

Chapter 16

Hardware Bonding... A new approach to an old problem

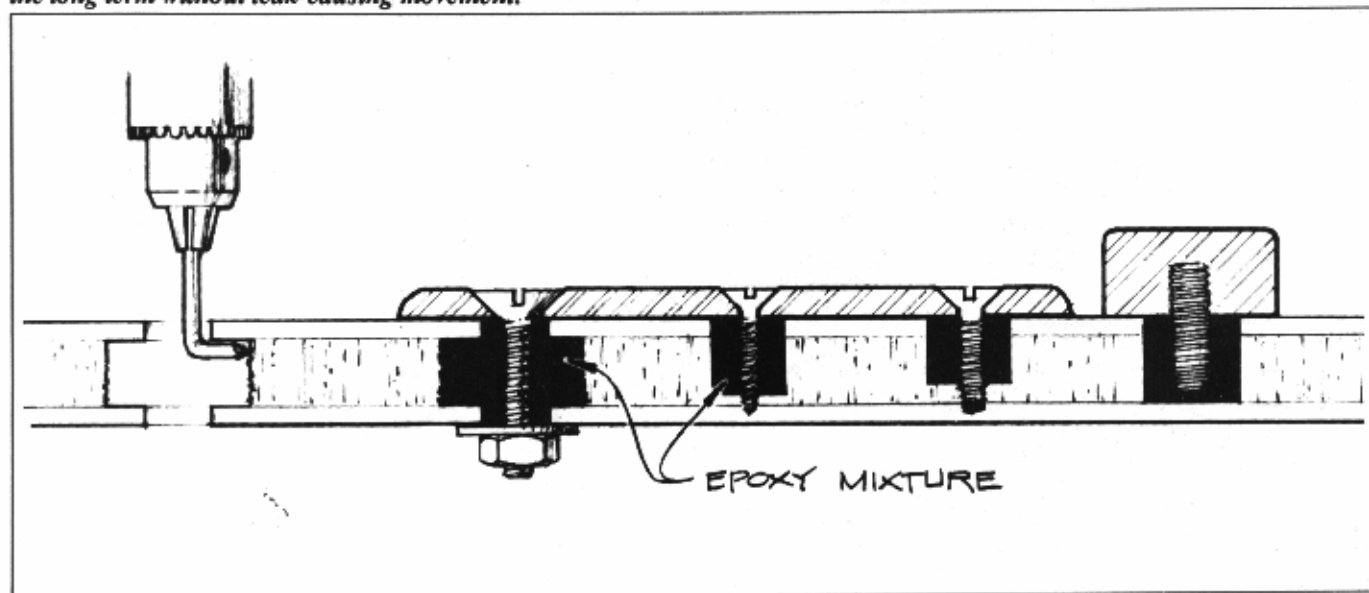
Deck leaks can usually be traced to the through-bolting which is necessary for the installation of load-bearing hardware such as cleats, stanchions and winches. Most hardware items are attached with multiple fasteners, which means the hardware installer must drill all of the mounting holes precisely or the fasteners will not share the load equally. Failure to

drill accurately will result in the hole with the most highly-loaded fastener beginning to elongate as the hardware is continually loaded. The hardware then develops some slop in its fit, providing an entrance point for moisture. Besides the inconvenience of a leak, this can be a significant problem for a wood or cored fiberglass deck by permit-

ting water entry. Once water gets into the laminate, it is almost impossible to remove and can be the beginning of serious long-term maintenance problems.

The popular and accepted response to this problem is to bed the hardware item in an elastic sealant material. There are a variety of sealants available; what they all have in common is a very

Figure 50 When properly installed, bonded hardware becomes an integral part of a deck or hull and can perform over the long term without leak-causing movement.



high elongation capability (usually 200% or greater) that is coupled with good adhesive qualities. Unfortunately, high elongation means low load-carrying capability. The strength of these sealants is very low (rarely exceeding 200 psi [1.4 MPa] in tensile) and cannot prevent hardware from moving when subjected to any significant load.

Because it does not prevent hardware movement, the sealant's job is limited to preventing water leakage. Unfortunately, time has shown that continual hardware movement breaks down the sealant material ultimately allowing moisture to pass through into the laminate.

For the past 20 years, we have been practicing a different approach to hardware installation. We call it "hardware bonding." The principle is to structurally bond or cast hardware into place using the maximum contact surface area available to transfer the load from the hardware to a deck or hull surface. The surface area of the hardware item itself, together with the fasteners, is used to **evenly transfer** the load to minimize stress concentrations. The result is hardware that, when properly installed, becomes an integral part of a deck or hull and can perform long term without leak-causing movement. (Figure 50) The hardware bonding process requires more time than the simple bedding approach with sealants, but the results have proven well worth the extra effort over the long term.

With wood boats, where wood fiber can easily crush under high loads, the hardware bonding approach has come to be the only practical long-term method of hardware attachment. While the density of fiberglass is somewhat higher than wood, it is still well below metals, and the same long-term benefits can be gained.

In saltwater applications, our experience has been that bonded hardware and fasteners show excellent resistance to corrosion attack. Where fasteners are vulnerable to flexure and saltwater attack (i.e. hollow or bridged traveler tracks, bonded U-bolts or solitary eyebolts) a small silicone sealant fillet covering the joint between the cured epoxy and the fastener will protect against moisture and salt intrusion. Of course, any exposed metal surface will be subject to the effects of saltwater corrosion; therefore, proper maintenance and cleaning procedures must be practiced.

Reattaching Loose Hardware

Remove the piece of loose hardware and thoroughly clean dirt, paint, sealants, etc., from the hardware and the substrate. Clean surfaces are imperative to successful bonding. Clean out the fastener holes, as well, by either re-drilling or filing with a rat-tail file. By enlarging the holes and filling them with epoxy and fillers, you will provide for better load distribution. Occasionally, hardware bolted through a cored panel will be over-tightened, crushing the skins and core material. Replacing the core with an epoxy mixture in the immediate area of the hardware installation will allow the thickened epoxy to withstand the compression loads exerted by the fitting's through-bolts and nuts.

A simple method of removing the 1/2" (12mm) or so of core material is to chuck a bent nail or an Allen wrench into a drill motor. (Figure 50) The spinning nail or Allen wrench will quickly pulverize the core material without damaging the skins, provided you are careful.

The underside of the hole can now be covered over with duct tape, and the hole filled complete-

ly with resin/hardener and a high-density filler of mayonnaise-like consistency. When cured, remove the duct tape and re-drill the fastener hole through the cured epoxy.

Temporarily place the hardware item in position and trace the outline of the base with a pencil.

Hardware Removal

A great deal of testing at Gougeon Brothers has shown that when bonding fasteners (screws, bolts, etc.), the chemical bond with the metal is not as important as the mechanical "keying" between the epoxy and the threads of the fastener. This factor allows the builder to coat the fastener with a mold release agent prior to bonding to permit easier removal of the fastener at a later time.

Fatigue tests of bonded threaded rod vs. threaded rod treated with mold release show a 4-10% reduction in the overall fatigue strength of the bonded fastener. A thin-film mold release will yield a more predictable performance than a thick-film. While this reduction in strength is slight, it should be considered when using a mold-release coated fastener.

However, attempts should always be made to promote bonding between the base surface of the piece of hardware and the epoxy. Only in the case of lightly loaded hardware should mold release be used on the hardware surface for easy removal.

Carefully tape the perimeter of the marked area, adding some plastic sheeting beyond the tape to prevent contaminating any of the surrounding surface area. Thoroughly sand the marked area with 50-grit sandpaper to provide good mechanical keying for bonding.

Sand the mating surface of the hardware item with coarse sandpaper so that fresh metal is exposed. At this time, the area not to be bonded on the hardware item can also be taped off to prevent contamination.

Prepare an appropriately-sized batch of resin and hardener with no fillers. (The WEST SYSTEM 101 Handy Repair Pack or 101-6 Maxi Repair Pack contains everything usually needed for typical hardware bonding jobs. *Figure 51/52*) Wet-out the deck surface with a thin coat of resin. With the aid of a pipe cleaner, wet out the fastener holes. Now apply a thin coat of resin to the hardware surface to be bonded; and while still wet, abrade the coated surface with coarse sandpaper, working the epoxy into the metal surface. This procedure resembles wet-

sanding but substitutes resin for water. The goal is to expose fresh metal, allowing it to immediately come in contact with the resin, excluding any air which might interfere with good bonding. We have successfully used this procedure with all forms of metal alloys, but it is somewhat less successful with aluminum. We recommend that our 860 Aluminum Etch Kit be used to chemically treat aluminum fittings before bonding with this metal.

Prepare a mixture of resin/hardener and add 404 High-Density filler to a peanut butter-like consistency. Apply the mixture to both mating surfaces in quantity sufficient to span any gaps. Gaps of up to 10% between the fastener diameter and the fastener hole size are easily bridged. Larger gaps will require an extra-thick mixture to maintain full contact.

Apply the thickened mixture to both the fastener threads and the hole it will enter, taking precautions to prevent any excess mixture from dripping through the hole. Install the hardware item, being careful not to over-tighten

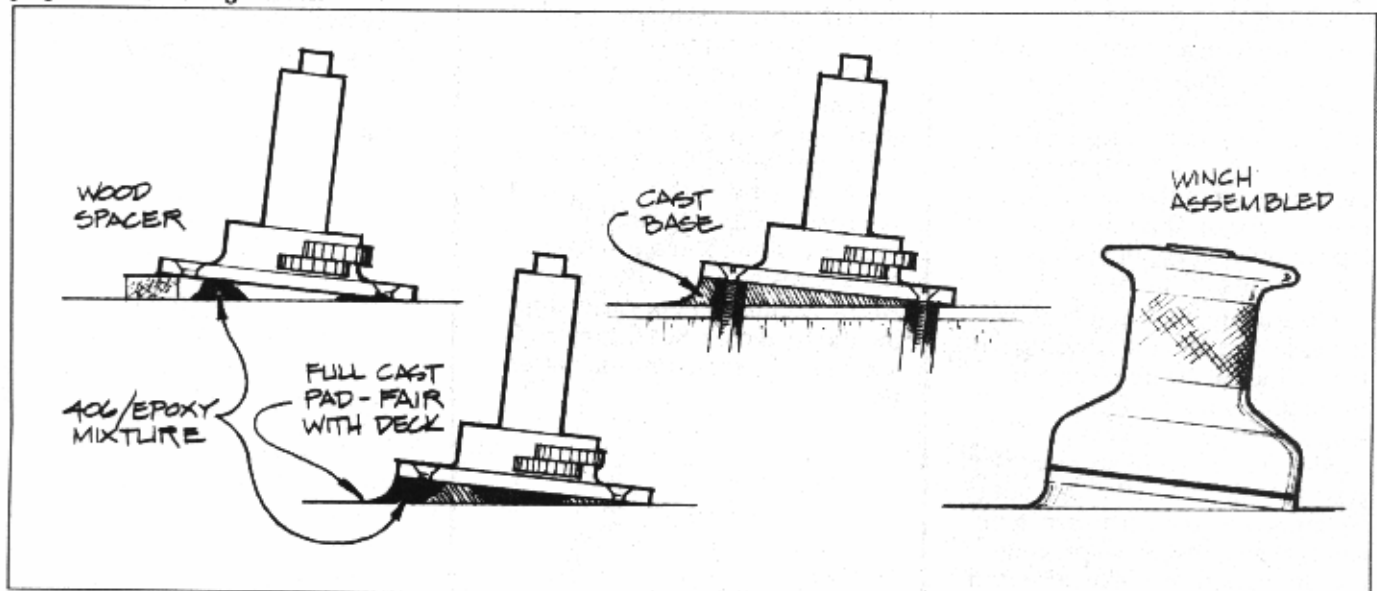
the fasteners. Clean away any excess epoxy mixture which may squeeze out around the hardware base with a chisel-shaped mixing stick. Remove the tape and allow the epoxy to cure for two days at 70°F (21°C) before subjecting the hardware to high loads.

Often, adequate backing plates were not installed by the original manufacturer, allowing hardware items to over-stress a localized area. This problem can easily be remedied by bonding in appropriately-sized pieces of plywood.

Hardware Casting

Occasionally, fittings must be set at specific angles to the hull or deck surfaces. Downrigger bases, lifeline stanchions, winches and turning blocks are all good examples. Traditionally, hand-carved, wedge-shaped shims have been used to achieve the proper angles with such fittings. Unfortunately, they require a great deal of time and carpentry skill to complete. Hardware casting can save time and is easy to do; but more importantly, it can result in a

Figure 53 Hardware casting is an easy method of making a waterproof installation of difficult-to-mount hardware with professional-looking results.



stronger, waterproof base. (Figure 53)

Clean the substrate and hardware bonding surfaces with 850 Solvent to remove any contaminants. Sand both with 50-grit sandpaper. Apply a release agent such as silicone spray, automobile wax or a non-stick cooking spray to the base of the piece of hardware.

Prepare a mixture of resin/hardener and coat the substrate surface. Set the fitting in place using small, temporary wedges to elevate the piece to the proper height and angle. Often, one edge of the fitting will rest on the deck and become the zero point for the required angle.

Prepare a mixture of resin/hardener and 404 High-Density filler the consistency of peanut butter. Remove the plunger of a 807 Syringe and load the mixture. You may have to cut 1/2" (12mm) or more off the end of the syringe to provide a large enough opening to squeeze out the mixture. Inject the mixture within the perimeter of the fitting base, building up several areas of contact between the base and the deck as illustrated. These areas of contact become support points. When the epoxy supports have cured, carefully mark the position of the hardware with a pencil and then tap it with a mallet to break it loose. Remove the temporary shims and mark the area on the deck surface which will become the perimeter of the base with a pencil. Tape off this area with duct tape to prevent accidental epoxy spillage outside the base area.

Once again, thoroughly clean the base area and the bonding surface of the hardware piece. Sand the mating surface of the hardware item with coarse sandpaper so that fresh metal is exposed. At this time, the area not to be bonded on the hardware item can also be taped off to prevent contamination. You may also find

it helpful to place small pieces of tape over the holes in the hardware item to prevent the epoxy mixture from oozing up through them when the piece is repositioned.

Prepare a sufficient quantity of resin/hardener and 404 filler to fill the entire casting area. If the base to be cast is more than 1/2" (12mm) thick, you may want to use 206 Slow Hardener to reduce the possibility of exothermic heat buildup during the curing process. The mixture must be thick enough to bridge any gaps without running out of the casting area. Roughly form the shape of the base with the mixture, surrounding the previously-formed epoxy supports. Build up the mixture slightly taller than the base will actually be.

Reset the fitting in its proper location, slowly pressing it into place allowing excess epoxy mixture to squeeze out from the base of the hardware piece. Sculpt this excess mixture into the desired shape, removing any excess before it cures. Thin wooden paddles of a similar contour as the base or plastic squeegees work well for this procedure.

Within four to seven hours, the epoxy mixture should have cured enough for final shaping. Sand with 50-grit sandpaper. If the molded base is extremely irregular, it may be easier to use a small hand plane or a file first. After the desired shape has been achieved, sand with 80-grit sandpaper. Clean the surface of dust or residue and apply three coats of resin/hardener mixture. Allow to cure 24 hours after applying the final coat. See Chapter 14 for finishing and painting instructions.

Removing Bonded Hardware

Occasionally it is necessary to remove bonded hardware items. At temperatures above 150°F (66°C), cured epoxy begins to lose its physical properties; the resin softens and its bonding capacity is reduced considerably. You can use this characteristic to your advantage when you would like to remove a piece of bonded hardware.

Begin by removing all fasteners. If you used a release agent on them when you bonded the piece in place, they should come loose without too much difficulty. Sometimes, however, it may be necessary to apply heat to them, using a soldering iron.

When the fasteners have been removed or are loose, heat the fitting briefly with a propane torch. Protect the area around the fitting from heat damage by covering with water-soaked plywood. A sharp rap with a mallet should be enough to dislodge the hardware. If the fitting doesn't break loose easily the first time, don't force it. Heat it a second time with the torch and try again.

After the fitting has been removed, drill out any remaining epoxy from the holes before reattaching the fitting to the deck surface.