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Elastic Bonding

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.

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

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

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

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

For every structural application, national and international rules, regulations and approvals must be observed.

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 mecanical 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.

		Mechanical Fixing	Laminating Taping	Elastic Bonding
Manufacturing	Time consumption	◒	●	○
	Material cost	☆	★	◒
	Process complexity	☆ / ◒	●	☆
	Health / safety / environment	★ / ○	●	◒
	Tolerance gapping	●	☆	★
	Assembling different (lightweight) materials	●	◒	★
Final performance	Durability / fatigue resistance	○	☆	★
	Durability / corrosion resistance	◒	☆	★
	Weight reduction	●	◒	★
	Comfort (acoustics)	●	◒	★

● *Very poor* ◒ *Poor* ○ *Neutral* ☆ *Good* ★ *Very good*

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.

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

208	*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
SA	*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)
SMM	*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)

Fig. 1 Sealing with Sikaflex®-295 UV

Application of Sikaflex®-292i adhesive

	Place 3 mm deep elastic spacers, of about 50 Shore A hardness, into position
292i	*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
208	*Uncured Sika adhesives or sealants should be removed with Sika® Remover-208*
295 UV	*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 bondline 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

208	*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
SA 205	*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)
SMM	*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

208	*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
SA 205	*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)
SMM	*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
292i	*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. Full service strength is attained after approximately 7 days
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

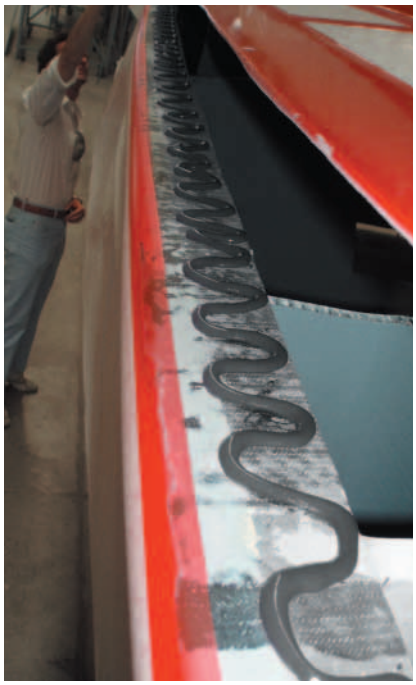

Fig. 1 Hull and deck are brought together

Fig. 2 A locating pin ensures perfect alignment

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)

208	*Heavily soiled surfaces should first be cleaned off with Sika® Remover-208, to remove the worst of the soiling*
SA	*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

208	*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
SA 205	*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)
SMM	*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)

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

Aktivator	*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)

Fig. 1 A keel is carefully slid into position

Fig. 2 The adhesive is applied

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.

Fig. 3 The joint is tooled off and finished

Application of Sikaflex®-292i adhesive

	Place elastic spacers of about 10 mm thick and 50 Shore A hardness into position
292i	*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
208	*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