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Figure 6-8 Clean out the seams with a scraper.

Figure 6-9 Fill the wet-out seam with thickened epoxy.

4. Wet out the opened seam surfaces with resin/hardener mix. Work epoxy into the seam as deeply as possible with a disposable brush or syringe.

5. Apply thickened epoxy filled with either 403 or 406 (peanut butter consistency) into the opened seams. Use a squeegee to force the thickened epoxy into the seam as far as possible (Figure 6-9). Check inside for epoxy leaking through the planks. Clean excess epoxy before it cures.

6. Shape the thickened epoxy at the inside corner of the seam to a square inside corner or a cove-shaped fillet. A fillet increases the bonding area around the seam and provides more protection to the edge of each plank. For more details on fillets see Section 3.4.3.

7. Sand the seams and plank surfaces fair after the epoxy has cured thoroughly. Fill and fair any remaining voids with an epoxy/low-density blend. Follow the coating/finishing procedures in Section 3.4.

6.3 Plywood

Marine Plywood has an excellent strength to weight ratio and is stable both along and across the board making it an ideal material for boat building and repair. Various types and qualities are available on the market today and generally price is a good indicator of quality.

It is important to ensure the plywood is marked BS1088 and has the country of origin stated to comply with the BS1088 regulations. Some boards will be manufactured by mills with Lloyds Type Certification, or other Certifications which are good indicators of quality, but should not be considered guarantees of quality as they refer to the manufacturer’s management and quality systems.

Cheaper marine plywood, often made in the Far East or Brazil is good for fitting out work, but will often have thin face veneers and thick central laminates. This means any fault in a centre veneer will affect a greater proportion of the thickness of the board than in a multi laminate panel. If the application is structural it is better to opt for a multi-laminate panel. Okoume (Gaboon) makes a very good and lightweight marine panel and is excellent for use with epoxy. Where heavy stress exists, or the panels are to be used in a tropical environment, a heavier and more durable plywood should be used made from Mahogany or Sapele.

Our experience shows that the quality of the timber used and the construction of the laminates vary considerably and we suggest contacting a reputable timber merchant who specialises in marine plywoods (such as Robbins Timber in Bristol). Such companies will be able to advise on the best type of marine plywood for the intended application.

6.3.1 Rebuilding a plywood joint

If the seam between plywood sheets has deteriorated, clean out the joint, seal the edges with epoxy and reinforce the joint with fibreglass tape applied with epoxy. The seam may be on a flat surface or at an edge or chine.
Rebuild a plywood joint as follows:

1. Clean out the seam by running a circular saw or scraping tool along the seam. Set the depth of the saw cut to the full thickness of the plywood when the seam runs along a frame. Set the width of the blade to shave the edges of both sheets of plywood at the joint and expose fresh wood on each edge. Remove any fasteners in the way of the cut. Let the wood dry thoroughly if necessary.

2. Drive the fasteners deeper at the joint to allow for a valley to be sanded along the joint for the placement of one or more layers of fibreglass tape.

3. Sand a 100mm to 125mm wide valley along the joint with a disc sander to allow the layer(s) of tape to lie below the surface. Make the depression about 0.75mm deep for each layer of 175g/m² (6 oz/yd²) fibreglass tape that will fill the joint. Use the sander or a chisel to remove any additional damaged or rotted plywood around the joint. At an edge or chine, use the sander or a router with a roundover bit to round the corner. A 6mm to 9mm radius will allow the glass tape to lie flat on the surface (Figure 6-10).

4. Wet out the seam and sanded area with resin/hardener mix. Recoat the seam with epoxy as necessary as it is absorbed into the end grain of the plywood. Inject or work epoxy between any delaminated veneers that are still sound.

5. Apply thickened epoxy filled with either 403 or 406 to a mayonnaise consistency into the pre-wetted seam. Use a plastic squeegee to force the thickened epoxy into the wet-out seam and smooth the excess mix along the joint. Work the thickened epoxy into any voids and between delaminated veneers previously wetted out with resin/hardener mix.

6. Apply a layer of fibreglass tape in the depression along the joint (Figure 6-11). Use the squeegee to work epoxy into the fabric and remove the excess. Apply additional layers, if desired, in the same manner. Place new layers 12mm to either side of the previous layer so the edges do not fall directly on top of each other. For details on applying fibreglass cloth, see Section 3.4.6.

7. Apply thickened epoxy filled with either 407 or 410 low-density filler to a peanut butter consistency to the joint. Use a squeegee to trowel on and shape the thickened epoxy slightly higher than the plywood surface (Section 3.4.5). Allow to cure thoroughly and sand fair.

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**6.3.2 Replacing damaged plywood sections.**

Sections of plywood panels may suffer from impact or dry rot damage and can be repaired without replacing the whole panel. The damaged section can be cut out and a replacement section bonded in without losing any panel strength.

Replace small plywood panel sections as follows:

1. Cut the damaged section out of the panel. Use a circular saw or reciprocating saw to cut the smallest square or rectangle that encloses the damage. Check the extent of damage on the interior of the panel.
2. Scarf or step the edges of the opening.
   a. Grind a scarf on the edges with a disc sander (Figure 6-12). Grind a minimum 8-to-1 bevel back from the edges of the opening. (If the panel plywood is 12mm thick, the bevel should extend at least 100mm from the edge of the hole on each side.)
   b. Mill a step on the edges of the hole with a router. Use a straight fluted bit to machine a step or steps in the panel round the opening. The width of each step should be eight times the step thickness. Steps are convenient when laminating several layers of thinner plywood to equal the thickness of the damaged panel. Make each step equal to the thickness of one replacement layer.

3. Fabricate the replacement panel using the same or equivalent plywood as the original. Cut the panel to the outside dimensions of the bevel or step.
   a. Use the disc sander to machine a bevel on the inside edge of the replacement panel to match the bevel on the opening. Dry fit the new panel to fit slightly below the existing surface (Figure 6-13).
   b. Use the router with the straight fluted bit to machine steps in the edges of the replacement panel to match the steps around the opening. If multiple layers of plywood are to be used, cut one layer to the dimension of each step. Dry fit the new panel to fit slightly below the existing surface.

4. Wet out the bonding area of the panels with resin/hardener mix. Recoat the end grain as necessary. (Plywood end grain will absorb a lot of epoxy.)

5. Apply thickened epoxy filled with either 403 or 406 to a mayonnaise consistency to the bonding area of the new panel. Apply enough thickened epoxy so that a small amount will squeeze out when the new panel is pushed into the dry-fit position.

6. Clamp the new panel in position with temporary staples or screws (Figure 6-13). Permanent fasteners should be non-corroding and pilot holes should be wet out with epoxy. Clean up excess epoxy before it cures. Allow the epoxy to cure thoroughly before removing clamps. Bond multiple thinner layers in place, one at a time, following the same procedure. Use a thinner epoxy/filler blend on the flat bonding areas between the layers.

7. Sand the surface and fill low areas with epoxy filled with either 407 or 410 low-density filler to a peanut butter consistency. Use a squeegee to apply the thickened epoxy, slightly overfilling low areas on the surface. Allow the mixture to cure thoroughly before fairing.

6.3.3 Replacing/installing plywood

It is possible to install new plywood over exposed frames or over existing hull or deck surfaces. Plywood used as the primary skin (bonded directly to the frames) may be laid out with scarfed joints falling directly over the frames or with butt joints over backing plates between the frames. Scarfed joints offer a cleaner appearance from the interior. The frame spacing and size of the boat determine the thickness of the plywood. The amount of compounding determines whether the total thickness can be applied in one layer or in multiple layers. Apply thinner plywood in multiple layers if one layer is too thick to bend over a curved surface.

Apply a primary plywood skin as follows:
1. Prepare plywood panels, scarf joints and beam surfaces. Plan both the panel layout and order of assembly so that the scarf on the following sheet lies over the scarf on the previous sheet (Figure 6-14).

2. Wet out the bonding surfaces of the plywood and frames. Wet out scarfs on the ends of adjoining sheets.

3. Apply a coat of thickened epoxy/406 blend to the bonding surfaces of the frame and the scarf of the previous sheet.

4. Lay the sheet in position over the frames. Align the scarf joint to avoid overlapping (Figure 6-14).

5. Clamp the sheet temporarily with drywall screws or staples. Use enough fasteners to clamp the sheet evenly. The epoxy mixture should squeeze out of the joints, assuring good adhesive contact. Station someone inside to clean excess epoxy at the frames and joints. The excess can be scraped clean or shaped into a fillet before it begins to cure.

6. Repeat the process with the remaining sheets. Allow the joints to cure thoroughly before removing temporary fasteners.

7. Sand the joints and fair the surface before adding another layer of plywood, glass cloth (3.4.6) or finishing (3.4.8).

Figure 6-14 Plan the panel layout so that scarf joints will fall over beams for better clamping.

6.3.4 Applying plywood over existing skins

When laminating an additional layer of plywood over an existing hull or deck, it is not necessary to scarf joints or place joints directly over frames because of the large bonding area. Restore existing plywood to sound condition before laminating new sheets onto the old structure.

Laminate new plywood over an existing deck or hull as follows:

1. Re-bond delaminated layers of plywood, after drying thoroughly. Drill a pattern of 3mm holes (approximately 25mm apart) in the delaminated area. Use a syringe to inject a slightly thickened epoxy/406 mix in the holes to wet out the delaminated area. Use staples or screws to clamp the layers together until the epoxy cures. When the epoxy has cured thoroughly, proceed with Step 2.

2. Sand the surface fair to clean, bare wood. Remove all old finishes and contaminants.

3. Open existing joints with a scraper, saw or router and fill the joints with epoxy. Repair with glass tape, if necessary, as suggested in Section 6.3.1.

4. Cut out severely damaged areas and scarf in new plywood, if necessary, as suggested in Section 6.3.2.

5. Plan the layout of the new plywood sheets to avoid new joints falling over existing joints.

6. Apply an epoxy/406 mix to both bonding surfaces with a roller. Thicken the mixture to a ketchup consistency to allow some penetration and still bridge any gaps between the surfaces. If the surface is rough or uneven, thicken the epoxy/filler blend to a mayonnaise consistency and apply with a notched spreader.
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7. Clamp the sheet in position with an even pattern of temporary screws or staples. Clean up excess epoxy at the joints. Repeat the procedure with each sheet. Allow the epoxy to cure thoroughly before removing temporary fasteners.

8. Sand the surface fair before final finishing.

6.4 Moulded or laminated veneer repairs

Another option for skin covering uses strips of thin veneer instead of sheets of plywood. Laminated boats were and are built by bonding layers of thin veneers together over curved forms; in effect building a sheet of plywood in the shape of a boat. This technique has produced lightweight rigid hulls that are not limited to the flat surfaces and hard chines of plywood boats. Using veneers for skin repairs offers the advantage of being able to conform to any curved shape, especially compound curves. This advantage can be used for repairs in several ways. Veneers can be used to patch small sections of laminated hulls that are too curved for a plywood patch. On a larger scale, laminating layers of veneer over an existing plywood or carvel planked hull is an excellent method of adding a great deal of stiffness to a hull or deck without removing the existing skin. More detailed information about laminating veneers as a building technique can be found in the book “THE GOUGEON BROTHERS ON BOAT CONSTRUCTION”.

![Figure 6-15 Remove the damaged section.](image1)

![Figure 6-16 Bevel the edges and fasten temporary stringers to the back of the opening.](image2)

![Figure 6-17 Cover the stringers with plastic to prevent bonding.](image3)

6.4.1 Laminating a curved patch in place

Laminating a patch to repair a moulded panel combines two procedures already covered: repairing damaged plywood sections and laminating frames. Laminating a curved panel section in a large damaged area requires temporary back-up stringers to act as a jig.

Laminate the patch in place as follows:

1. Remove the damaged section of the panel. Define the area of damage. Use a circular saw or reciprocating saw to cut the smallest square or rectangle that removes all damage (Figure 6-15). Check the extent of damage on the interior of the panel as well.

2. Scarf the edges of the opening with a disc sander. Grind a minimum 8-to-1 bevel back from the edges of the opening. (If, for example, the panel plywood is 12mm thick, the bevel should extend at least 100mm from the edge of the hole on each side.)

3. Fasten temporary stringers to the back side of the opening with screws (Figure 6-16). The stringers should be strong enough and spaced closely enough to hold the veneers to the proper shape. Cover the stringers with plastic to prevent bonding (Figure 6-17).

4. Staple the first layer of veneers over the stringers. Run the veneers diagonally, approximately 35° from vertical. Scarf the ends of the veneers to match the scarf on the edge of the opening. Bond these first layer veneers only where the scarfs make contact, using the bonding procedure in Section 3.4.2. Use 403 or 406 filler to thicken the epoxy to a mayonnaise consistency.