3. BASIC TECHNIQUES

The following procedures are common to the majority of repair or building projects – on the boat or in the home and regardless of the type of structure or material on which work is being carried out.

3.1 Surface preparation

Whether bonding, fairing or applying fabrics, the success of the application depends not only on the strength of the epoxy but also on how well the epoxy adheres to the surface to which it is being applied. Unless bonding to partially cured epoxy, the strength of the bond relies on the ability of the epoxy to mechanically "key" into the surface. Thus, the following three steps of surface preparation are a critical part of any secondary bonding operation.

For good adhesion, bonding surfaces must be**:**

1. Clean

Bonding surfaces must be free of any contaminants such as grease, oil, wax or mould release. Clean contaminated surfaces with WEST SYSTEM 850 Solvent. *(Figure 6).* Wipe the surface with fresh paper towels before the solvent dries. Clean surfaces before sanding to avoid abrading the contaminant into the surface. Follow all safety precautions when working with solvents.

2. Dry

All bonding surfaces must be as dry as possible for good adhesion. If necessary, accelerate drying by warming the bonding surface with a hot air gun, hair dryer or heat lamp *(Figure 7)*. Use fans to move the air in confined or enclosed spaces. Be careful of condensation when working outdoors or whenever the temperature of the work environment changes.

3. Sanded

Thoroughly abrade hardwoods and non-porous surfaces with 80-grit aluminium oxide paper to provide a good mechanical "key" for the epoxy *(Figure 8)*. Ensure the surface to be bonded is solid. Remove any flaking, chalking, blistering or old coating before sanding. Remove all dust after sanding.

The importance of the three operations detailed above cannot be stressed too strongly – for high strength, durable bonds, surfaces must be clean, dry and thoroughly abraded after removing previous surface coatings.

Figure 6 Clean the surface. Use a solvent, if necessary, to remove all contaminates.

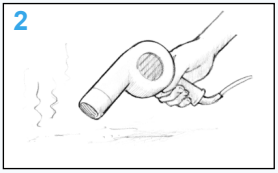


Figure 7 Dry the Surface. Allow wet surfaces to dry thoroughly or use heat or a fan to speed the drying.

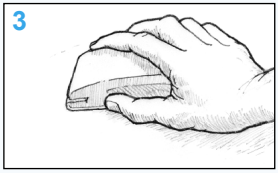


Figure 8 Sand non-porous surfaces. Provide a texture for the epoxy to key into.

Primary/Secondary bonding

Primary bonding relies on chemical linking of adhesive layers such as the wet lay-up of fibreglass laminate in a mould. All the layers of adhesive cure together in a single fused layer. Epoxy applied over partially cured epoxy will chemically link with it to form a primary bond. The ability to chemically link diminishes as the previous layer of epoxy cures and the bond becomes a secondary bond.

Secondary bonding requires a mechanical, rather than chemical linking of an adhesive to a material or cured epoxy surface. The adhesive must "key" into pores or scratches in the surface - a microscopic version of a dovetail joint. Correct surface preparation provides a texture that will help link the cured epoxy to the surface

Special preparation for various materials

Cured epoxy - Amine blush can appear as a wax like film on cured epoxy surfaces. It is a by-product of the curing process and is more noticeable in cool, moist conditions. Amine blush can clog sandpaper and inhibit subsequent bonding but it is water soluble and can easily be removed. It is not unreasonable to assume it has formed on any cured epoxy surface.

To remove the blush, thoroughly wash the surface with clean water and an abrasive pad. Dry the surface with fresh paper towels to remove the dissolved blush before it dries on the surface. Sand any remaining glossy areas with 80-grit sandpaper and clean.

Wet-sanding will also remove the amine blush. If a release fabric (peel ply) is applied over the surface of fresh epoxy, amine blush will be removed when the release fabric is peeled from the cured epoxy and no additional sanding is required.

Epoxy surfaces that are still tacky i.e. **not fully cured**, may be bonded to or coated with epoxy **without washing or sanding.** Before applying coatings other than epoxy (paints, bottom paints, varnishes, gelcoats, etc.), allow epoxy surfaces to cure fully, then wash, sand, clean and **follow coating manufacturer's instructions.**

Removing epoxy

Removing uncured or non-curing epoxy. Scrape as much material as possible from the surface using a stiff metal or plastic scraper - warm the epoxy to lower its viscosity. Clean the residue with WEST SYSTEM 850 Cleaning Solvent. (Follow safety warnings on solvents and provide adequate ventilation). Allow solvents to dry before recoating. After recoating wood surfaces with epoxy, brush the wet epoxy (in the direction of the grain) with a wire brush to improve adhesion.

Removing fibreglass cloth applied with epoxy. Use a heat gun to warm and soften the epoxy. Begin in a small area near a corner or edge. Apply heat until a putty knife or chisel can be slipped under the cloth (about 50°C). Grab the edge with a pair of pliers and slowly pull up the cloth while heating just ahead of the separation. On large areas, use a utility knife to score/cut the glass and remove in narrower strips. Resulting surface texture may be coated or remaining epoxy may be removed as follows.

Removing cured epoxy coating. Use a heat gun to soften the epoxy (about 50°C). Heat a small area and use a paint or cabinet scraper to remove the bulk of the coating. Sand the surface to remove the remaining material. Provide ventilation when heating epoxy.

Hardwoods - Thoroughly abrade with 80-grit paper and remove dust before coating.

Teak/oily woods - Wipe the surface with WEST SYSTEM 850 solvent or pure acetone and when the solvent has evaporated, abrade with 80-grit paper. Clean the sanding dust away and then wipe the abraded surface with solvent – the solvent dries the oil at the surface and allows the epoxy to penetrate. Ensure the solvent has evaporated before coating but apply the epoxy within 15 minutes of the solvent wipe.

Porous woods - No special preparation needed but it is advisable to abrade with a medium grit paper to open pores. Remove dust.

Metals - Metals must have all previous surface pre-treatments and contaminants e.g. rust removed, taking the surface back to the bare metal by thoroughly degreasing then abrading with a coarse paper such as 80-grit or grit blasting and then degreasing again. The use of an adhesion promoter is advised on non-ferrous metal substrates. Given below is the preparation for the more common metals used in boat building:

Mild Steel - Degrease and then thoroughly abrade (ideally, grit blast), removing all contamination to expose bright metal. Apply epoxy as soon as possible and certainly within 4 hours after surface has been prepared.

Stainless Steel - Degrease and then thoroughly abrade (ideally, grit blast), removing all contamination and the stainless coating to expose bright metal. Apply epoxy as soon as possible and certainly within 4 hours after surface has been prepared.

Aluminium - Non-anodised material must be degreased and either thoroughly abraded or chemically etched, (sulphuric acid/sodium dichromate solution or branded aluminium etch compound).

Anodised aluminium and anodised aluminium alloys - must be bonded as quickly as possible after degreasing and abrading and certainly within 30 minutes.

Hard anodised aluminium alloy - must be stripped by abrasive blasting or by etching in sulphuric acid/sodium dichromate solution or branded aluminium etch compound. Unstripped metal is not suitable for bonding.

Polyester/GRP - Remove contamination with WEST SYSTEM 850 Solvent. Thoroughly abrade with 80-grit paper to a dull finish and remove dust.

Ferrocement - Remove all previous paints and coatings by wet sand blasting - this is less aggressive than using dry sand and should not damage the sound surface. If after blasting, laitance is visible on the surface or rust from the reinforcing wires can be seen, then it is necessary to wash with dilute solution of hydrochloric acid - this should be fresh water with a 4% to 5% addition of hydrochloric acid. Wash thoroughly with water and allow to dry completely before coating.

Concrete - Remove all previous coatings and abrade with a stiff wire brush. Remove all dust and debris before coating.

3.2 Bonding (gluing)

This section refers to two types of structural bonding. Two step bonding is the preferred method for most situations because it promotes maximum epoxy penetration into the bonding surface and prevents resin starved joints. Single step bonding is occasionally used when joints have minimal loads and excess absorption into porous surfaces is not a problem. In both cases, to achieve the ultimate bond strength, work the epoxy into the surface with a roller or brush.

Before mixing epoxy, ensure all parts to be bonded fit properly and that surface preparation has been completed. *(See surface preparation section 3.1 page 11)*. Gather all clamps and tools necessary for the operation and cover any areas that need protection from spills.

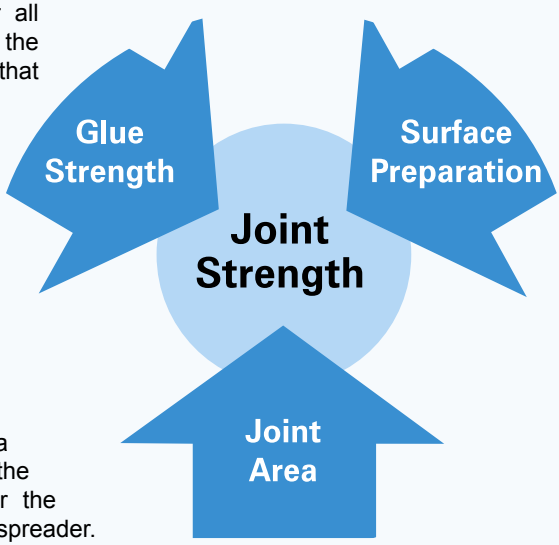
Bonding

Joint strength - the ability to adequately transfer a load from one part to another - depends on the combined effects of three factors.

GLUE STRENGTH - Careful metering and thorough mixing will ensure the epoxy mixture cures to full strength.

SURFACE PREPARATION - For the best adhesion and load transfer, the surface must be corectly prepared.

JOINT AREA - The bonding or adhesive area of the joint must be adequate for the load on the joint. Increased overlap, scarf joints, fillets and reinforcing fibres across the joint can be used to increase bonding area.



Two-step bonding

1. Apply a resin/hardener mix to the surfaces to be joined *(Figure 9)*. This is called "wetting-out" or "priming" the bonding surfaces. The epoxy is applied with a disposable brush in small or tight areas; wet-out larger areas with a foam roller or by spreading the resin/hardener mix evenly over the surface with a plastic squeegee/spreader. Proceed with step two immediately or any time before the wet-out coat becomes tack free.

2. Modify the resin/hardener mix by stirring in the appropriate filler until it becomes thick enough to bridge any gaps between the mating surfaces and to prevent "resin-starved" joints. Apply an even coat of the thickened epoxy to **one** of the bonding surfaces, sufficient so that a small amount will squeeze out when the surfaces are joined together *(Figure 10)*.

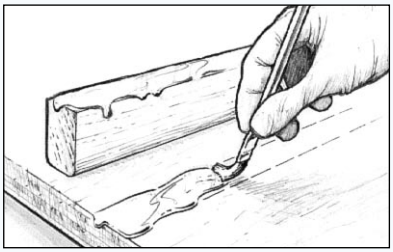


Figure 9 Apply resin/hardener mixture to the bonding surfaces.

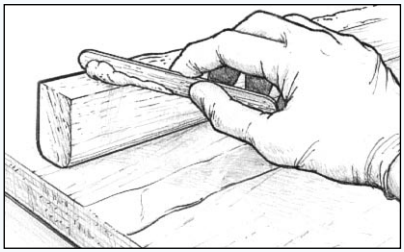


Figure 10 Apply thickened epoxy to one of the bonding surfaces.

As already stated, the thickened epoxy can be applied immediately over the wet out surface or any time before the epoxy becomes tack free. For most small bonding operations, add the filler to the resin/hardener mix remaining in the batch that was used for the wet-out. Mix enough resin/hardener for both steps. Add the filler quickly after the surface is wet out and allow for a shorter working life of the mix.

3. Clamp components. Attach clamps as necessary to hold the components in place. Use only enough clamping pressure to squeeze a small amount of the thickened mix from the joint, indicating that the epoxy is making good contact with both mating surfaces *(Figure 11)*. Do not squeeze all the thickened mix from the joint by using too much clamping pressure.

4. Remove or shape excess adhesive that squeezes out of the joint as soon as the joint is secured with clamps. A WEST SYSTEM 804 mixing stick with one end sanded to a chisel edge is an ideal tool for removing the excess *(Figure 12)*. Allow to cure thoroughly before removing clamps.

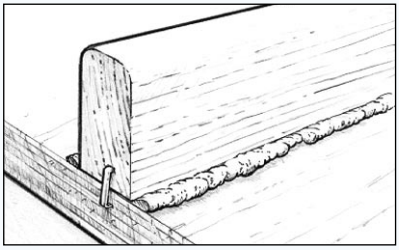


Figure 11 Clamp components in place before the epoxy gels.

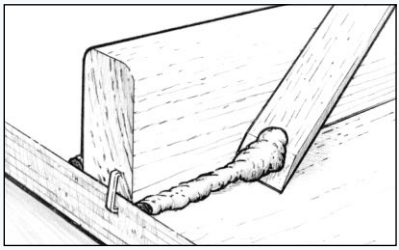


Figure 12 Remove or shape excess epoxy that squeezes out of the joint.

Single-step bonding

Single-step bonding is applying a thickened epoxy mix containing 403 Microfibres directly to both bonding surfaces without first wetting out the surfaces with a resin/hardener mix. However, it is strongly recommended that the epoxy is thickened no more than is necessary to bridge gaps in the joint (the thinner the mix, the more it can penetrate the surface) and this method is not used for highly-loaded joints or for bonding either end grain or other porous surfaces.

3.3 Bonding with fillets

A fillet is a cove-shaped application of thickened epoxy that bridges an inside corner joint. It is an excellent technique for bonding components because the surface area of the bond is increased and serves as a structural brace. All joints that will be covered with glasscloth will require a fillet to support the cloth at the inside corner of the joint.

The procedure for bonding with fillets is the same as normal bonding but, instead of removing the squeezed-out thickened epoxy after the components are clamped in position, the epoxy/filler blend is shaped into a fillet. For larger fillets, as soon as the bonding operation is complete and before the squeezed-out epoxy becomes tack free, add more thickened mix to the joint and shape into a fillet.

1. Bond components as described above.

2. Shape and smooth the squeezed-out thickened epoxy into a fillet by drawing a rounded filleting tool (a mixing stick is ideal) along the joint, dragging excess material ahead of the tool and leaving a smooth cove-shaped fillet bordered on each side by a clean margin. Some excess filleting material will remain outside the margin *(Figure 13*) which can be used to refill any voids. Smooth the fillet until you are satisfied with the appearance. A mixing stick will leave a fillet with about a 10mm radius. For larger fillets, an 808 Plastic Squeegee is recommended, cut to shape or bent to the desired radius.

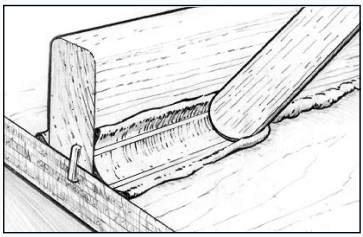


Figure 13 Shape and smooth the fillet.

Apply additional thickened epoxy to fill voids or make larger fillets. Add sufficient mix along the joint line with the rounded mixing stick to create the desired size of fillet. For longer or multiple fillets, empty caulking gun cartridges or disposable cake decorating bags can be used. Cut the plastic tip to lay a bead of thickened epoxy large enough for the desired fillet size. Heavy duty, sealable food storage bags with one corner cut off may also be used.

3. Clean up the remaining excess material outside the margin by using a mixing stick or a putty knife *(Figure 14)*. Glasscloth or tape may be applied over the fillet area before the fillet has cured (or after the fillet is cured and sanded).

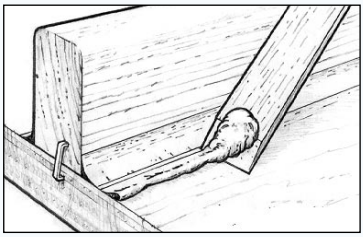


Figure 14 Clean up the excess epoxy outside the fillet margin.

4. When the fillet has fully cured, sand smooth with 80-grit sandpaper. Wipe the surface clean of dust and apply two or three coats of resin/hardener over the entire fillet area before final finishing.

3.4 Bonding fasteners and hardware

Installing screws and other threaded fasteners with WEST SYSTEM epoxy dramatically improves the load carrying capacity of the fastener by spreading the load into a greater area of the substrate. There are several methods of hardware bonding dependent upon the loads carried by the hardware.

Basic fastener bonding

For improved pullout strength and eliminating moisture ingress, the easiest method is to simply wet out stripped fastener holes and new pilot holes before installing the screws. Epoxy penetrates the fibre around the hole, effectively increasing the fastener diameter.

1. Wet out a standard-size pilot hole and work the resin/hardener mix into the hole with a pipe cleaner or syringe *(Figure 15)*. Thicken a second coat of epoxy as necessary for stripped or oversized holes.

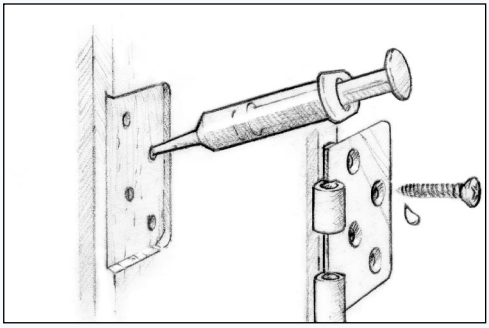


Figure 15 Wet out a standard pilot hole and install the fastener.

2. Insert the fastener in the hole and allow the epoxy to cure.

Advanced fastener bonding

For greater strength and stability, drill oversized holes to increase the exposed substrate area and the amount of epoxy around the fastener. If the fastener/hardware can be clamped by other means, the oversized hole can be extended to the end of the fastener.

1. Drill oversized holes approximately $^{2}/_{3}$ the depth of the fastener. *(Figure 16a)*.

2. Drill a normal sized pilot hole at the bottom of the oversized hole to the full length of the fastener. The normal sized pilot hole serves to hold or clamp the hardware in position until the epoxy cures.

3. Wet out the holes and the fastener with a resin/hardener mix. Allow the epoxy to thoroughly soak into the exposed end grain of the wood.

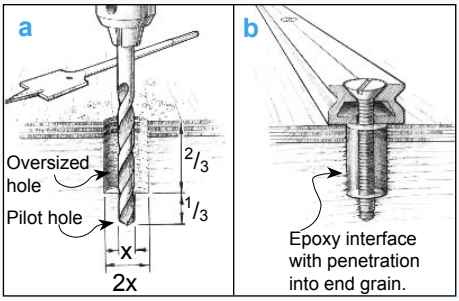


Figure 16 Drill oversized holes to increase the exposed substrate area and the amount of epoxy around the fastener.

4. Fill the hole with thickened epoxy/adhesive filler. Use 404 High-Density (preferred), 406 Colloidal Silica or 403 Microfibres.

5. Install the fasteners with just enough force to hold the hardware in place. Allow the epoxy to cure thoroughly before applying load to the hardware *(Figure 16b)*.

Bonding hardware

Bonding hardware goes much further than only bonding the fasteners. By bonding the hardware base to the surface, the hardware load capacity is significantly increased by providing a solid bearing surface for the hardware. It also seals the wood underneath and is a stronger, longer lasting attachment than bonding the fasteners only. It is especially useful to mount hardware on surfaces which are not level, curved or uneven.

1. Prepare the mounting surface and the hardware base for good adhesion *(see surface preparation page 11)*.

2. Wet out the oversized hole with epoxy. Allow the epoxy to soak into the exposed end grain of the wood (as with fastener bonding).

3. Coat the bottom contact surface of the hardware with unthickened epoxy. Wire brush or sand the wet epoxy into the surface with 50-grit sandpaper. Sanding the base, coated with epoxy, exposes the epoxy directly to fresh metal avoiding any oxidisation of the metal.

4. Inject a non-sagging epoxy/404 or 406 mix into the hole. Use sufficient mix to ensure there are no voids in the hole after inserting the fastener. Coat the bottom of the hardware and the fastener threads with thickened epoxy *(Figure 17)*.

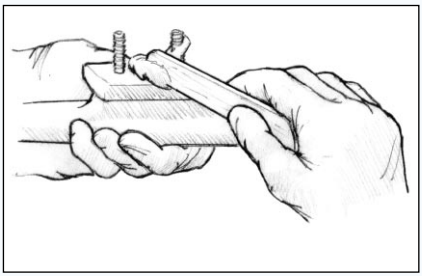


Figure 17 Coat the hardware bottom and the fastener threads with thickened epoxy.

5. Place the hardware in position. Insert and tighten fasteners until a small quantity of mix squeezes out of the joint *(Figure 18)*.

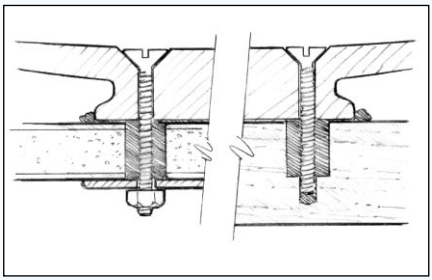


Figure 18 Tighten the fasteners until a small amount of epoxy squeezes from the joint.

6. Remove excess epoxy or shape into a fillet. Allow the epoxy to cure at least 24 hours at 15°C before applying load to the hardware. Allow more time in cool weather.

Casting a base

Use thickened epoxy to cast a base under the hardware when mounting hardware to a curved or uneven surface or mounting hardware at an angle to the surface.

1. Prepare the fasteners, holes, substrate and base as described above.

2. Bond small blocks to the substrate to support the base at the desired height and position *(e.g., winch base, Figure 19"A")*.

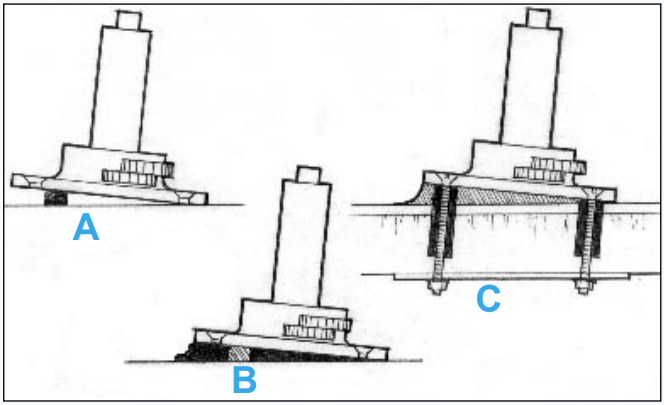


Figure 19 Support the base in position with blocking - apply enough thickened epoxy to fill the void.

3. Apply enough thickened epoxy – non-sagging, peanut butter consistency - to fill the volume below the required position of the hardware to a level marginally higher than the blocks. If the gap between the base and the surface is over 12mm fill the gap in two separate layers to avoid exotherm.

4. Place the hardware in position, resting on the blocks *(Figure 19"B")* and install the fasteners.

5. Smooth the excess epoxy into the desired fillet shape around the base *(Figure 19"C")*. Allow the epoxy to cure fully before loading. Protect exposed epoxy from UV. *(see finish coating page 29)*.

Bonding studs

Bond threaded rods or studs into the substrate (instead of bolts or screws) and attach the hardware with nuts. This variation is appropriate for many engine, motor or machine installations. Coat the base of the hardware with wax/mould release to make it removable. Although the hardware is not "bonded" to the substrate, the epoxy still provides a bearing surface that perfectly matches and supports the base of the hardware.

1. Prepare the studs/threaded rods by waxing the upper ends (above the surface) and cleaning the lower ends (below the surface).

2. Place a nut and washer on the studs, wet out the lower ends and push them into the epoxy filled holes. Allow the epoxy to cure thoroughly before attaching hardware and tightening the nuts *(Figure 20)*.

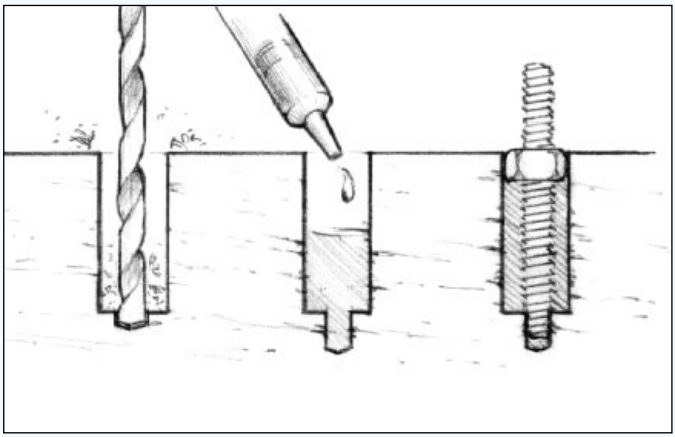


Figure 20
Bond threaded rods or studs into the substrate as an alternative for easily removable hardware.

Removing fasteners

If a fastener needs to be removed at a future date, coat the threads with wax or mould release (contaminating the surface sufficiently to prevent a good bond).

Remove a permanently bonded fastener by applying heat to the head of the fastener with a soldering iron or propane torch. Use a heat shield to protect the surrounding area. Heat will travel down the fastener, softening the epoxy with which it is in contact. At about 50/55°C the epoxy should soften enough to allow the fastener to be backed out. Allow more time for heat to travel along longer and/or larger diameter fasteners.

3.5 Laminating

The term "laminating" refers to the process of bonding together a number of relatively thin sheets, like plywood, veneers, fabrics or core material, to create a composite. A composite may be any number of layers of the same material or combinations of different materials. Methods of epoxy application and clamping will differ depending on the materials being laminated.

A quick method to apply epoxy for laminating is to use a foam roller. An even faster method for large flat surfaces is to simply pour the resin/hardener mix onto the middle of the panel/veneer/ fabric and spread the epoxy evenly over the surface with a plastic spreader. Apply thickened mixes with an 809 Notched Spreader.

Using staples or screws is the most common method of clamping when there is a solid material on which to fasten. An even distribution of weights will suffice when laminating over a base that will not hold mechanical fixings, such as a foam or honeycomb core material.

Vacuum bagging is a specialized clamping method for laminating a wide range of materials. Using a vacuum pump and plastic sheeting, the atmosphere is used to apply perfectly even clamping pressure over all areas of a panel regardless of the size, shape or number of layers. For detailed information on vacuum bagging, refer to 002-150 Vacuum Bagging Techniques.

Clamping

Any method of clamping is suitable to prevent movement between the parts being joined. Methods of clamping include spring clamps, "C" clamps and adjustable bar clamps, rubber bands cut from inner tubes, packaging tape, applying weights, and vacuum bagging. When placing clamps near epoxy covered areas, use polyethylene sheeting or peel ply under the clamps so they do not inadvertently bond to the surface. Staples, nails or drywall screws are often used where conventional clamps are unsuitable. Any fasteners that need to remain should be of a non-corroding alloy such as bronze. In some cases, the thickened epoxy or gravity will hold parts in position without clamps.

3.6 Fairing

Fairing refers to the filling and shaping of low or uneven areas so they blend with the surrounding surfaces and appear "fair" to the eye and touch. After major structural assembly has been completed, final fairing can be accomplished easily with WEST SYSTEM epoxy and low-density fillers.

1. Prepare the surface as detailed for bonding *(page 11)*. Sand smooth any bumps or ridges on the surface and remove all dust from the area to be faired.

2. Wet out porous surfaces with resin/hardener mix *(Figure 21)*.

3. Mix resin/hardener and 407 Low-Density or 410 Microlight™ filler to a peanut butter consistency. The thicker the mix, the easier it will be to sand when cured.

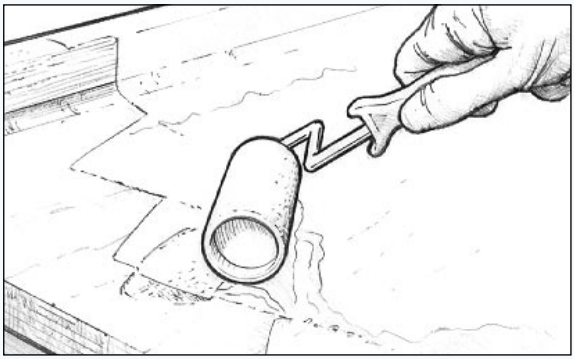


Figure 21 Wet out porous surfaces before applying fairing compound.

4. Trowel the thickened epoxy mix onto the wetted surface with a plastic spreader, working it into all voids and depressions. Smooth the epoxy to the desired shape, leaving the mix slightly higher than the surrounding area *(Figure 22)*. Remove any excess thickened epoxy before it cures. If filling voids over 12mm deep, apply the fairing mix in several applications allowing each application to partially cure before proceeding and/or use 206 Slow Hardener or 209 Extra Slow Hardener, depending on temperature.

Note: On vertical and overhead surfaces, allow the wet-out coat to gel before applying the fairing compound which may sag or slide off the fresh wet-out coat. Apply the fairing compound while the wet-out coat is still tacky.

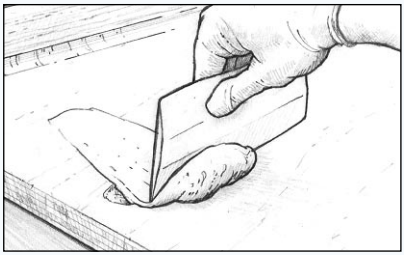


Figure 22 Apply fairing compound to fill all voids and smooth to shape.

5. Allow the final application of thickened epoxy to cure thoroughly.

6. Sand the fairing material to blend with the surrounding contour *(Figure 23)*. Begin with 50-grit sandpaper if it is necessary to remove a lot of fairing material. Use 80-grit paper when close to the final contour.

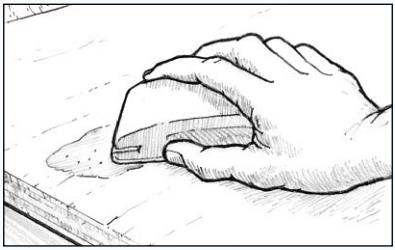


Figure 23 Sand cured fairing compound to desired contour.

CAUTION! Wear a dust mask when sanding cured epoxy. Remove the sanding dust and fill any remaining voids following the same procedure.

7. When satisfied with the fairness, apply two or three coats of resin/hardener mix to the area with a disposable brush or roller. Allow the final coat to cure thoroughly before final sanding and finishing.

3.7 Applying woven cloth and tape

Glass cloth may be applied to surfaces by two methods to provide reinforcement and/or abrasion resistance. It is usually applied after fairing and shaping are completed and before the final coating operation. It is also applied in multiple layers i.e. laminated and in combination with other materials to build composite parts.

The “wet” method refers to the cloth being applied to an epoxy-coated surface before the coating reaches final cure. The “dry” method is to apply the cloth over a dry surface and then impregnate the glass with epoxy. **The wet method is preferred whenever possible.**

Wet method

By working with small quantities of epoxy, it is possible to work at a comfortable pace over quite large areas to be reinforced.

1. Prepare the surface for bonding as discussed in surface preparation (page 11).

2. Pre-fit and trim the cloth to size. Roll the cloth neatly so that it may be conveniently rolled back into position later.

3. Roll a heavy coat of epoxy on the surface.

4. Unroll the glass cloth into position over the wet epoxy. Surface tension will hold most cloths in position. (If applying the cloth vertically or overhead, it is possible to wait until the epoxy becomes a little tacky). Work out wrinkles by lifting the edge of the cloth and smoothing from the centre with a gloved hand or a squeegee/spreader. If cutting a pleat or notch in the cloth, lay it flat on a curve or corner, make the cut with sharp scissors and temporarily overlap the edges.

5. Any areas of cloth which appear to be dry, (white in appearance) apply more epoxy with a foam roller.

Clear wood finishes
(stripper canoes, etc.)

An alternative wet out method is to lay the epoxy onto the fabric with a short bristled brush. Dip the brush in the epoxy and lay the epoxy onto the surface with a light even stroke. Do not force the epoxy into the cloth, which may trap air in the fabric and show through the clear finish. Apply enough epoxy to saturate the fabric and the wood below. After several minutes, lay on additional epoxy to dry (white) areas. If epoxy appears milky due to high humidity or overworking, warm the surface by passing a heat gun or hair dryer over the surface. Use low heat to avoid out-gassing. Be sure to use 207 Hardener for clear finishes.

6. Remove the excess epoxy with a squeegee *(Figure 24)*, using long overlapping strokes of uniform pressure. The object is to remove the excess epoxy that may allow the cloth to “float off” the surface but avoid creating dry spots by exerting too much pressure on the squeegee. Excess epoxy appears as a shiny area while a properly wet out surface appears evenly transparent with a smooth cloth texture. Subsequent coats of epoxy will fill the weave of the cloth.

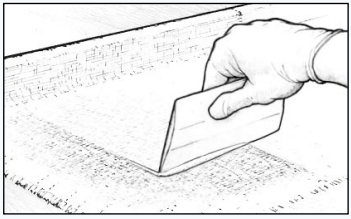


Figure 24 Squeegee away excess epoxy before it begins to gel.

7. Further layers of cloth may be applied immediately by repeating the steps above.

8. Trim the excess *(Figure 25)* and overlapped cloth after the epoxy has reached its initial cure. The cloth will cut easily with a sharp utility knife as long as the epoxy is not fully cured. If required, trim overlapped cloth as follows.

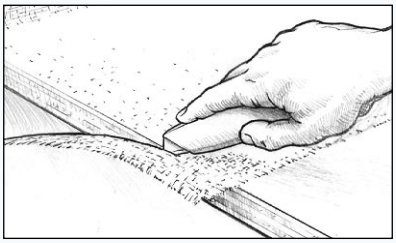


Figure 25 Trim excess cloth after the epoxy gels but before it cures hard.

a) Place a metal straightedge on top of and midway between the two overlapped edges.

b) Cut through both layers of cloth with a sharp utility knife *(Figure 26)*, being very careful not to cut too deeply.

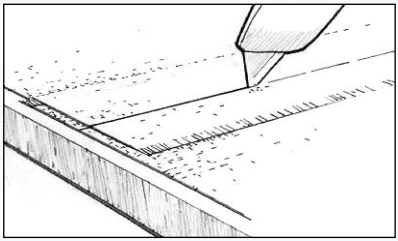


Figure 26 Trim overlapped cloth after the epoxy gels.

c) Remove the top-most trimming and then lift the opposite cut edge to remove the overlapped trimming *(Figure 27)*.

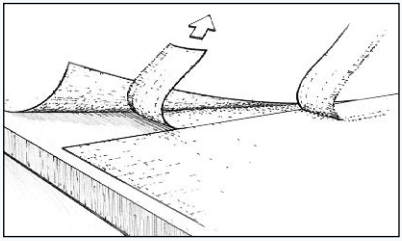


Figure 27 Remove the topmost trimming, lift the opposite cut edge to remove the overlapped trimming.

d) Re-wet the underside of the raised edge with epoxy and smooth into place.

The result should be a near perfect butt joint, eliminating double cloth thickness. However, a lapped joint is stronger than a butt joint, so if appearance is not important, it may be advisable to leave the overlap and fair in the unevenness after coating. Alternatively use WEST SYSTEM 743 tapered edge cloth to eliminate the need to butt join, contact Wessex Resins & Adhesives Limited or your local distributor for further information.

Any remaining irregularities or transitions between cloth and substrate can be faired by using an epoxy/filler fairing compound if the surface is to be painted. Any fairing completed after the final glass cloth layer should receive several additional coats of epoxy over the faired area.

9. Coat the surface to fill the weave before the wet-out becomes tack free (Figure 28). Follow the procedures for final coating in the next section. It will take two or three coats to completely fill the weave of the cloth and to allow for a final sanding that will not damage the cloth.

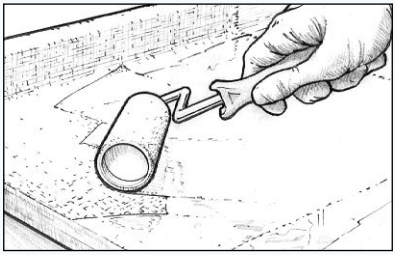


Figure 28 Coat the surface to fill the weave before the wet-out becomes tack free.

Dry method

1. Prepare the surface for bonding *(see surface preparation page 11)*.

2. Position the cloth over the surface and cut it 30 mm larger on all sides. If the surface area to be covered is larger than the cloth size, allow multiple pieces to overlap by approximately 5 mm. On sloped or vertical surfaces, hold the cloth in place with masking or duct tape, or with staples.

3. Mix a small quantity of epoxy (three or four pumps each of resin and hardener).

4. On horizontal surfaces, pour a small pool of resin/hardener near the centre of the cloth but it is essential to use a roller or brush for wetting cloth on vertical surfaces.

5. Spread the epoxy over the cloth surface with an 808 Plastic Squeegee, working the epoxy gently from the pool into the dry areas *(Figure 29)*. As the fabric is wet out it becomes transparent, indicating the cloth has absorbed sufficient epoxy. If applying cloth over a porous surface, ensure that sufficient epoxy is left to absorb into both the cloth and the surface below. Try to limit the amount of squeegeeing as excessive “work” on the wet surface produces minute air bubbles which are placed in suspension in the epoxy. This is especially important if a clear finish is required.

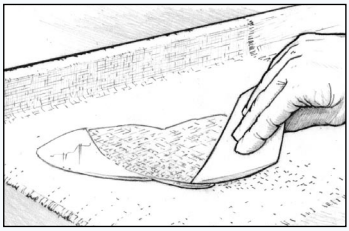


Figure 29 Spread the epoxy over the cloth surface with a plastic speader.

6. Continue pouring and spreading (or rolling) small batches of epoxy from the centre towards the edges, smoothing wrinkles and positioning the cloth. Check for dry areas (especially over porous surfaces) and re-wet as necessary before proceeding to the next step. If cutting a pleat or notch in the cloth, lay it flat

on a compound curve or corner, make the cut with a pair of sharp scissors and temporarily overlap the edges.

7. Now refer to Steps 5, 6, 7, 8 and 9 detailed above in the “wet method” to complete the procedure.

3.8 Epoxy barrier coating

The object of barrier coating is to build up an epoxy thickness that provides an effective moisture barrier and a smooth base for final finishing.

Apply a minimum of two coats of WEST SYSTEM epoxy for an effective moisture barrier. Apply three coats if sanding is to be carried out. Moisture protection will increase with additional coats and, in the case of osmosis repair and protection, six coats or about a thickness of 600 microns must be applied. Six coats, with 422 Barrier Coat Additive in the final five coats, provides maximum moisture protection. Additives or pigments should not be added to the first coat. **Do not add thinners or solvents to WEST SYSTEM epoxy.**

Disposable, thin urethane foam rollers, such as WEST SYSTEM 800 Roller Covers, allow greater control over film thickness, are less likely to cause the epoxy to exotherm and leave less stipple than thicker roller covers. Cut the covers into narrower widths to reach difficult areas or for long narrow surfaces like stringers. A paint brush can be used for smaller areas, if the bristles are stiff enough to spread the epoxy to an even film.

Complete all fairing and cloth application before beginning the final coating. Allow the temperature of porous surfaces to stabilise before coating otherwise, as the material warms up, air within the porous material may expand and pass from the material (out-gassing) through the coating and leave bubbles in the cured coating.

1. Prepare the surface for bonding *(see surface preparation page 11)*.

2. Mix only as much resin/hardener as can be applied during the open time of the mix. Pour the epoxy into a roller pan as soon as it is mixed thoroughly.

3. Load the roller with a moderate amount of the epoxy. Roll out the excess on the raised section of the roller pan to obtain a uniform coating on the roller.

4. Roll lightly and randomly over an area approximately 600mm x 600mm to transfer the epoxy evenly over the area *(Figure 30)*.

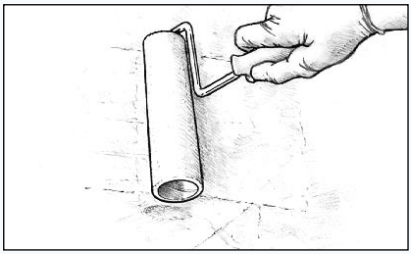


Figure 30 Roll lightly and randomly over a small area. Spread the epoxy into a thin even film.

5. As the roller dries out, increase pressure to spread the epoxy into a thin even film. Increase the coverage area if necessary to spread the film more thinly and evenly. **The thinner the film, the easier it is to keep it even and avoid runs or sags in each coat.**

6. Finish the area with long, light, even strokes to reduce roller marks. Overlap the previously coated area to blend both areas together.

7. Coat as many of these small working areas as possible with each batch. If a batch begins to thicken before it can be applied, discard it and mix a fresh, smaller batch.

8. **"**Tip off" the coating by dragging a foam roller brush lightly over the fresh epoxy in long, even, overlapping strokes after each batch is applied. Use enough pressure to smooth the stipple, but not enough to remove any of the coating *(Figure 31).* Alternate the direction in which each coat is tipped off, 1st coat vertical, 2nd coat horizontal, 3rd coat vertical, etc. A WEST SYSTEM 800 Roller Cover can be cut into segments to make an excellent "tipping" brush.

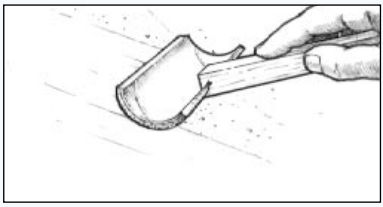


Figure 31 Tip off the coating by dragging a foam roller brush lightly over the fresh epoxy.

Recoating

Apply second and subsequent coats of epoxy following the same procedures. Ensure the previous coat is still tacky, but has cured firmly enough to support the weight of the next coat. To avoid sanding between coats, apply all coats in the same day. *See Special Preparation - Cured epoxy on page 12*.

3.9 WEST SYSTEM Epoxy and Barrier Coating for Osmosis repair.

Osmosis, otherwise known as gel-coat blistering, is a complex phenomenon. The technical issues and repair instructions are contained in our specialist manual **"Gelcoat Blisters, A guide to Osmosis repair".** It is essential to fully read, understand, and follow the instructions contained in it when considering a treatment. Any such treatments should only be carried out under the close supervision of a qualified Marine Surveyor or by an experienced boatyard or Contractor who has clear evidence of successful past treatments. Specialist yards or Contractors will have links with a qualified experienced surveyor and will usually obtain a full report prior to commencing a treatment. We stongly recommend that advice is sought from a qualified Marine Surveyor concerning a particular hull prior to the commencement of any treatment. Because of the variability of hull constructions and the complexity of the Osmosis phenomenon there can be no guarantee of a 100% success rate in treatments. Recurrence is always a possibility but by following these instructions we believe that the risks of recurrence will be minimised.

3.10 Final surface preparation

After the final coat has cured overnight, wash with clean water and abrade the surface to prepare for the final finish.

Correct finishing techniques will not only add beauty, but will also protect surfaces from ultraviolet light which will break down the epoxy over a long period of time. The most common methods of finishing are painting or varnishing. These coating systems protect the epoxy from ultraviolet light and require proper preparation of the surface before application.

Preparation for the final finish is just as important as it is for recoating with epoxy. The surface must be clean, dry and sanded and free of amine blush.

1. Allow the final epoxy coat to cure thoroughly.

2. Wash the surface with a Scotch-brite™ pad and water to remove the amine blush. Dry with paper towels.

3. Sand to a smooth finish *(Figure 32)*. If there are runs or sags, begin sanding with 80-grit paper to remove the highest areas. Sand until the surface feels and looks fair. Complete sanding with the appropriate grit for the type of coating to be applied - check coating instructions. Paint adhesion partly relies on the mechanical grip of the paint keying into the sanding scratches in the surface of the epoxy. If a high-build or filling primer is to be applied, 80-100 grit is usually sufficient. For primers and high-solids coatings, 120-180 grit may be adequate. Finishing with 180 grit paper is often recommended for coatings with high-gloss finishes. Grits finer than this may not provide enough “tooth” for good adhesion and may promote sags and runs. Always follow the paint manufacturer’s recommendations for surface preparation. Wet sanding is preferred by many people because it reduces sanding dust and in addition, Steps 2 and 3 above become one operation.

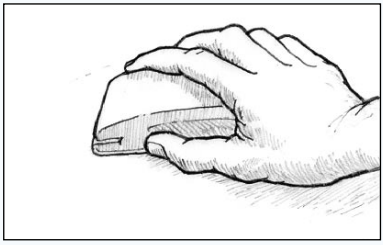


Figure 32 Sand to a smooth finish.

4. When satisfied with the texture and fairness of the surface, rinse the surface with fresh water which should flow evenly without beading or fisheyeing. If the rinse water forms into droplets or beads (a sign of contamination), wipe the area dry with a paper towel, then wet sand again until all water droplets are eliminated. *(Figure 33)*.

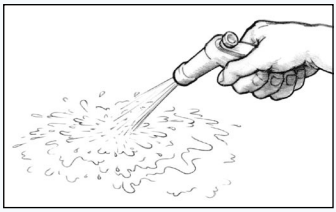


Figure 33 Rinse the surface with fresh water after sanding.

Proceed with the final coating after the surface has dried thoroughly. To reduce the possibility of contamination, it is advisable to begin coating within 24 hours of the final sanding. Follow the paint manufacturer's instructions but we suggest making a test panel to evaluate the degree of surface preparation required and the compatibility of the finish system.

3.11 Finish coatings

Coating function

Paint or varnish applied over an epoxy barrier coat is intended to decorate the surface and protect the epoxy from sunlight. In so doing, the finish coating extends the life of the epoxy moisture barrier which, in turn, provides a stable base that extends the life of the finish coating. Together, the two form a protective system far more durable than either coating by itself.

Protection from sunlight is a primary consideration in the selection of a final coating. Long term UV (ultraviolet) protection of the barrier coat depends on the effectiveness with which the finish coating resists UV and retains it's pigmentation and/or shield of UV filters on the surface of the epoxy barrier coat. A high gloss finish reflects a higher proportion of the light from the surface than a dull finish. Therefore, a white - especially a high gloss white – coating is much more durable.

Most types of coatings are compatible with cured epoxy which is an almost completely inert, hard plastic. Thus, most paint solvents will not soften, swell or react with an epoxy surface. However, it is advisable to build a test panel to assure coating compatibility. **It is always recommended to check manufacturer's instructions to verify compatibility and suitability.**

Coating types

Latex paints are compatible with epoxy and they do an adequate job of protecting the epoxy barrier from UV radiation. In many architectural applications latex paint may be the most suitable coating to use. Their durability is limited.

Alkyd finishes - enamel, alkyd enamel, marine enamel, acrylic enamel, alkyd modified epoxy, traditional varnish and spar varnish - offer ease of application, low cost, low toxicity, and easy availability. Their disadvantages are low UV resistance and low abrasion resistance.

One-part polyurethanes offer easy application, cleanup and better properties than alkyds. They are also more expensive and some may be incompatible with amine cured epoxy systems such as WEST SYSTEM epoxy, although 207 Hardener offers good compatibility. Test first.

Two-part linear polyurethane (LP) paints offer the most durable protection available. LP's are available as pigmented or clear coatings and offer excellent UV protection, gloss retention, abrasion resistance and complete compatibility with epoxy. However, compared to other types of coatings, they are expensive, require more skill to apply and present a greater health hazard, especially when sprayed.

Epoxy paints are available in one-part and two-part versions. Two-part epoxies offer many characteristics similar to the higher performance polyurethanes. They are durable and chemically resistant, but offer limited UV protection compared to the linear polyurethanes.

Antifouling paints are available in a variety of formulations. Most antifouling paint systems are compatible with epoxy and can be applied directly over a prepared epoxy barrier coat. If unsure of compatibility or having curing or adhesion problems with a specific paint, use the primer recommended for that antifouling paint over the barrier coat. Follow the recommendations given for preparation of GRP surfaces. Other paints, including marine LP's and primers, are not recommended for use below the waterline.

Primers are usually not needed to bond a paint film to epoxy, although interfacing primers may be required with some specialised bottom paints and high-build primers are useful for hiding scratches or flaws in the substrate. If the instructions on the selected paint or varnish recommend a specially primed surface, follow the recommendations given for fibreglass preparation. Self-etching primers are not effective on an epoxy coating because of the chemical resistance of the epoxy.

Polyester gelcoat is a pigmented version of polyester resin used to build GRP boats and many other products. Gelcoat provides a smooth pre-finished surface and is applied during the production process of the boat or component part. It is not often used as a post-production finish coating, but it can be applied over epoxy and is useful in some repair situations. Unreacted epoxy will interfere with gelcoat cure. Refer to 002-550 Fibreglass Boat Repair & Maintenance, published by Wessex Resins, for detailed information on patching gelcoat over an epoxy repair.

Always follow the instructions from the manufacturer of the coating systems. Nevertheless, as previously stated, it is recommended to make a test panel to evaluate the degree of surface preparation required and the compatibility and handling characteristics of the finish system.