the 22 mm planks applied with the Sikaflex® bonding technology result in the same durability at a more economic price.

The joint for caulking is realised in two ways:

1. Symetric or asymetric joints
   Advantages:
   - Simple manufacturing process
   Disadvantages:
   - Limited joint depth for restoration or refurbishment grindings
   - Higher risk of water penetration between planks and the deck (detachment due to wood swelling)

   **Important:**
   A bond breaker tape on the bottom of the joint to prevent 3-side adhesion is not necessary.

2. Deep joint method
   Advantages:
   - High grinding (removal) reserve
   - Cost saving by using thinner wood planks
   - Better adsorption of wood expansion
   Disadvantages:
   - More complicated working procedure for curved planks

   **Important:**
   We generally recommend to use the deep joint method whenever possible.
4.1.3 Joint dimensioning

The joint width depends on the width of the plank, the humidity of the wood when manufactured and the expected humidity in use of the ship.

**Important:**
The change of wood humidity is under normal conditions (wood humidity max. 12%) in the range of 5% to 6%.

The humidity of the wood can be measured or estimated from the following graph:

<table>
<thead>
<tr>
<th>Apr. humidity</th>
<th>90%</th>
<th>85%</th>
<th>80%</th>
<th>75%</th>
<th>70%</th>
<th>65%</th>
<th>60%</th>
<th>55%</th>
<th>50%</th>
<th>45%</th>
<th>40%</th>
<th>35%</th>
<th>30%</th>
<th>25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.1</td>
<td>18.1</td>
<td>16.2</td>
<td>14.7</td>
<td>13.2</td>
<td>12.0</td>
<td>11.0</td>
<td>10.1</td>
<td>9.4</td>
<td>8.6</td>
<td>7.8</td>
<td>7.0</td>
<td>6.2</td>
<td>5.4</td>
<td>Temper.</td>
</tr>
<tr>
<td>21.0</td>
<td>18.0</td>
<td>16.0</td>
<td>14.5</td>
<td>13.1</td>
<td>12.0</td>
<td>10.9</td>
<td>10.0</td>
<td>9.2</td>
<td>8.4</td>
<td>7.7</td>
<td>6.9</td>
<td>6.1</td>
<td>5.3</td>
<td>10°</td>
</tr>
<tr>
<td>20.8</td>
<td>17.9</td>
<td>15.8</td>
<td>14.3</td>
<td>13.0</td>
<td>11.8</td>
<td>10.8</td>
<td>9.9</td>
<td>9.0</td>
<td>8.3</td>
<td>7.3</td>
<td>6.7</td>
<td>5.9</td>
<td>5.0</td>
<td>15°</td>
</tr>
<tr>
<td>20.0</td>
<td>17.5</td>
<td>15.5</td>
<td>14.0</td>
<td>12.8</td>
<td>11.5</td>
<td>10.5</td>
<td>9.7</td>
<td>9.0</td>
<td>8.1</td>
<td>7.3</td>
<td>6.4</td>
<td>5.6</td>
<td>4.8</td>
<td>20°</td>
</tr>
<tr>
<td>19.8</td>
<td>17.1</td>
<td>15.1</td>
<td>13.9</td>
<td>12.4</td>
<td>11.2</td>
<td>10.3</td>
<td>9.4</td>
<td>9.1</td>
<td>8.1</td>
<td>7.0</td>
<td>6.2</td>
<td>5.3</td>
<td>4.5</td>
<td>25°</td>
</tr>
<tr>
<td>19.3</td>
<td>16.9</td>
<td>14.9</td>
<td>13.5</td>
<td>12.1</td>
<td>11.0</td>
<td>10.0</td>
<td>9.1</td>
<td>8.8</td>
<td>7.5</td>
<td>6.6</td>
<td>5.8</td>
<td>5.0</td>
<td>4.2</td>
<td>30°</td>
</tr>
</tbody>
</table>

Quelle: R. Kaylwert und Angaben des U.S. Forest Products Laboratory, Madison 1951

**Important:**
The minimal joint width is in any case 4 mm. Adjacent joints to walls and profiles should be doubled in size.

Preconditions of teak bonding

The teak quality is essential for an optimal result in respect of functionality and optical aspect.

Standing year rings as well as the absence of alternating spiral growth are essential to assure a uniform plank deformation under the different climates. Laying year rings may in addition lead to a danger of foot injuries due to scale of wood formation.

**Calculation example:**

Plank width: 50mm
Production condition: wood humidity measured: 7%
Expected climatic conditions in use: 30°C/70% r.h
Corresponding wood humidity (see table): 12.4%
Maximal change in wood humidity: 12.4% – 7% = 5.4%
Maximal plank movement (teak) 5.4% x 0.2% / % wood humidity change x 50 mm = 0.54 mm
Practical excepted joint movement: 10% of the joint width
Calculated joint width: 0.54 mm x 10 = 5.4 mm (practical 6 mm)
4.1.4 Procedure of levelling, bonding and caulking of teak decks

**General working conditions**

The preferred working conditions for applying sealant to decking are as follows:

- Outside temperature 5 °C to 35 °C and maximal 75% relative humidity
- Avoid increasing temperature during the first day
- Avoid exposure to direct sunlight and rain
- Prevent exposure to the elements for a minimum of 8 hours after the last step of the process
- Ensure adequate ventilation if necessary
- Avoid dirt, dust, oil, fat, grease, water during all processes as these can cause adhesion failure

**Surface preparation and primer application**

Timber decks are usually applied on top of a sub deck of steel, aluminium, polyester GRP or wood. Aluminium and steel decks may be deformed by the welding process and require a levelling process whereas wooden and polyester GRP decks are normally even by nature.

### Aluminium or steel decks

- **Steel**: the surface must be grinded or sand-blasted to remove rust, loose particles, flaked paint, contaminants, etc. When complete, remove all dust with a vacuum cleaner.
- **Aluminium**: This surface should be slightly sweep-blasted or sanded.

**Treat the surface 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).

**Take care to avoid dust, dirt or other contaminates until the next step has been carried out.**

- Check the air humidity and temperature and apply the product only if the surface temperature is higher than indicated in table on page 6 (Minimal substrate temperature to avoid water condensation). Respect the lower temperature limit.
- Surface and air temperature has to be between 10 °C and 35 °C.
- Mix the two parts of SikaCor® ZP Primer for 3 minutes, using an electric paddle mixer. Scrape the sides and the bottom of the container and mix for another 30 seconds. Do not split pre-packed cans. Use full kits only.
- Always monitor the pot life (1 hour at 30 °C, 3 hours at 10 °C).
- **Apply SikaCor® ZP Primer with a short hair roller. SikaCor® ZP Primer consumption, approx 200g / m².**
- **Drying time before next application:**
  - 10 °C: 5 to 14 hours
  - 20 °C: 3 to 14 hours
  - 30 °C: 2 to 14 hours

*Protect the area until SikaCor® ZP Primer has hardened.*

If the area is contaminated, vacuum clean again and then treat thoroughly using Sika® Aktivator-205.

If drying time exceeds the maximum 3 days flash of time, abrade the surface with a rotating sanding machine using P36 grit and vacuum clean thoroughly. Then reapply the SikaCor® ZP Primer.

### Glass fibre reinforced plastic decks

- **Heavily soiled surfaces should be cleaned off first with a pure solvent (Sika® Remover-208) to remove the worst of the soiling.**
- **Lightly abrade the contact area with a sanding pad.**
- **Remove the dust with a vacuum cleaner.**
- **Treat the substrate with Sika® Aktivator-205, using a clean, lint-free rag or a paper towel. Change the rag frequently.**
- **Flash off time**: 10 minutes (min) to 2 hours (max).
- **Apply a thin coat of Sika® MultiPrimer Marine using a clean brush, a foam pad or a felt applicator.**
- **Flash off time**: 30 minutes (min) to 24 hours (max).

*Fig. 2 Typical welds and weld splatter of a steel deck. Fig. 3 Applying SikaCor® ZP Primer with a roller.*
Deck levelling

Steel and aluminium decks are usually deformed by the welding process. They need to be levelled before applications of the teak panels. Levelling is carried out using Sika Transfloor®-352 SL or SikaTransfloor®-352 ST. SikaTransfloor®-352 SL should be used on even decks SikaTransfloor®-352 ST is more thixotropic and can be used for decks with a shear of 3 degrees.

SikaTransfloor®-352 SL and SikaTransfloor®-352 ST show excellent adhesion to the SikaCor® ZP Primer. It represents a lightweight two-component polyurethane based system that cures to a smooth and efficient sound damping layer.

**Application temperature**

The temperature (substrate / product / air) should be between 10 °C to 35 °C

In case of unfavourable climatic conditions, humidity in the air may condensate on a colder surface. Therefore the substrate temperature has to be controlled and should be equal or higher than indicated in the following graph (see page 7).

**Important:**
Condensation or water droplets on the levelled deck will cause adhesion failure; always monitor the dew point.

The deck levelling process

1. Stir component A and add component B of SikaTransfloor®-352 SL or SikaTransfloor®-352 ST.
2. Mechanically mix for three minutes at a medium speed. Avoid air entrapment.
3. Immediately transfer the entire contents of the SikaTransfloor®-352 mixture to another container, scraping the sides and bottom. Mix the new container for another minute before transferring the mixture onto the deck. Never scrape the remaining contents out of a pail onto the deck as this may not be completely mixed. Instead transfer any remnants to the next pail in the process and mix in with a new quantity. Repeat this as many times as required.
4. Pour the SikaTransfloor®-352 mixture onto the area to be applied. Always observe the working time restrictions: 45 minutes at 10 °C, 35 minutes at 20 °C and 25 minutes at 30 °C
5. Spread the mixed SikaTransfloor®-352 onto the deck using a bar or straight edge at a thickness just exceeding the highest elevation point of the steel or aluminium deck. Do not apply at a thickness over 30 mm. If this should be necessary, the operation must be carried out in several consecutive processes with intermediate sanding of the cured SikaTransfloor®-352 surface followed by vacuum cleaning. Working conditions: 10 °C to 35 °C and 80 % r.h. max.
6. Drying time: The SikaTransfloor®-352 coating can be walked over after 24 hours and is ready for the next stage in the process.
Deck bonding and bedding

Application on levelled surface with Sika Transfloor®-352 SL or SikaTransfloor®-352 ST.

Proceed with sanding the surface of cured SikaTransfloor®-352 prior to application of the bonding/bedding compound Sikaflex®-298. In the time between the curing of the levelling compound and applying the bedding compound, the surface of the SikaTransfloor®-352 must be kept free of soiling from footprints, dirt, dust, grease, fat, oil and other contaminants. The sanding process should be carried out using appropriate belt-sanding equipment with an 80 grit paper and followed by a thorough vacuum cleaning.

Application on other substrates

If levelling with SikaTransfloor®-352 is not required, planks should be offered up and their positions should be marked. When all have been marked, the planks should be removed ready for the primer.

For all woods: Apply a thin continuous coat of Sika® MultiPrimer Marine using a roller or spray equipment

Flash off times: 30 min to 24 hours

Ideally the surface as well as the joint is primed if the planks are embedded and the sealing of the joint is executed in a short time period.

Application of Sikaflex®-298 and embedding of the planks

Sikaflex®-298 is a low viscous, exceptionally strong flexible one-component adhesive which is applied with a 4 mm comb trowel. The consumption should be around 1.2 liters (2x 600 ml sausages) per m². The quantity has to be adjusted according to the surface texture. In any case the planks have to be embedded totally without any air pockets between substrate and planks.

Hold the planks in place by mechanical means such as weights/sandbags or by vacuum pressing.

Important:

Only cover an area that will allow adequate time for a manageable quantity of deck planking to be placed before a skin forms on the adhesive (see Product Datasheet).

Fig. 9 Applying Sika® MultiPrimer Marine to a teak deck with a roller (hidden side)

Fig. 10 Carefully applying Sika® MultiPrimer Marine

Fig. 11 Hand application picture comb trowel and comb trowel detail

Application temperature

<table>
<thead>
<tr>
<th>Temperature</th>
<th>10 °C (50 °F)</th>
<th>20 °C (68 °F)</th>
<th>30 °C (86 °F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pot life Sikacore® ZP Primer</td>
<td>3 h</td>
<td>2 h</td>
<td>1 h</td>
</tr>
<tr>
<td>Waiting time before application of Sikaflex®-352 ST or SL</td>
<td>5 h – 14 h</td>
<td>3 h – 14 h</td>
<td>2 h – 14 h</td>
</tr>
<tr>
<td>Working time Sikaflex®-352 ST and SL</td>
<td>45 min approx.</td>
<td>35 min approx.</td>
<td>25 min approx.</td>
</tr>
<tr>
<td>Waiting time before installation of timber decking with Sikaflex®-298</td>
<td>up to 14 days</td>
<td>up to 14 days</td>
<td>up to 14 days</td>
</tr>
</tbody>
</table>

Working/waiting/drying time for Sikacore® ZP Primer, SikaTransfloor®-352

Minimal substrate temperature to avoid water condensation on the surface

<table>
<thead>
<tr>
<th>Air temperature</th>
<th>5 °C</th>
<th>10 °C</th>
<th>15 °C</th>
<th>20 °C</th>
<th>25 °C</th>
<th>30 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% humid.</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>12</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>50% humid.</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>12</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>60% humid.</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>12</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>70% humid.</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>12</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>80% humid.</td>
<td>3</td>
<td>6</td>
<td>10</td>
<td>15</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>90% humid.</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>19</td>
<td>24</td>
<td>29</td>
</tr>
</tbody>
</table>

1 calculated by the dew point plus 3 °C security

Example air temperature 10 °C / relative humidity 60 % result: minimal surface temperature: 6 °C : conclusion: not allowed working conditions (minimal 10 °C).
The fixation may be released after 24 hours. If a shorter waiting time is needed or in case of low temperature/humidity we recommend spraying sparingly a mist of water over the surface just before placing the planks. The needed water quantity is only about 1 gram water per square meter of Sikaflex®-298.

In such a case the fixation time is reduced to some hours.

Fig. 12  Sikaflex®-298 applied with a comb spreader

Fig. 13  Putting down the decking

Fig. 14  A teak floor being laid, showing the bedding compound and the weights to hold it in place

Fig. 15  Vacuum press

Fig. 16  Vacuum equipment
Deck caulking with Sikaflex®-290i DC

As soon as the teak planks are fixed, the caulking may be done.

**Priming the substrate seams**

Priming of the planks is an absolutely vital step in the process of caulking with Sikaflex®-290i DC.

If the planks are not already primed, this operation has to be done using a brush in a smaller size than the joint width. In order to achieve long-term adhesion of Sikaflex®-290 DC to the sides of the joints, meticulous preparation of the seams is required. Remove all dirt with a vacuum cleaner. Apply a thin coat of Sika® MultiPrimer Marine to the edges of the joint seams. It can be applied by brush or spray in one coating operation. Application temperature: 10 °C to 35 °C. Drying time: 10 °C to 35 °C: 30 min to 24 hours.

**Important:** If the caulking process is followed not later than one day after the bedding, priming can be done simultaneously for both working steps (plank priming including seams). Take care to avoid soiling of the teak before caulking has been done.

**Application of Sikaflex®-290i DC deck caulking compound**

Before any work commences, ensure that the temperature of the wood does not exceed 35 °C. In addition, the ambient temperature during application should be constant or falling and ideally within the range of 5 °C and 35 °C. Apply Sikaflex®-290i DC ensuring that air is prevented from entering the seam by placing the tip of the nozzle against the bottom of the joint and keeping the gun at an angle of about 60°. If narrow joints need to be caulked a specially designed nozzle may be required. Use a handheld gun, a piston-driven airgun or a battery operated gun. Continue to apply along the seam so that the joint appears to slightly overfill behind the nozzle, but maintain a constant motion.

After applying Sikaflex®-290i DC but before skinning occurs, compress the excess material onto the surface of the deck using a slightly flexible spatula at an angle of 60°. This produces a convex appearance of the joint and fills the seam completely (see Fig. 19).

Protect the joints from rain and direct sunlight prior, during and after caulking, for a period of at least eight hours. Do not use excess material from the spatula to prevent bubbles in the joint.

Sikaflex®-290i DC is ready for sanding following the conditions outlined on the bar chart in Fig. 17.

**Deck sanding**

For efficient sanding results, use an industrial sander. It is recommended to begin with a medium paper at about 80 grit, progressing up to 120 grit. Suitable sanders are belt sanders, flat plate, or elastically suspended sanders. Sanding should be carried out in line with the seams. The waiting time between application of Sikaflex®-290i DC and sanding is indicated in Fig 17.

**Finishing**

**It is not** recommended that a finish such as a varnish be applied to the exterior teak deck as these can contain solvents or plasticizers which can adversely affect the cured Sikaflex®-290i DC or the drying of the lacquer. Varnishes do not often exhibit the flexible characteristics of a caulk, and so the finish may also show cracks, which could render the deck unsightly.

See also chapter 4.1.6: Maintenance of teak decks.
4.1.5 Prefabricated teak decks

Many shipyards appreciate the use of prefabricated teak decks because they can be manufactured off-site, rather than on board where the process can block other activities. Prefabricated panels are efficient in their versatility to be produced in various shapes, quickly or on demand; as soon as the panel manufacturer has obtained the dimensions of the boat deck production can be started, thus saving substantially on labour costs. The prefabricated panels are also very easy to handle and to bond to the deck.

Types of prefabricated teak decks

In modern boat-building wooden decorative decks are often constructed in the form of prefabricated panels bonded or bedded onto the sub deck. This method is often favoured for time and cost savings.

These kinds of panels are either made to measure (custom made) from a template fitting the prescribed deck section, or are cut out of unidirectional panels. Prefabricated teak deck panelling comes either with or without a backing.

Backings may be

- Marine plywood in different thickness
- HPL (flat laminate)
- Fiberglass lamination with epoxy resins

![Typical prefabricated teak deck profiles](image1)

![Customised teak decking made to measure](image2)

![A prefabricated teak deck is laid out in preparation for fitting](image3)

![Deep joint prefabricated teak decking and the strength and flexibility inherent in the adhesive](image4)
Bonding of the prefabricated elements

To bond or bed the prefabricated panels, use one-component polyurethane adhesives such as Sikaflex®-298 or Sikaflex®-291i in case of intensive vacuum pressing.

The adhesive has to act as an additional layer in between the sub deck and the panel in order to waterproof the overall surface of the deck. As a prefabricated feature deck does not have to be drilled for screws and bolts there is no puncturing of the layer and therefore no risk of water leakage which could damage the sub-deck.

Substrate preparation

Fibreglass backings

- Heavily soiled surfaces should first be cleaned off with a pure solvent (Sika® Remover-208) to remove the worst of the soiling
- Lightly abrade the contact area with an abrasive pad very fine
- Remove the dust with a vacuum cleaner
- Treat the substrate with Sika® MultiPrimer Marine, using a clean brush or roller
- Waiting time until deck bonding: 30 minutes (min) to 24 hours (max)

Timber or plywood backings

- Abrade the contact area on the deck with a sanding pad (60-80 grit)
- Remove the dust with a vacuum cleaner
- Apply a thin, continuous coat of Sika® MultiPrimer Marine using a clean brush or a roller
- Waiting time until deck bonding for Sika® MultiPrimer Marine 30 min to 24 hours

Timber deck with HPL-backing

- Abrade the contact area on the deck with a sanding pad (60-80 grit)
- Remove the dust with a vacuum cleaner
- Apply a thin, continuous coat of Sika® MultiPrimer Marine using a clean brush or a roller
- Waiting time until deck bonding for Sika® MultiPrimer Marine 30 min to 24 hours

Aluminium or steel decks

- Steel: the surface must be ground or sand-blasted to remove rust, loose particles, flaked paint, contaminants, etc. When complete, remove all dust with a vacuum cleaner

Timber deck without backing

- Remove the dust with a vacuum cleaner
- Apply a thin, continuous coat of Sika® MultiPrimer Marine using a clean brush or a roller
- Waiting time until deck bonding for Sika® MultiPrimer Marine 30 min to 24 hours

Application and positioning of the prefabricated deck elements

Sikaflex®-298 is a low viscosity, exceptionally strong flexible one-component adhesive which is applied with a 4-5 mm comb trowel. The consumption should be around 1.2 litres (2x 600 ml sausages) per m². The quantity has to be adjusted according to the surface texture. In any case the planks have to be embedded totally without any air pockets between substrate and planks.

Remove the air after the element was laid down with a steel roller. Start in the middle of the deck towards the edge of the element.

Timber or plywood backings

- Abrade the contact area on the deck with a sanding pad (60-80 grit)
- Remove the dust with a vacuum cleaner
- Apply a thin, continuous coat of Sika® MultiPrimer Marine using a clean brush or a roller applicator
- Drying times: Sika® MultiPrimer Marine 30 min to 24 hours
Bonding process

Apply the adhesive to the previously prepared surface and spread it using a spreader with 4 mm triangular notches. The bed thickness may vary depending on the thickness of any gap that needs to be filled.

If HPL or GRP-laminates have to be bonded, spray a light mist of water on the Sikaflex® prior to positioning the panels (about 1 g/m²). If one of the bonded partners is wood, the application of a water mist is not necessary but sometimes useful to accelerate the cure at lower temperature. The deck panel must be positioned accurately and pressed firmly into place. Use a roller to eliminate air pockets.

Uncured Sika adhesives or sealants should be removed with Sika® Remover-208 on non-porous substrates. On porous substrates let harden the Sikaflex® soiled on teak and eliminate it mechanically.

Clamps, weights or screws (removable once the adhesive has set) can be used to secure the panel. Alternatively, the vacuum press method can be used.

After 24 hours the panels can carry their full service load and the temporary fastenings can be removed.

Finishing

Remaining joints should be caulked as soon as the fixation means are removed. For horizontal joints, Sikaflex®-290i DC can be used. Vertical joints should be caulked with Sikaflex®-295 UV.

Important:
If masking tapes are used, they have to be removed as soon as possible before skinning of the Sikaflex® occurs.

Fig. 25 Application of Sikaflex®-298
Fig. 26 Holding in place with weights
Fig. 27 Sealing the edges after renovation with Sikaflex®-295 UV
4.1.6 Maintenance of teak decks

The teak deck changes its color during exposure to the sun and will weather in time to a silver patina. The resulting greyish brown is sometimes wished. In such case we recommend to clean the deck surface regularly with Sika® Teak Cleaner. Use a sponge or a brush and work always it the direction of the wood grain. In warm climates this procedure should be carried out every day. Bleach, strong acids and aggressive chemicals should not be used at any time.

To maintain the colour and appearance of a new teak deck, Sika offers a maintenance system: Sika’s Teak Maintenance System is fully compatible with Sikaflex®-290i DC caulked teak decks.

Sika’s Teak Maintenance System consists of the following:

1. Sika® Teak Cleaner
   
   This product is used to clean the surface of the teak.
   
   Apply directly to either wet or dry teak using a brush. Work always in the direction of the wood grain. Leave for 15 minutes before rinsing off with fresh water.

2. Sika® Teak Brightener
   
   Following the treatment of Sika® Teak Cleaner, apply Sika® Teak Brightener to the wet surface using a clean rag and allow to set for a maximum of 5 minutes before rinsing off thoroughly with fresh water.

3. Sika® Teak Oil
   
   Apply this with a clean rag to dry, cleaned wood and allow the oil to penetrate before removing the excess. Reapplication is recommended at the first signs of weathering.
4.1.7 Teak deck repair

Most quality timber decks are of teak. For this reason, most of the procedures outlined in this manual are focused on that material.

Deciding whether or not a wooden deck needs to be repaired is not always easy. First, it must be established that a joint has failed or that the wood has been damaged sufficiently to cause a problem.

Each and every joint should be closely inspected. Any points at which there is a small gap or crack in the caulk should be marked with distinctive chalk.

Similarly, the wood surface should also be closely examined for undue wear, gashes, splitting or splintering and should be marked with chalk in a similar way.

However, parts or all of damaged planks should be replaced, according to how badly they are damaged.

If joints are mostly in good condition, but are damaged in one or two places, these can be repaired by replacing the local caulk. More extensive damage, may suggest that all of the jointing would need to be replaced.

The following table shows the recommended responses to the outcome of a deck analysis.

<table>
<thead>
<tr>
<th>Serious wood damage</th>
<th>Slight wood damage</th>
<th>Wood undamaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replace deck with new prefabricated or built in-situ deck</td>
<td>Replace all joints, then sand and restore whole deck</td>
<td>Replace all joints</td>
</tr>
<tr>
<td>Replace damaged joint areas, replace damaged wood areas, then sand and restore whole deck</td>
<td>Replace damaged joint areas, then sand and restore whole deck</td>
<td>Replace damaged joints only</td>
</tr>
<tr>
<td>Replace damaged wood areas. Sand and restore whole deck</td>
<td>Sand and restore whole deck</td>
<td>Clean the deck. Restore the wood if necessary</td>
</tr>
</tbody>
</table>

---

**Deck analysis responses**

Please note that water intrusion between wood and deck may lead to fouling of the wood. It is recommended to control the deck periodically and repair non-tight areas before the whole deck is affected or part of the wood detaches from the deck due to the wood expansion with permanent water contact.

**How to detect untight areas?**

Wood that has become damaged by water trapped in a failed joint becomes more porous than the wood surrounding it. This can result in the damaged wood changing colour. It also means that it will remain wet after the rest of the deck has dried. Wetting the deck and closely examining the areas that remain wet after the rest has dried, is an effective method for identifying problem areas.

---

**Determination of the type of adhesive which will be replaced**

In the following part all possible repair solutions are described. However to achieve a perfect result, the chemical composition of the original deck caulking material as well as the elastic adhesive of the planks have to be determined if they are not known.

One simple test is to observe the burning behaviour of the sealant or adhesive.

For that a small test piece of the test product will be ignited with a pocket lighter.

The type of flame, the flammability and the smoke gives a good indication of the product base.

- Flammable. Yellow flame with an intense black fume and black ashes indicates a polyurethane
- Flammable. Yellow flame without black fumes indicates a Product based on Hybrids or MS-polymers
- Non propagating light yellow flame with a white to grey fume and white ashes indicates a silicon based product

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**Important:**

Never repair a joint simply by cutting the sealant out and replace it with a sealant unless the chemical base is identical.

---

Which repair solution will be chosen depends on the state of the deck and the expected result.
Repair recommendation

If the old joint is soft and sticky we recommend to eliminate the old material completely using a router. Enlarge the joint to ensure a proper wooden surface. After such a removal, all sealant types can be newly applied as described in the chapter 4.1.4 Procedure of levelling, bonding and caulking of teak decks.

Removing of old caulking

There are five principal methods for removing old caulking. These are:

- Manual cutting with a sharp knife
- Using an oscillating cutter (Fein Tools) with a chisel-tip blade that is the same width as the joint
- Using an electrically heated rubber-cutting ‘rubbercut’ tool (Rema)
- Using a router. This method must be used if the old caulking material is not Sikaflex®-290i DC as the sides of the joint will be shaved by the router blade.

The method used normally reflects the size and the nature of the job. For a small, one-off job, the manual method would be the cheapest and the simplest method. A large job or a professional repair workshop would likely need to use either the oscillating cutter or the Rubbercut tool for both the time-saving and the quality of the finish.

The router would be used where it is necessary to make sure that there is no residue of the old caulking remaining. This would be especially important when the old caulking material is of unknown chemical composition as it might both have an unwelcome reaction with the new caulking material and have an inferior adherence to the sides of the joint.

<table>
<thead>
<tr>
<th>Old joint</th>
<th>PUR</th>
<th>MS / Hybrides</th>
<th>Silicones</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUR</td>
<td>Just cut out the defective joint. Clean the surface to be resealed with Sika® Aktivator and leave it for at least one hour before the application of the new sealant</td>
<td>Not recommended</td>
<td>Not recommended</td>
</tr>
<tr>
<td>MS or Hybrid</td>
<td>Not recommended</td>
<td>Seek advice from the manufacturer</td>
<td>Not recommended</td>
</tr>
<tr>
<td>Silicone</td>
<td>Not recommended</td>
<td>Not recommended</td>
<td>Cut out the defective material, clean with isopropyl alcohol and seal the joints after 1 hour flash off time</td>
</tr>
</tbody>
</table>

Important:

It is important to take care and ensure that the directions of cut is WITH the grain as shown in Fig. 33.
**Removal with a sharp knife**

Insert the blade of a craft knife into one side of the joint perpendicular to the deck surface.

Cut along the joint taking care to keep the blade straight otherwise the wood might get damaged, or the old caulking will not be completely cut away.

Insert the blade at an angle from the top of one side of the joint to the bottom of the other.

Cut along the joint taking care to keep the blade at a constant angle. This will remove a triangular bead of old caulking along the length of the joint.

Insert the blade vertically at the other side of the joint. Once again, care should be taken to keep the blade straight otherwise the wood might get damaged, or the old caulking will not be completely cut away.

Adjust the blade to cut an opposite diagonal, to remove half of the remaining caulking.

Remove the 'A' shaped remainder using a scraper of appropriate width. A hand-chisel of the same width of the joint or slightly less would be ideal for this purpose.

**Removal with an oscillating cutter**

Switch on the oscillating cutter. Grind the blade with a grinding stone (from the tool manufacturer).

Insert the blade in the joint and remove it. For this joints it may be necessary to do this in two steps.

The cut caulking will be ejected out of the joint with a continuous strip.

Switch on the oscillating cutter. Grind the blade with a grinding stone (from the tool manufacturer).

**Removal with an electrical rubbercut tool**

Switch on the Rubbercut tool. Exert a pressure to the cutting head in the forward direction. The tip will heat up to a temperature which cuts the old caulking.

Insert the tool and advance it along the joint, taking care not to damage the planks at the sides of the joint and in the case of smoking, insert a new cutting blade.

The cut caulking will be ejected out of the joint in a continuous strip.
Replacing of old joints

Old and damaged or detached sealants should be replaced to prevent water intrusion in between Teak and Substrate. One of the problems could be a incompatibility of the old sealants with the new joint sealant.

The best solution is to remove the old sealant completely using a guided router and the new sealant adheres to the teakwood.

If the old sealant cannot be removed completely, an analyse of the old sealant should be done to detect possible incompatibilities between old and new sealant (see page 14).

Replacing defective planks

- Completely remove the caulking from the joints around any planks that are to be removed. (See 'Removing Old Caulking' on page 15)
- Identify the damaged planks with a chalk
- Remove the damaged plank, taking care not to damage the substrate. (If a strong adhesive has been used to bed the plank in place, it may be necessary to destroy the first plank removed in any series. The aperture can then be used to insert a shim beneath adjacent planks to enable their removal if necessary.)
- If only part of the plank is to be replaced. Cut off the damaged area using a vibrating saw. Prepare the new plank to the same dimensions as the damaged one
- Remove any old adhesives, bedding or other foreign matter from the substrate and remove the jointing material from around the edge using a craft knife, a scraper and sandpaper to ensure that the exposed edges are completely free of any residue
- Analyse the type of sealant. (see page 13)

In case of silicone as original sealant, grind the edge of the planks or better using a router with a guide to assure a complete removal of the old sealant.

Dry fit the new plank to make sure that it will locate and align with the existing planks

Clean, or if necessary, prime the substrate according to the type of material as described in the appropriate procedure

Prime all faces of the remaining planking as well as of the new plank (including the hidden side) using Sika® MultiPrimer Marine

Drying time: 30 min to 24 h

Apply and spread bedding compound Sikaflex®-298 at the appropriate depth to the sub deck

Insert the replacement plank, bedding it in place and aligning and levelling it carefully with existing planking

Hold the new planking in position using weights, screws or wedges

Allow the Sikaflex®-298 to cure for a minimum period of 24 hrs

Apply Sikaflex®-290 DC caulking, ensuring that no air is trapped in the joints and allowing the compound to slightly overfill the gap

Slightly overfill the joint. Leave it if the deck will be sanded after caulking or use a spatula at 60° angle to press the sealant slightly into the joint.

Let the Sikaflex® 290i DC cure as indicated in Fig. 8

Important:
If the deck should not be grinded, the joint filling process can be done using masking tapes
Sanding of the deck

To reduce sanding time we recommend to remove most of the hardened bead of Sikaflex®-290i DC with an electric vibrating scraper.

For efficient sanding results, use an industrial sander. It is recommended to begin with a medium paper at about 80. Suitable sanders are belt sanders, flat plate, or elastically suspended sanders.

Connection areas may be sanded with a palm sander (see Fig. 51).

When the surface is uniformly smooth, change the sanding belt to 120 grit and re-sand the whole area again, keeping the sander aligned with the wood grain as much as possible.

Remove all dust with a vacuum cleaner.

Replacing the whole deck

In such case the wood has to be removed and the deck has to be cleaned. Sanding or sandblasting has to be done down to the original substrate. Then install a new deck as outlined in part 4.1.4 for in situ produced deck covering or in part 4.1.5 in case of prefabricated decks.

1. Damaged area
2. Removed planks
3. Embedded new planks
4. Repaired deck
4.1.8 Alternatives to Teak

Teak has been used for hundreds of years as a durable deck material. Alternatives for teak such as iroko, padouk etc. are used in some cases but necessitate an intensive protection work to assure a long time function. Usually they are used in workboats as thick protective floors.

Teak deck alternatives are shown in the chart beside

Other woods

Advantages:
- Not submitted to legislation (FSC-label)
- Good relation price / durability

Disadvantages:
- Durability of these wood is lower than teak
- Shrinkage (hygric) is higher than teak
- No longtime experience in deckings’ are known
- More irregular grain such as alternating spiral growth etc. Periodical deck control is necessary.

Frequently used woods:

Iroko (Kambala)

Padouk

Others possible alternatives are: oregon pine, afromosia, basralocus, cedro, cordia, kahja, sipo, IPE etc.

Important:
Decks done with these woods may show an irregular hygric movement. Such deck coverings have to be observed frequently and eventually noticed joint detachments have to be repaired immediately

Treated broadleaf

This type of wood are home-grown broadleaf treated with natural or synthetic resins.

One example of these product types is Kebony. This is a maple wood treated with natural resins.

With this treatment the following characteristics are achieved:
- Durability comparable to teak with the same colour change to grey – brown.
- Hardness, abrasion resistance higher than Teak
- Expansion property as teak

Surface preparation and adhesives are identical to chapter 4.1.4.
**Synthetic (engineered) teak**

Synthetic teak consists in thin layers of teak which are bonded together. The advantage of this process is the use of the entire tree. (Heartwood and sapwood).

Further information’s have to be requested by the manufacturer.

**Synthetic coverings**

These prefabricated decks are made of different plastics. Quality and durability may differ as well as slip resistance and feel. These coverings are mainly used on yachts.

We distinguish between principally three types of synthetic coverings:

- Polyurethane elastomers / GRP backing
- Synthetic rubber composites
- PVC based coverings

**Polyurethane elastomers**

One product of this category is Esthec from Bolith.

This company offers a broad range of coverings (form, colour design)

Sikaflex®-298 or Sikaflex®-291i are an ideal bonding solution.

These elastic products compensates the thermal and dynamic movement between the deck and the covering and increases the inherent acoustic dampening characteristics.

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Fig. 54 Different designs, photos: Esthec
Preparing PUR based deck coverings

The covering material must be free from release agents or other media used in the production process. Use appropriate solvent recommended by the manufacturer.

On nonporous coverings, the side that is to be bonded should be cleaned with Sika® Aktivator, using a clean, lint-free rag or a paper towel. Change the rag frequently!

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

Preparation of the deck

GRP decks

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

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

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

Timber decks

Abrade the contact area on the deck with a sanding paper (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)

Aluminium or steel decks

Steel: Grind (36 P grit) or sand-blast the surface in accordance with ISO 8501-1: 1998 SA 2½

Aluminium: Lightly sweep-blast the surface

Thoroughly vacuum clean the surface

If the area is contaminated, treat the surface with Sika® Aktivator 205 using a clean towel

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

Avoid dust or other contamination until the next step has been carried out

Apply a continuous coating of two-component SikaCor® ZP Primer within 2 hours of the Sika® Aktivator treatment to the surface, using a clean brush or a roller at a consumption of approx. 200 gr/m² or 80 μm thickness.

Aluminium or steel decks, coated with a two-component paint, varnish or fairing compound

Ensure that the treated metal deck is compatible with Sikaflex®-291i or Sikaflex®-298. Test the paint with a solvent like acetone or a commercial available silicon remover or paint thinner.

If the paint can be removed, sandblast off the paint down to the metallic surface and use SikaCor® ZP Primer (see page 5)

Lightly abrade the contact area with a very fine abrasive pad

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

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

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

Bonding process

Apply Sikaflex®-298 or 291i on the previously prepared surface and spread using a spreader with 4 mm triangular notches. The thickness layer should be about 1.2 mm, 2x 600 ml sausages per m²

The covering material must be placed in position within 20-30 minutes of applying the adhesive, therefore the adhesive should be applied only to an area large enough to receive the section of covering that can be fitted in this time. Prevent air entrapment!

Once the covering has been placed in position it should be rolled down with a rubber roller, working from the centre outwards to expel any entrapped air and push any excess adhesive out to the edges, where it can be removed. It is essential to ensure that no trapped air remains

To accelerate the curing process we recommend to apply a mist of water using a paint gun. Do it sparingly as Sikaflex® needs only 1 gram of water per square meter.

Caution: If the covering material is laid under tension, the edges must be held or suitably weighted

Fix the deck with weights or vacuum press over night

Uncured Sikaflex® may be removed from Tools with Sika® Remover-208. On rough surfaces we recommend to leave the adhesive to cure and remove it mechanically

Synthetic rubber composites

Typical products in this range is Norament. The surface preparation as well as the bonding process is the same as described for Esthec.

PVC-coverings

Most of the alternatives for teak decks are based on PVC. The composition varies for each deckings. PVC coverings contain organic plasticizer. This plasticizer may have a long time interaction with the used adhesive. Therefore we do not give any recommendation for bonding such products. In such case it is best to get in contact with he distributor in order to receive an adhesive which is recommended by the manufacturer.

Important:
Due to the variety of the deck coverings we recommend to seek advice from the procedure of the coverings or contact your local Technical Service department, Sika Industry.
4.1.9 Bonding of timber elements

In yachts and pleasure craft as well as in ocean-going vessels, stairs, companionways and handrails are frequently made from tropical hardwood, chosen both for their durability and their attractive appearance.

The use of screws to attach these fixtures can impair both their durability and their appearance as they are vulnerable to moisture gaining access through the fixing holes. Hardwood components like these can be fixed with adhesives, where the absence of screw holes leaves the wood unimpaired and more resistant. This is of particular importance where the wood is load bearing as in the construction of accommodation ladders.

Bonding also has other benefits. The resilient adhesive layer softens the sound of footsteps and cushions vibrations, the integrity of painted surfaces can be preserved without loss of corrosion protection and the effects of moisture penetration are eliminated.

The Sika products for bonding timber elements are Sikaflex®-298 (low viscous) for big bonding parts or parts which do not need a instant fixation until the hardening process took place (horizontal applications).

For smaller parts or parts which are bonded on an inclined substrate we recommend Sikaflex®-291i.
### Substrate preparation

**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 (abrasive pad very fine).
- Remove the dust with a vacuum cleaner.
- 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 a felt applicator.

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

**Stainless steel**

- 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 abrasive pad (abrasive pad very fine).
- Clean with a proper rag or a vacuum cleaner.
- Pre-treat the substrates with Sika® Aktivator, 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)

### Metall deck coated with a 2 C-paint

Ensure that the painted metal deck is compatible with Sikaflex®-291i or Sikaflex®-298. Test the surface with a rag and thinner. The paint should not be removable by this operation. When the paint is dissolvable sandblast off the paint down to the metallic surface and use SikaCor® ZP Primer (see page 4).

- Lightly abrade the contact area with a very fine sanding pad (Scotch Brite very fine).
- Remove all dust with a vacuum cleaner.
- Treat the substrate with Sika® Aktivator, using a clean lint-free rag or paper towel. Change the rag frequently!

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

### Application of Sikaflex®-298 and Sikaflex®-291i

The choice whether you use Sikaflex®-291i or -298 depends on the parts to be bonded.

- Big horizontal areas are better to bond with Sikaflex®-298 as this low viscous product is easier to apply with a trowel. The bedding process should be made with weights or with a vacuum press.
- Smaller parts, inclinates on vertical applications, or parts which have to be fixed with a vacuum press are best to be bonded with Sikaflex®-291i. The higher viscosity of this product prevents a squirting out during vacuum application.

**Important:**

It is essential that the elements are completely pressed down to the substrate to avoid water penetration underneath the timber element. This may create fouling and subsequent degradation of the wood.

Remove cured excess Sikaflex®-298 or -291i with a knife and seal the edge without additional pre-treatment.

If necessary joints on the side of the elements may be sealed with a weathering resistant sealant like Sikaflex®-295 UV.

### Untreated Wood

- If the surface is soiled, abrade the contact area 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 time:** 30 minutes (min) to 24 hours (max)
4.2 Bedding and Sealing Fittings and Hardware

4.2.1 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 and such as tensile, torsion and shear stresses.

Poorly sealed joints can suffer serious damage such as metal corrosion, osmosis and water leaks which, in turn, 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.
4.2.2 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, 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

- Pre-treat the substrate with Sika® Aktivator, 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)

Aluminium fittings

- Lightly abrade the contact area with a very fine sanding paper
- Pre-treat the substrate with Sika® Aktivator, 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.
4.3 Bonding of Rub Rails and Fenders

4.3.1 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 these are, the more effectively they perform this function.

The elastic behaviour varies according to the type of material used, so the shock-absorbing 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.
4.3.2 Bonding rub rails to the hull

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, 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**

- Abrade 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.
- Abrade the bond face of the rub rail with coarse sand paper (80 / 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).

**Application of Sikaflex®-292i or Sikaflex®-291i**

- Apply a masking tape on the substrate.
- 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 (Fig. 1).
- Assemble the components within 20 minutes of applying the adhesive.
- Press the rub rail into place, either directly onto the face of the hull.
- 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 over standing 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.

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**Fig. 1** Assembly of a rub rail

**Fig. 2** A sample section of rub rail

**Fig. 3** Sealing the edge of a chrome hand-rail

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4 Sealing and Bonding

Finished painted hulls of aluminium or steel, coated with a two-part lacquer

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

---

2 Bonding of Rub Rails and Fenders
4.4 Sealing Sacrificial Anodes

4.4.1 General description

A sacrificial anode, or sacrificial rod, is a metallic anode used in cathode protection where it is intended to be dissolved to protect other metallic components. The more active metal is more easily oxidized than the protected metal and corrodes first (hence the term “sacrificial”); it generally must oxidize nearly completely before the less active metal will corrode, thus acting as a barrier against corrosion for the protected metal.

In marine the sacrificial anode is made of Zinc, where the Cathode which has to be protected is steel.

Sea water is a particularly good electrolyte and accelerates corrosion of metals exposed to it.

As fixing the anodes mechanically means that the hull is pierced, the anodes must therefore be sealed to the outside of the hull to prevent water ingress. Sikaflex®-291i provides a sound watertight seal for this application.
4.4.2 Sealing sacrificial anodes

Substrate preparation

Painted steel hull

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

Sacrificial anode

- Clean the anode with Sika® Aktivator
- Let dry for 10 minutes (minimum) and 2 hours (maximum)

Application of Sikaflex®-291i sealant

- Sikaflex®-291i should be applied around the hole and the bolt in a fillet around all the edges of the fixing once it is securely fastened
- Use a plastic spatula to remove excess sealant squeezed out around the edges
- Uncured Sika adhesives or sealants can be removed with Sika® Remover-208

Fig. 1 Sikaflex®-291i is applied
Fig. 2 The anode is fitted
Fig. 3 Examples of weld-on sacrificial anodes
Fig. 4 Examples of bolt-on type sacrificial anodes
4.5 Bonding Decorative Panels and Work Surfaces

4.5.1 General description

The interiors of many boats are based on a variety of traditional and modern materials including mirrored glass, Avonite® and Corian®. 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.
4.5.2 Bonding decorative panels and tables

Surface preparation
- Lightly abrade the bonding area with a very fine abrasive pad
- Apply a thin continuous coat of Sika® MultiPrimer Marine using a clean brush or felt applicator
- Felt applicator drying time: Sika® MultiPrimer Marine 30 min (min) to 24 hours (max)

Application of Sikaflex® adhesive to horizontal panels
- Horizontal surfaces: Sikaflex®-298
- Inclined surfaces: Sikaflex®-291i

Application of Sikaflex® adhesive to vertical panels
- 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

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

Fig. 1 Bonding a decorative panel vertically
Fig. 2 Bonding a decorative panel horizontally
Fig. 3 A galley work surface fitted using Sikaflex®-292i
Fig. 4 Application of Sikaflex®-291i
4.6 Bonding Lightweight Internal Partitions

4.6.1 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.

Due to the low density core, lightweight panels cannot be mechanically fixed to the hull structures in the same way as traditional plywood panels. 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.
4.6.2 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.

![Partitions and Sikaflex application](image)

Fig. 1 Sikaflex®-292i bead application for bonding to the support

Fig. 2 Lightweight panels being fitted to an open hull

Fig. 3 Sikaflex®-292i applied to a lightweight panel prior to fitting

Fig. 4 High-quality lightweight panels finished in traditional high-gloss wood veneer and bonded using Sikaflex®-292i.
4.7 Bonding Anti-Slip Plates for Engine Rooms

4.7.1 General description
Anti-slip plates used in technical, storage or engine rooms are traditionally fixed using rivets or other mechanical fixings. Being in an area that is subjected to intense vibration, these often become loosened and a regular amount of repair work or maintenance is often required. The use of elastic bonding technology not only absorbs vibration and noise but also allows a better distribution of the stresses, thus avoiding the need for repair work. In addition, both the fixing and the sealing of the plates can be carried out in a single timesaving operation.
### 4.7.2 Bonding anti-slip plates

#### Surface preparation

**Aluminium**

- Lightly abrade the bonding area with a very fine abrasive pad.
- Treat the surface with Sika® Aktivator-205 with a lint free paper towel.
- 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: Sika® MultiPrimer Marine 30 min (min) to 24 hours (max).

**Two-component coating on metals**

- Ensure that the paint is compatible with Sikaflex®-252i.
- Test the paint with a solvent like acetone or a commercial available silicone remover.
- If the paint can be removed, sandblast off the paint down to the metallic surface and prepare as indicated in the Sika Marine Pre-Treatment Chart.
- Treat the surface with Sika® Aktivator.
- Flash-off 10 minutes (min) to 2 hours (max).

#### Application of Sikaflex®-292i adhesive

- 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 weights or other 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.
5.1 Elastic Thick Layer Bonding

5.1.1 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.

5.1.2 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.

Elastic thick layer bonding from Sika is relatively simple to design, tolerant of dissimilar materials, very strong and durable, 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.
5.2 The Sika Solutions for Structural Bonding

5.2.1 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 localised 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 fly bridges 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 re-fitted 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></th>
<th>Mechanical Fixing</th>
<th>Laminating Taping</th>
<th>Elastic Bonding</th>
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<tr>
<td>Comfort (acoustics)</td>
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○ Very poor  ○ Poor  ○ Neutral  ★ Good  ★ Very good
5.3 Fly Bridge Bonding

5.3.1 Application description

Many modern motor yachts have fly bridges. 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 fly bridges using flexible adhesive systems evens the distribution of stresses and optimises resistance to impact and fatigue effects.

In service, fly bridges 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®-295i UV in white colour.
5.3.2 Fly bridge bonding procedure

Preparing the substrate GRP

- 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 Material Safety Datasheet obtainable through your local Sika company.
5.4 Deck to Hull Bonding

5.4.1 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. There is also no need to order and stock all of these items.

It is hard to envisage a more perfect solution to deck to hull bonding.

For information regarding bond line dimensions, please contact Sika’s Technical Service department, who can also provide appropriate values for FEM calculations.
5.4.2 Deck to hull bonding procedures with Sikaflex®-292i

Preparing the substrate for aluminium

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).

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).

Other substrate

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

Application of Sikaflex®-292i

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.

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 (Fig. 1 and 2); 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.

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

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.
5.5 Keel to Hull Bonding

5.5.1 Application description

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.
5.5.2 Keel to hull bonding

**Substrate preparation**

**Aluminium 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, using a clean, lint-free rag or a paper towel. Change the rag frequently!
- Flash-off: 10 minutes (min) to 2 hours (max)

**GRP hulls**

- 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)
- Pre-treat the substrate with Sika® MultiPrimer Marine, using a clean brush or a felt applicator.
- Drying time: 30 minutes (min) to 24 hours (max)

**Steel hulls and keels, coated with two-part corrosion protection paints**

**Important:**

One-component paints are not suitable to be bonded on it. To control the quality of the paint we recommend cleaning a small part with paint thinner. If the paint resists to the solvent it is suitable and can be bonded as described in the following part. In case of the paint can be dissolved, it has to be removed and replaced by a two-component epoxy paint.

**Important:**

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

For the preparation of other substrates, please refer to the Pre-Treatment Chart for Sika Marine Applications.
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 smooth finish.

Uncured Sika adhesives or sealants can only be removed using 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.
Direct Glazing in Marine
6.1 General Remarks for Window Bonding

6.1.1 Description

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

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

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

The traditional role of glazing as protection against the elements whilst allowing light and vision to pass through, has been extended to include the extra benefit of structural member. Direct glazing, using peripherally applied structural adhesive systems, has become the primary method of installing windows due to the extensive list of benefits:

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

Direct glazing represents a 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 chapter 6.2 for organic glass and 6.3 for mineral glass for dimensioning the adhesive layer.

Fitting dimensions

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

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.
**General Remarks for Window Bonding**

**Gap backfilling**

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

**Surface preparation**

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

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

**Primers and cleaners**

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

**6.1.3 Product selection for both mineral and organic windows**

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

<table>
<thead>
<tr>
<th>Window Type</th>
<th>Bonding</th>
<th>Sealing / backfill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral glazing (single glazing)</td>
<td>Sikaflex ®-296</td>
<td>Sikaflex ®-296</td>
</tr>
<tr>
<td>Mineral glazing (double glazing)</td>
<td>Sikaflex ®-296</td>
<td>Sikasil ® WS-605 S</td>
</tr>
<tr>
<td>Organic glazing</td>
<td>Sikaflex ®-295 UV</td>
<td>Sikaflex ®-295 UV</td>
</tr>
</tbody>
</table>
6.2 Bonding and Sealing Organic Windows

6.2.1 Application description

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

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

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

To minimise the risk of environmental stress cracking, flat sheets of plastic glazing material should be installed completely flat; they should not be forced to take up a curvature by the use of mechanical fastenings. When the design calls for curved glazing panels, these should be prefabricated to order and properly tempered by a specialist supplier to ensure installation with no remaining stresses.

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

Please contact your local Sika company for technical advice.
6.2.2 Procedure for bonding and sealing with Sikaflex®-295 UV organic windows

Bondline configuration

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

Basis of calculation are substrates MMA/GFK, wind load 2 kN/m², \( \Delta T = 30^\circ C \)

Adhesive width (bite)

Joint thickness

Joint width

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)

### Aluminium frame

- Mask off any areas that need it
- Lightly abrade the contact area with a fine sand pad
- Remove the dust with a vacuum cleaner
- Pre-treat with Sika Aktivator-205, using a clean, lint-free rag or paper towel.
- 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)

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

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

Note: For important projects consult Corporate Technical Service Sika Industry

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

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

**Bond line protection**

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

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

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

**Application of Sikaflex®-295 UV adhesive**

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

**To prevent slip down of vertical glazing panels, distance blocks (wood or plastic) must be placed in the lower rebate during installation. After curing, these must be removed. The backfill gap must be at least 8 mm (see page 2)**

Fastening aids can be removed after 24 hours. After this time, the expansion gap between glazing panel and the backfill gap should be filled and completely sealed with Sikaflex®-295 UV. 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

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

**Window edge sealing/backfilling**

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

**Sika rule**

\[ O = 2 \times D \]

Example: If D = 8 mm, the overlap should be at least 16 mm
6.3 Bonding and Sealing Mineral Glazing

6.3.1 Application description

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

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

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

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

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

**Important:**

Local and international rules for maritime constructions and appropriate legislation must always be observed.
6.3.2 Procedure for bonding and sealing mineral glazing with Sikaflex®-296

Adhesive and sealant dimensioning

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

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

**Determination of the adhesive width (bite)**

![Diagram showing adhesive bite (width) 15 – 25 mm]

**Adhesive thickness**

![Diagram showing adhesive thickness]

**Joint width**

![Diagram showing joint width]

**Substrate preparation**

**GRP frame**

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

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

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

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

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

- Pre-treat the substrate with Sika® Aktivator, using a clean, lint-free rag or paper towel. Change the rag frequently!
- Flash-off: 10 minutes (min) to 2 hours (max)
- Apply a thin, continuous coat of Sika® Primer-20G G+P, using a clean brush or felt applicator
- Drying time: 30 minutes (min) to 24 hours (max)

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

Apply Sikaflex®-296 to the frame rebate or glazing panel using a triangular nozzle with a bead width of at least 10 mm.

Assemble all components within 20 minutes of applying the adhesive.

To prevent slip down of vertical glazing panels, distance blocks (wood or plastic) must be placed in the lower rebate during installation. After curing, these must be removed. The rebate gap must be at least 10 mm (see page 2).

Clamps and other fastening aids can be removed after 24 hours. After this time, the expansion gap between glazing panel and the rebate should be filled and sealed with Sikaflex®-296.

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 tooing remove any masking tape before the adhesive skins over.

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

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

Fig. 2 Adhesive is applied to the window frame

Fig. 3 The window is fitted
7.1 Sika Marine Products

Fig. 1 Sikaflex®-290 DC weather- and UV-resistant, medium-viscous marine caulking compound, 300 ml cartridge, 600 ml unipac

Fig. 2 Sikaflex®-291I multifunctional marine sealant, 100 ml tubes, 300 ml cartridge, 600 ml unipac, white, black, grey

Fig. 3 Sikaflex®-292I structural marine adhesive, 300 ml cartridge, white

Fig. 4 Sikaflex®-295 UV weather-resistant, marine adhesive for direct glazing and backfilling of organic glazing, 300 ml cartridge, 600 ml unipac, white, black

Fig. 5 Sikaflex®-296 weather-resistant, marine adhesive for direct glazing and backfilling of mineral glass, 600 ml unipac, black

Fig. 6 Sikaflex®-298 self-levelling marine adhesive, 600 ml unipac, 10 l pail, black

Fig. 7 SikaFiresil® Marine N grey, 300 ml cartridge

Fig. 8 Sikatransfloor®-352 ST and Sikatransfloor®-352 SL, two-component levelling compound, 25 kg (A+B) pail, grey

Fig. 9 Sikasil® WS-405 S, 300 ml cartridge, black
Fig. 10 Sikasil® Fi-Plus, 300 ml cartridge, white

Fig. 11 Sikaktiv® Aktivator cleaning agent and adhesion promoter, 30 ml, 250 ml and 1 l can, transparent

Fig. 12 Sikaktiv® Aktivator-205 (former Sikaktiv® Cleaner-205), cleaning agent for non-porous substrates, 250 ml, transparent

Fig. 13 Sikaktiv® MultiPrimer Marine, 250 ml can, 1000 ml can

Fig. 14 Sikaktiv® Primer-209 D adhesion promoter for organic glazing, 30 ml, 250 ml can, black, Sikaktiv® Primer-206 G+P adhesion promoter for mineral glass, black

Fig. 15 Sikactiv® ZP Primer, two-component, anti-corrosion primer / paint system for steel and aluminium prior to the application of Sikafloor® Marine-352, 6.25 kg, 12.5 kg, 30 kg pail, grey

Fig. 16 Sikaktiv® Handclean special cleaning tissues for cleaning skin and removing uncured Sikaflex®

Fig. 17 Sikaktiv® Tooling Agent V, 1 l, 5 l, 60 l, canister

Fig. 18 Sikactiv® Teak Oil Premium sealer and finisher, 1 l bottle, Sikactiv® Teak Brightener for marine teak decks, 1 l bottle, Sikactiv® Teak Cleaner for marine teak decks, 1 l bottle
Fig. 19 Manual application gun for 300 ml cartridge and 400 ml unipac

Fig. 20 Manual application gun for up to 600 ml unipacs

Fig. 21 Air-powered application gun for up to 600 ml unipacs

Fig. 22 The battery operated gun dispenser, for 300 ml cartridge or 600 ml unipacs

Fig. 23 Manual operated gun for 300 ml cartridge

Fig. 24 Sika® Remover-208, 1 l
## 7.2 Sika Marine Product Selector

### Adhesives / sealants

|-----------|------------------|---------------|---------------|------------------|-------------|-------------|-------------------|----------------------|-------------------|

### Applications

- **General sealing overpaintable**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

- **General sealing, weathering resistant**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

- **Fire retardant sealing**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

- **Organic glass bonding**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

- **Mineral glass bonding**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

- **Deck levelling**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

- **Wooden deck bonding**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

- **Caulking**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

- **Bonding of coverings**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

- **Sanitary sealing**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

### Service conditions

- **High temperature > -40°C to 150°C**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

- **Normal temperature -40°C to 90°C**
  - Sikaflex®-290i DC
  - Sikaflex®-291i
  - Sikaflex®-292i
  - Sikaflex®-295 UV
  - Sikaflex®-296
  - Sikaflex®-298
  - Sikasil®-WS-605 S
  - Sika Firesil Marine N
  - SikaTransfloor-322

See also Pre-Treatment Chart for Marine Applications

### Key to symbols

- ▲▲▲ Best solution
- ▲▲ Good solution
- ▲ Possible solution
7.3 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.

### Primer and cleaner consumption

<table>
<thead>
<tr>
<th>Joint width</th>
<th>No. of metres per 300 ml cartridge</th>
<th>No. of metres per 100 ml tube</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
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<tr>
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<td>10</td>
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<td>3.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product</th>
<th>Yield per 100 ml at 20 mm width</th>
<th>Brush application tissue application*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(m)</td>
<td>(l/m²)</td>
</tr>
<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
7.4 Conversions and Calculations

Formulae

To estimate the number of litres required

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

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

To determine the volume of a semi-circular bead
Quantity in litres = \( \frac{3.142 \times \text{diameter (mm) x diameter (mm) x length (metres)}}{8000} \)

To determine the volume of a triangular bead
Quantity in litres = \( \frac{\text{width (mm) x height (mm) x length (metres)}}{2000} \)

To convert kilograms to litres
Quantity in litres = \( \frac{\text{weight in kilograms}}{\text{density (grams/ml or kg/l)}} \)

To convert between temperature scales
Fahrenheit = \( (\text{degrees celsius (°C)} \times 9) - 32 \)
Celsius = \( (\text{degrees fahrenheit (°F)} \times 5) + 32 \)

Conversion factors

<table>
<thead>
<tr>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ounce = 28.3495 g</td>
</tr>
<tr>
<td>1 pound = 0.45359 kg</td>
</tr>
<tr>
<td>1 hundredweight = 50.8023 kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch(^2) = 645.16 mm(^2)</td>
</tr>
<tr>
<td>1 foot(^2) = 0.0929 m(^2)</td>
</tr>
<tr>
<td>1 yard(^2) = 0.8361 m(^2)</td>
</tr>
<tr>
<td>1 acre = 4046.86 m(^2)</td>
</tr>
<tr>
<td>1 mile(^2) = 2.59 km(^2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 pint (UK) = 0.5683 l</td>
</tr>
<tr>
<td>1 pint (USA) = 0.4732 l</td>
</tr>
<tr>
<td>1 gallon (UK) = 4.5461 l</td>
</tr>
<tr>
<td>1 gallon (USA) = 3.7854 l</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch = 25.4 mm</td>
</tr>
<tr>
<td>1 foot = 0.3048 m</td>
</tr>
<tr>
<td>1 yard = 0.9144 m</td>
</tr>
<tr>
<td>1 furlong = 201.17 m</td>
</tr>
<tr>
<td>1 mile = 1.6093 km</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 bar = 0.1 MPa</td>
</tr>
<tr>
<td>1 Pascal = 1 N/m(^2)</td>
</tr>
<tr>
<td>1 kgf/cm(^2) = 0.09807 MPa</td>
</tr>
<tr>
<td>1 psi = 6894.76 Pa</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature scales</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>35</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>25</td>
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<tr>
<td>20</td>
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<tr>
<td>15</td>
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<tr>
<td>10</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

SI prefixes

<table>
<thead>
<tr>
<th>Name</th>
<th>Symbol</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>giga</td>
<td>G</td>
<td>10(^9)</td>
</tr>
<tr>
<td>mega</td>
<td>M</td>
<td>10(^6)</td>
</tr>
<tr>
<td>kilo</td>
<td>k</td>
<td>10(^3)</td>
</tr>
<tr>
<td>hecto</td>
<td>h</td>
<td>10(^2)</td>
</tr>
<tr>
<td>deca</td>
<td>da</td>
<td>10(^1)</td>
</tr>
<tr>
<td>deci</td>
<td>d</td>
<td>10(^{-1})</td>
</tr>
<tr>
<td>centi</td>
<td>c</td>
<td>10(^{-2})</td>
</tr>
<tr>
<td>milli</td>
<td>m</td>
<td>10(^{-3})</td>
</tr>
<tr>
<td>micro</td>
<td>μ</td>
<td>10(^{-6})</td>
</tr>
<tr>
<td>nano</td>
<td>n</td>
<td>10(^{-9})</td>
</tr>
</tbody>
</table>

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.
8.1 Glossary of Terms

Aktivator
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.

Ageing
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.
Glossary of Terms

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 will safely allow the process that follows it to be started. (E.g. Adhesive application.)

FEM (Finite Element Method)
Calculation using iterative analysis methods. Calculation values are available from Technical Service Sika Industry.

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. Aluminium, steel.)

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).

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 centrically 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.