FYI GUIDE TO COMPOSITE CANOE & KAYAK REPAIR

Composite canoe and kayak are built using resin and fiberglass fabric or combination of fiberglass, Kevlar®, or graphite/carbon fabrics. In simplest terms composite construction consists of multiple layers or laminates of fabric encapsulated and bonded together by resin. Actual fabrics and resins used can vary depending on the intended use but the basic construction technique pretty much universal. Most boats feature an outer clear or colored layer of gel coat which is basically a pigmented resin mixture formulated for abrasion resistance. On some boats the gel coat is eliminated to save weight and these boats are referred to as a "skin-coat."

Fortunately, the repair process is also pretty much the same, regardless of the specific laminate matrix. This pamphlet is designed to outline the basic process which will involve both structural repair and cosmetic restoration. Sometimes the line between cosmetic and structural gets blurred, especially when significant abrasion is involved. We'll try to guide you through how to determine whether the damage you're concerned with is structural or cosmetic as well.

GLOSSARY

To make sure we're all talking the same language here, it makes sense to define some of the materials and terms we'll be using.

CLOTHS/FABRICS

Fiberglass Cloth: a white woven fabric with a fine weave that is balanced in both directions. Fiberglass cloth comes in varying weights, measured in ozs per yard with 6 oz and 10 oz. the most applicable for canoe and kayak repair. Heavier fabric is stronger but also stiffer and will not contour as well in tight corners or curves. For example, 10 oz. cloth is good for repairing damage on flat panels of your hull whereas 6 oz. or lighter will work better if you're repairing the stems of your boat. Prior to impregnation with resin, fiberglass cloth is white. Once impregnated cloth will become transluscent. Fiberglass cloth can be used to effectively repair Kevlar® and most other composite hulls.

S-Glass: a derivative of fiberglass cloth that is woven to provide added abrasion resistance and is more expensive than standard fiberglass cloth. S-glass works well when used as the outermost layer of your hull.

Woven Roving: a coarse woven fiberglass cloth. The weave is much larger than on cloth and this material is used to provide stiffness to a hull. It tends to absorb a lot of resin and thus be heavier than conventional fiberglass cloth.

Fiberglass Mat: a "fabric" made up of unconnected random fiberglass fibers. Well suited for "chopper gun" construction wherein premixed fibers and resin are sprayed on a mold. Compared to cloth mat is significantly weaker and heavier due to a high concentration of resin.

Kevlar®: an "aramid" fabric developed by DuPont. Lighter and stronger than fiberglass cloth, Kevlar® is easily identified by its signature gold color. It is the material of choice for high performance hulls due to its combination of weight and strength. Kevlar is more difficult to work with than conventional cloth but is still feasible for "home based" repair. Kevlar® does not sand well as it tends to "fuzz". If your repair is to include Kevlar® and you want a smooth surface finish, consider using fiberglass or S-glass as the outer layers.

Graphite/Carbon: a black fabric that is lighter than Kevlar® and stiffer but does not flex and can be brittle. Graphite fabric is very abrasion resistant but is quite difficult to work with and is used selectively in high performance boats and has less application for repair than other fabrics.

Resin: the "glue" that impregnates and binds the fabric or cloth layers together. All resin is somewhat hazardous and all manufacturer's precautions should be carefully followed. There are 3 basic resins used in canoes and kayaks:

Polyester: a basic resin that is inexpensive, relatively safe to use but is not as strong as vinylester or epoxy. Polyester resin is readily available at hardware and auto stores and works well in a majority of repair situations.

Vinylester: a specially formulated ester based resin that is designed to provide better elongation before rupturing, a desirable trait when it comes to boats as it allows the hull to distort upon impact or when passing over an underwater obstacle. Vinylester is harder to locate and somewhat more hazardous to use than polyester.

Epoxy: the strongest and most rigid of resins but also the most hazardous. If your desire is to minimize weight and maximize strength, epoxy is the best choice but must be used with care.

Catalyst: is required to cure the resin from a liquid to a solid. Catalysts are designed to work with specific resins and mixtures vary. It's best to obtain the same brand of resin and catalyst to ensure compatibility. Mix ratios will vary from catalyst/resin to catalyst/resin but should be carefully adhered to for best results.

GelCoat: is a specially formulated resin/catalyst mix that is designed to provide abrasion resistance and high gloss. The gel coat is the outer layer of the laminate and structural repair will also involve restoration of the gel coat. Some boats dispense with the gel coat layer to save weight. Boats constructed in this fashion are called skin coated.

Assessing the Challenge

The first step in preparing for boat repair is to analyze the nature of the damage. Damage to a hull will usually come in two forms or a combination of both: puncture or fracture and abrasion. Most of the time, you're aware (but perhaps unwilling to admit) when the damage occurred. It is also possible for a hull to degrade over time and use and show signs of fatigue and flexibility in previously rigid areas of the hull.

Structural repair is obviously required when the hull is punctured or cracked all the way through. Less obvious is damage that is localized to one side of laminate without ready evidence of corresponding damage on the opposite side. Indicators of structural damage include excessive localized flexibility. This can be easily determined by pressing on corresponding section on opposite side of hull. Often careful inspection on the interior of the hull will reveal white lines in the lay-up indicating resin fractures (when bond between fabric and resin has been broken.)

Abrasion is usually a cosmetic issue as long as confined to the gel coat layer of the hull. Gel coat kits are available to address this and for the sakes of your boat, it's advisable to be proactive and repair the gel coat before the internal hull layers are affected. If gel coat has been worn off or chipped away, inspect the fabric layers underneath for damage.

Getting prepared and protected

Once extent of damage is determined, it's time to get things in order for the task in hand. A "repair kit" is likely to include:

- safety glasses/goggles
- respiratory protection
- disposable gloves (several pair)
- long sleeve shirt and pants – preferably disposable

TIP: Professional laminators often wear 2 or 3 pair at one time. When one pair gets too messed up they're able to pull it off and continue to work without delay.

- brushes of various sizes (bristle or foam)

TIP: Flexible plastic spreaders such as used with auto body filler are very handy for working resin into fabric.

- sandpaper
- sharp knife
- fine edged screwdriver or stiff putty knife for lifting chips of gelcoat or damaged fabric
- scissors to cut cloth (must be very sharp to cut Kevlar®
- plastic bucket to mix resin (cut off milk jug works well)
- stirring sticks
- rags
- drop cloths
- quality plastic wrap such as Saran Wrap®
- cardboard, duct tape, masking tape (for jigs for aligning sides of tears and to tape off areas to be repaired)
- gel coat repair kit
- solvent (mild such as denatured alcohol for cleaning surface before repair) and/or acetone for cleaning spilled resin
- appropriate composite fabric, resin, and catalyst

You'll also need an appropriate work place. Fiberglass work is smelly, tends to be messy, and is something not to be undertaken inside your living quarters. Prolonged exposure to vapors is dangerous and should be avoided. If you will be working indoors, make sure there is plenty of ventilation.

The temperature the work is being performed at is also important. Once you mix resin and catalyst you have a limited amount of what's called "working time" before the mixture "kicks" and starts to solidify. Note the recommendations provided by the resin manufacturer and mix only the amount of resin you can anticipate using during available working time. Most frequently, suggested air temperatures range from the mid-60s to mid 70s F. Higher temperatures shorten the working time of the resin and cooler temps can slow or halt the cure time.

TIP: If you have to perform repairs when temperatures are higher than desirable, you can extend the working time by mixing the resin in a broad flat pan rather than a bucket. Another technique is to use two pans, one slightly larger than the other. Put a layer of water in the larger pan and place the smaller (containing your resin mixture) on the water filled pan. The water will slow down the generation of heat that accelerates the curing process.

REPAIRING PUNCTURES, TEARS, & CRACKS

The type of damage and its severity and location may vary but the basic repair process is much the same. It involves proper surface preparation, alignment of each side of fracture or tear or edges of the puncture, determining size and number of repair patches, and finally installation of the patches.

Tip: Proper and thorough surface preparation is essential to successful repair. Don't rush this stage of the process or cut corners. It can and will come back to haunt you.

SURFACE PREPARATION

The majority of structural repair will be done on the interior of the hull with exterior work being more cosmetic in nature. It is necessary to properly prepare both sides of the hull.

Interior & Exterior Surface Prep

First, make sure that the area around the area around the damage is thoroughly dry. Moisture entrapped in the laminate can further deteriorate the hull and can inhibit development of a complete bond with repair materials.

All loose or raised fibers and/or gel coat must be removed. This would include any frayed fibers on edges of damage or any extensive grouping of white or opaque fiberglass fibers or light yellow Kevlar® fibers. The change in color indicates deterioration of the bond of fiber and resin. If you have isolated white lines showing in the laminate and the fabric weave is intact you can let these slide. A sharp knife and pry tool such as a fine edged screwdriver are helpful in removing damaged material.

Interior Preparation
If you're dealing with a fracture, grind or sand away a gentle "U" shaped groove along the fracture to provide sufficient surface area for bonding repair materials to original hull.

Once damaged materials are removed it'll be necessary to sand the interior surface with 80 grit paper to remove any contamination or soil. If the interior of your hull is painted it will essential to sand away all paint traces before proceeding. Sand approximately 4 to 6" out from damaged area, depending on size and extent of damage. The greater the extent of the damage the larger the area to be involved in the repair. Continue to sand surface until surface is slightly textured. You'll be applying multiple layers of fabric to restore the hull integrity; the larger the damage the more layers of reinforcement that will be required. Immediately prior to applying resin to interior surface, wipe surface clean with solvent such as denatured alcohol to remove sanding residue or other contaminants.

Once surface is prepared, it will be necessary to align the edges of the repair to ensure conformity. In most cases, a "jig" can be fashioned to align the sides of the repair using cardboard and duct tape. Place a piece of plastic wrap between the hull and cardboard at any point where the jig or supporting structure may be exposed to resin. If you're dealing with a puncture resulting in missing material, cut a cardboard disk larger than the hole, cover it with a quality plastic wrap and tape disk to exterior of the hull so that it conforms to hull. This will provide a surface to align repair with hull.

Cut a piece of repair fabric that fits damaged area. If you're dealing with a thick laminate or deep damage that needs to be filled, cut small pieces and bits of fabric to lay directly in the damaged area underneath piece of fabric sized to cover damage.

Cut additional pieces of fabric in successively increasing sizes, each about ¾" inch larger than the previous piece. In most cases, a minimum of 4 layers will be required. For more extensive damage, figure on 6 layers as necessary.

TIP: To avoid patch edges being lifted after installation, cut fabric with a radius or curved edge rather than straight sides with sharp corners.

TIP: For strongest repair, rotate cloth when cutting patches so that fabric weave runs in different directions from patch to patch.

Interior Repair Procedure:
Following manufacturer's instructions carefully mix resin and catalyst, limiting quantity to what can be used within the working time specified. (Don't forget to take temperature into consideration.)

Using brush coat on a light coat of catalyzed resin onto interior of hull. If employing filler pieces place them in position and tamp in place with brush. Keep tamping until fabric changes color, indicating saturation.

Next wet out surface to correspond with patch sized to fit damage. Place this patch over hull and tamp in place. Use additional resin, tamp patch starting from center and working towards edge, continuing until change in color indicates saturation. Be particular careful to remove any trapped air as indicated by bubbles or raised areas. It is essential that maximum surface contact occurs for strongest repair.

Once first patch is fully saturated wet out surface again sized to fit the next larger patch. Repeat process of applying patch, working from center towards edges. Once patch is in place, proceed with successive patches until all are in place and fully saturated with resin.

Use resin sparingly. If working on curved surface with vertical panels, resin will tend to run or drip. Any runs must be cleaned up immediately. Additional resin adds only weight, not strength. Use only enough resin to wet out fabric patches. Excessive resin can also result in a layer of resin between patches, preventing patch to patch bonding and resulting in a weak repair and even allowing patch to float out of position.

TIP: If you're repairing a curved section of the hull it's important to make sure that cloth is held firmly in contact with hull surface. During curing process the patching cloth will try to return to a flat profile. You can keep it in position by tamping it with your brush or by laying a layer of quality plastic wrap over repair and using a flexible weight to press patch into position. Water or sand bags work well as flexible weights, draped over repaired area.

Remove any plastic wrap used during repair once the resin has started to set up, approximately 30 minutes after resin is mixed. Actual time will vary depending on temperature and resin factors.

Allow repair to cure completely before use. This will be a minimum of 24 hours from start of repair. Resin cures quickly at first and then cure proceeds more slowly. It usually takes about 24 hours to reach maximum strength.

If desired, you can paint the repair to match existing hull finish after cure is complete.

Exterior Hull Preparation
You want to use a light touch on exterior repair work as the primary focus will be cosmetic, this is the side of the work most people will see. Depending upon the nature of the damage, a gel coat repair kit may be adequate or your hull may require some additional finishing work.

Remove the alignment jig (if used). Check out how "fair" (smooth) the hull surface is. If only uneven portion of surface is due to missing gel coat, the kit may be all that is required for repair. If the damage penetrated into underlying areas you will need to first fill the gouge and then finish with gel coat kit.

If you're dealing with a fracture, you'll need to grind or gouge a "V" or "U" shaped groove on the fracture line. This can be accomplished with a Dremel® type tool or even a sharp edged screwdriver held at an angle. Do not try to go too deep. It's better to sand away gel coat further from the fracture to provide create "V" shaped area.

Tape hull around damage, approximately ½" out from edge of damage. This will limit area to be sanded. Lightly sand gel coat within tape with extra fine sandpaper. Wipe clean with solvent.

Exterior Hull Repair
Fill gouge with a 2 part epoxy paste adhesive, readily available at hardware and marine stores. Mix parts equally and spread mix into gouge. Make sure final surface is lower than surrounding gel coat to allow installation of layer of gel coat over repaired surface. Allow adequate time for putty to cure as specified by manufacturer's instructions.

Gel Coat Repair
Rough up top surface of filler with extra fine grit paper. Mix small amount of gel coat with catalyst as specified by manufacturer. Multiple thin layers of gel coat are better than one thick layer. Stir thoroughly.

Apply catalyzed gel coat to damaged area spreading thinly. As first layer of gel coat cures it will lose its' shine. Once layer is dull, apply second layer. Make sure there are no air bubbles in new gel coat.

When gel coat is level with original gel coat, spread a slim edge onto existing gel coat to cover scratches from sanding. A flexible spreader works well to feather new gel coat with old.

TIP: To reduce finish sanding, take plastic wrap and spread smoothly over final gel coat layer, pressing gently with fingers to smooth gel coat. Tape plastic tight over gel coat and allow gel coat to cure. Remove wrap before sanding.

To bring up gloss in gel coat, wet sand surface starting with 220 grit and proceeding to 400 to 600. You can't use too much water. Sand with a light hand and in a circular motion. The more you sand the shinier the finish and the more durable the repair. If a "factory-quality final appearance is desired, finish with rubbing and then polishing compound. Allow gel coat to cure for 24 hours before use.

Clean Up
Please properly dispose of all used materials. Resin is potentially flammable and should be handled with care. Please respect and abide by local disposal regulations.