Composite Repair supplies list

1. Clothes that you don’t care about (or a long sleeve Apron)
2. Disposable gloves (quality ones that aren’t paper thin)
3. Acetone or lacquer thinner
4. Rags
5. Dust Masks for sanding (3M 8511 series recommended)
6. 60 or 80 Grit sandpaper
7. 120 Grit sandpaper
8. 180 Grit sandpaper
9. (possibly 220, 320, 500, 600, 800, 1000, or 1500 grit sand paper as well if you want a semi-polished look)
10. Craft paper/paper grocery bag/thin box (template/pattern for cutting out cloth)
11. Masking Tape
12. Masking Paper
13. Resin Part A (West Systems Resin #105 or similar)
14. Resin Part B (West Systems Fast Hardener #205 or similar)
15. Resin Part B (West Systems Slow Hardener #206 or similar)
16. Digital Scale, 1 gram precision (or 0.1 gram precision if using a resin with a high resin:hardener ratio, like higher than 5:1)
17. Mixing Cups
18. Mixing Sticks
19. Disposable ‘chip brushes’ (not foam brushes)
20. Carbon or Fiberglass cloth (or possibly Kevlar, but only if required as it cannot be sanded and is much less forgiving of mistakes)
21. Sharp Scissors (high quality fabric scissors are worth their weight in gold)
22. Peel Ply
23. Long bladed, light duty utility knife
24. Short bladed, heavy duty utility knife
25. Extra knife blades
26. Putty knife
27. Spray Paint, Spar Varnish, or Gel Coat
28. (optional) Hand held Disc sander or angle grinder with sanding head and rough sandpaper (60-80 grit)

CompositeEnvisions.com is a great website for carbon cloth, peel ply, and most other things needed for repair

Before you begin:

Please read all the way through the instructions prior to starting and look ahead 2-3 steps as you go along. Subsequent steps may require prep or be time sensitive – especially when dealing with mixed resin. Make sure you know what to do and are ready to complete several steps at a time when needed.

If you’re new to this, it’s a good idea to do a trial-repair (or 2 or 3) until you get the hang of working with resin and cloth. There is an art to working with composite materials and your 20th repair will be much, much prettier, durable, and lighter than your first. If you are doing this for the first time, its best to get beginner mistakes out of the way on a dummy-repair that doesn’t matter. Otherwise you may have a lot of sanding in your future to smooth over your mistakes ☹ Try to find a surface that mimics the approximate contour of your repair like a box, bucket, jar, water bottle, and have a couple go’s at it before you try it on your boat

Prep:

1. Put on gloves, wet a rag, and clean the repair area with acetone or lacquer thinner very well

Failure to clean the repair area well may result in the resin being repelled

1. Sand the repair area with 60 grit – Extend sanding 2” beyond the actual damage (in most cases)

Important – remove all residue by scraping, sanding, or solvent wash, or epoxy will not adhere well

Important – define the boundaries of the repair and take care to not sand outside this area. It will look sloppy if you sand haphazardly.

**Optional** – if you want your repair to be flush with the surrounding hull (typically on repairs below the water line), take the disc sander and dish out an area around the repair so that it is 1-3mm below the surrounding surface, depending on how many cloth layers are needed. (Take special care not to sand Kevlar fabric, as it will not sand. Kevlar must be cut with a sharp blade)

1. After sanding is complete, thoroughly remove all the dust with a dry brush or a wet rag
2. Tape off the area around the repair with masking tape, following your defined sanding area
3. Apply a perimeter of masking paper around the tape to catch drips and runs, and allow a surface to squeegee the excess resin onto.
4. Cut out the appropriate shapes (patches) from the Carbon or Fiberglass cloth
   1. Typically, one or two layers of cloth is sufficient. I most often use 6oz carbon cloth and 1 layer is often enough. For a large or badly damaged area, I may use 2 layers of 6oz carbon cloth. Alternately, if the surface is highly contoured 2 or 3 layers of thinner 3.2oz cloth may follow the contour more easily. My early repair attempts usually had 2 or 3 layers of cloth where I really only needed 1 or 2. In general I’d say start with less because you can always add more if the repair is still soft but you cannot remove layers.
   2. If multiple layers are needed, make a “Bulls eye” of cloth layers where the smallest layer is almost the same size as the damage, then make a larger layer that extends beyond the damage by 2” if practical (in tight areas, a lot of extra cloth is not always practical)
   3. If 3 layers are used, make the middle layer half way in between the size of the smallest and largest patch.
   4. Use Craft paper to make a pattern, then cut out the cloth on a table.
   5. Cut the cloth about ½” smaller than the taped off area on all sides. If the cloth extends over the tape, it is hard to remove and obviously creates a bad bond, and the patch will peel off over time
5. Once the cloth is cut out, carefully set it aside in an organized staging area. (Once the resin is mixed, you don’t want to waste time figuring out which piece goes where or replace damaged/frayed pieces)
6. Cut out Peel Ply to extend beyond the patch about 3” on all sides and place with the matching pieces of carbon cloth. It does not need to be very precise.

Note: Prep is 60% of the work! A half-assed prep job will lead to a half assed repair!

Glassing

1. Gather all the necessary supplies and organize them so that everything is staged and easy to access. You’ll need: Pre-cut cloth, pre-cut Peel Ply, Resin part A, Resin Part B, scale, stir sticks, masking tape, extra gloves, chip brushes, garbage can, flexible squeegee, shop towels
2. Decide if you’re going to use 205 fast hardener or 206 slow hardener. If the temperature is below 70°, you should likely use 205. If it is going to be below 60°, you must use 205. If the temperature is in the upper 70’s or higher, 206 will give you more working time. Also consider the following factors:
   1. Resin cures faster with higher temperatures
   2. The working time of resin varies a lot depending on how much resin is mixed at once, the shape of the container, the temperature outside, exposure to sunlight, and how quickly the resin is spread out on to the surface or fabric. (more surface area = more heat radiates into the air = less retained heat from the exothermic reaction = slower cure)
   3. In general, you can expect 5 minutes working time with 205, and about 10 minutes with 206, less in hot weather, more in cooler weather.
   4. The curing action of resin is Exothermic, meaning it creates its own heat. This is important because if you mix a lot of resin together (even small amounts in a cup), it can get very hot and gel very quickly, making the resin unusable. Remember that large batches of resin can cure very quickly!
   5. Once resin “Kicks” or begins to turn from a liquid to a gel, it becomes unusable to saturate cloth. Be aware of when your resin begins to gel. Once you notice it, you have very little working time left! In some cases, just a handful of seconds if its warm out.
   6. Partially ‘Kicked’ resin can be used to back fill holes if you do not have resin thickener
   7. In general, use 206 hardener if you are new to composite repair and the temp is above 65 for at least 4-6 hours.

Note: You can lay down multiple layers at the same time, as long as the resin has not ‘blushed’. Blushing is a chemical process whereby Amines come out of solution and create a cloudy appearance on the surface of the cured resin. ‘Amine Blushing’ happens near the end of curing (when it is in the solid state) and inhibits the ability of subsequent layers of resin to adhere to the first layer. To ensure proper bonding between layers, lay up all layers at one time before blushing occurs, or, wait for the first layer to fully cure, wash with acetone, sand with 80 grit, and layup the next layer.

1. Put on clothes that you do not care about. Resin generally ruins anything it touches
2. Prepare a chip brush: cheap disposable brushes often shed bristles during use. Pull on the bristles with moderate force and shake the brush out to remove the loose bristles. (When the bristles come out during the repair, they’re annoying to remove when soaked in resin).
3. Put on disposable gloves. Stage a 2nd pair in case you rip one. Resin covered fingers are no fun.
4. Decide if you need to back-fill any deep grooves, holes, creases ect.
   1. Holes need to be back filled if, when the cloth is pulled tight, there would be a pocket of air beneath the fabric. This is most often needed on convex surfaces (like the bottom of a boat) when they take an impact. Often, the impact will create a divot in the hull. If the cloth is just stretched over the recess without back fill, that will create a weak spot that is likely to puncture again.
   2. To back fill a divot, mix a small amount of resin (probably <18 grams total) as described below, and stir in thickener until you have the consistency of mayonnaise.
   3. Get a popsicle stick, paint stir stick, or something to smoosh the filler into the divot
   4. Use a flexible squeegee to smooth and flatten the thickened resin. It should be even with the undamaged surfaces adjacent to the divot
   5. Wipe off any excess thickened resin from around the fill area with the squeegee or putty knife
5. Turn on the digital scale, change it to grams, zero the scale with the mixing cup on it.
6. If using West Systems 105 epoxy, add 5 parts resin to 1 part hardener by weight. If using another Epoxy, follow the directions on the can for the ratio of resin to hardener. Its better to mix multiple small batches than 1 big batch in general, but I try to mix enough to wet-out the entire patch in 1 batch, unless it’s a large repair)
   1. Examples:
      1. 5 grams resin, 1 gram hardener
      2. 25 grams resin, 5 grams hardener
      3. 50 grams resin, 10 grams hardener
   2. As soon as you add the hardener, you’re on the clock! You only have a few minutes to use the resin so move efficiently, but not hastily.
7. As soon as the hardener is added, vigorously stir the mixture for about 30 seconds, but try not to add too many air bubbles (some bubbles are fine, but you don’t want it to look white and foamy) be sure to get all around the bottom and sides, because *unmixed resin will never cure!*
8. Brush a light layer of resin onto the surface
9. Lay the first layer of cloth onto the surface (remember, start with the largest patch first for multi-layer patches)
   1. Try not to move it around too much as it will tend to fray around the edges and distort the shape. If you need to push or pull the cloth, do not work the edges as it will cause the cloth to fray and come out of the basket weave.
10. Brush on enough resin to saturate the cloth. Fiberglass will become transparent when wet out.
    1. It helps wet out the cloth if you ‘push’ the resin into the cloth as opposed to brushing it. Use brushing motions to spread the resin and pushing motions to saturate the cloth.
    2. Use caution around the edges of the cloth, as the brush will pull strands of the fiber out of the cloth weave, leaving you with a distorted shape or stringy hairs coming off
11. If your resin Kicked / Gel’d mix a new batch
12. If you can still use your first batch of resin, lay down the 2nd layer of cloth (if needed)
13. Wet out the 2nd layer with resin (if needed)
14. If your resin kicked and you have a 3rd layer, mix new resin (if needed)
15. Lay down the 3rd layer (if needed)
16. Wet out the 3rd layer (if needed)
17. Manicure the patch as much as possible. Make sure it is pressed securely into concave corners, as it can pull up if you move the patch around during brushing. Poke at air bubbles between layers with something sharp (like a grill skewer or utility knife blade) and see if you can work them out. Don’t take too much time though, because the peel ply needs to be applied while the resin is still in its fully liquid or early gel state.
18. Lay the Peel Ply over the patch, extending at least 3” beyond it on all sides.
19. Take a flexible squeegee (like a Bondo knife) and carefully squeege the excess resin from the middle towards the masking paper on all sides of the patch. Be sure not to pull or move the fabric with the squeegee. Hold the peel ply in place with your other hand to provide an anchor for it. Do not over-squeege. The cloth will suck in air bubbles if too much resin is removed
    1. The goal here is to remove as much resin as possible while still having wet cloth. Resin adds no strength, only weight, and excess resin actually makes the patch weaker. Wipe the resin outside the taped off area similar to how you wash your car windshield with a squeegee.
    2. Be sure not to allow the peel ply or cloth layers to slide laterally at all – this will screw up all your work to this point! The cloth may wrinkle, get pulled over the taped off area, or pull out of concave corners if you are not careful!
20. Once the resin is squeegee’d out, you can tape the peel ply in place to prevent the wind from blowing it, or, if you’re doing repairs on both sides of the boat, it will hold the patch in place until it cures.
21. Repeat the Mix resin/Lay cloth/Wet out/Peel Ply/squeegee/tape-in-place procedure for the remaining patches
22. Clean up!
    1. Watch for runs! If you can find them and wipe them off while they’re liquid or semi-solid, it saves a lot of work later
    2. If you need to get resin off your hands, Acetone or Lacquer Thinner is about all that will work, and even then it doesn’t work great. It’s much better not to get it on you in the first place!

Removing the peel ply and shaping the resin while it’s still semi-soft

1. Wait until the resin is just barely tacky to the touch, probably between 1 and 8 hours after mixing depending on the temperature and which Hardener was used. Temperature plays the major role here.
2. Slowly peel up 1 corner of the Peel Ply. The resin on the boat should not move, should not pull up, and should not lift any fabric with it. If the Peel Ply lifts any resin or cloth from the boat, the resin is not cured enough yet. Wait another 30-60 minutes and check again.
   1. When I say ‘lift from the boat’ I mean resin that is not fully cured will create small hair strings between the cloth and peel ply, similar to melted cheese strings on a hot pizza, or pulling gum off your shoe. If you see any of those, you’re not ready to proceed.
3. Once you can peel up a corner of peel ply without lifting any resin or fabric, you can remove the entire sheet of peel ply. The surface should be relatively smooth with just the peel ply texture on the surface
4. Pull the tape – carefully!
   1. Pull the tape slowly and watch for strands of fabric that were caught outside the patch area. If a strand starts to pull up, take a sharp knife and cut it as close to the surface as possible
   2. If any fabric got pushed over the tape, you must take a very sharp knife laying down almost parallel to the surface, and cut inwards towards the patch until you get through the tape. From there, angle the knife upwards and cut out of the patch. Obviously, you don’t want tape to be the primary bond of your patch! That would create a weak spot and the patch would start to peel from there over time. You must ensure no tape is under the patch at the edges!
5. If you catch the resin at the perfect time, you can shave off any high spots with a sharp knife. Its easier to do it now than when it cures!
   1. The perfect time is basically as soon as its possible to cleanly remove the peel ply. At this point, the resin is 90% cured, but not all the way hardened. This 3/4-hard state of resin is much, much easier to shave and cut than 100% hard resin (its state after a day or so).
6. If the resin hit a high spot in the tape and has a blunt/sharp edge, now is the time to cut it down at a shallow angle. It will make smoothing with sandpaper much easier tomorrow! Also, it is nearly impossible to sand a smooth blend from a blunt transition line. If you can even get a little taper to the edge, it makes blending easier and better looking in the end.
7. Let the resin cure fully (Usually about a day. It can be as little as a few hours in hot weather, or up to a couple days in cool weather)

Final smoothing and sanding

1. Before you begin, put on a quality dust mask! Breathing micro fibers of epoxy, carbon, or fiberglass is dangerous! Spend $5 on a single dust mask. The cheapo $0.50 masks are worthless. Your lungs are worth the extra couple bucks. I highly recommend the 3M 8511 series dust masks with exhaust valve that are available at most stores like Home Depot, Lowes, Sherwin Williams, etc. Make sure you use both straps on the mask or its worthless.
2. For flat or Convex repairs, get a rigid (stiff backed) sanding block and load it with 80-120 grit sand paper
3. Try to knock down the high spots in the patch with the coarse sand paper but don’t allow it to dig in too deep in the flatter areas
4. Once the high spots are flattened smooth the patch with 150, 180 or 220 grit sandpaper
   1. If you’re using gel-coat repair for your top coat, you can probably stop at 150 or 180 grit depending on how nice you want it to look
   2. If you’re going to clear coat the patch or use spray paint (or any other thin-bodied finish), you probably want to sand it to at least 220 grit and maybe higher.
5. It is recommended that you paint the patch with either an opaque paint or at minimum a clear Spar Varnish to provide UV protection. Over time, Ultraviolet light from the sun will degrade the epoxy and cloth. After about 600 hours of sun exposure, the composite becomes about 30% weaker, so it’s a good idea to clear coat or paint the patch.

Drink a beer to celebrate your resounding success, or drink a few beers to numb the pain of your terrible failure ☺

Hopefully you were successful and back on the water!

Happy Paddling,

Marcus