

CAUTIONS / INSTRUCTIONS

EPOXY

Epoxy is used for many purposes in the building of your boat. It is used to join wood, bond fiberglass, fill gaps, and seal the wood. We supply epoxy from Raka Boat Building Supplies. Epoxy is a two-part adhesive that consists of a resin and hardener. Different resins and hardeners provide different characteristics of strength, rigidity, and cure time. To simplify your building, we have supplied only one resin and one hardener. The resin that we supplied, labeled 127, is a general-purpose resin with excellent properties for boat building. The hardener, labeled 350, is a non-blushing hardener that gives a slow to moderate cure time. This is the only hardener that you'll need.

The resin and hardener mix at a 2:1 ratio (2 parts resin to 1 part hardener). It is critical that an accurate mix ratio be obtained. If too much hardener is added to the resin it will never cure to a hard material. To help ensure that the correct mix ratio is obtained we've provided mixing pumps (one with a restrictor to be used with the hardener), graduated 250ml cups, and small syringes for mixing varying amounts of epoxy. The mixing pumps can be used for dispensing epoxy hardener and resin into the graduated cups (this provides a double check on the volume). For mixing amounts of epoxy less than 60 milliliters (*ml*), fill one syringe each with resin and hardener (not mixed) and use these to dispense the appropriate amount to a mixing cup.

Straight 350 hardener mixed with the 127 resin will provide approximately a 30 minutes pot life at a temperature of about 75 degrees depending of the size and shape of the container.



CAUTION!

The following section on curing contains very important information. Please read, and understand it thoroughly before proceeding.

Curing

Epoxy cures through a chemical reaction between the hardener and the resin. Different hardeners and resins will cure at different rates. The rate of curing is also highly temperature dependent. There are two different stages of curing. The first stage is when the epoxy is wet, before it loses its tackiness and can be worked with. We'll refer to this as initial curing. Full curing, when the epoxy has reached its full strength, typically occurs after one week.

Using 127 resin and 350 hardener will result in an initial curing time of about 24 hours at a temperature of 70° to 75°f. At this temperature full cure will take about one week. Epoxy cures faster in higher temperatures and slower at lower temperatures. Throughout this manual we've provided time frames for completing the next phase of work, you'll often see a time frame of 18 to 24 hours. You should view this time frame in relation to the temperature range that you're working in. If you can't get to the next phase of work within the above time frame you're better off erring on the side of caution and sanding all the epoxy surfaces before putting on the next layer.

If you need to speed the curing time of the 350 hardener, we recommend either 1) draping a tarp over your work and using a small space heater to raise the temperature to 90 degrees to 100 degrees (be very careful to avoid fire hazards), or 2) setting your work in direct, hot sunshine (this appears to work best).

Epoxy Additives

We have included pre-mixed additives with your epoxy kit. These are fumed silica (Cabosil), microballoons (glass micro-bubbles), and two types of wood flour. They are pre-blended to produce the desired results for each application. Use the appropriate amount of the specified additive for each step. Be careful not to breathe in the dust. It's a health hazard.

MIXING RATIOS

We have included recommended mix ratios for fillers for each task. Each use also has a description of the final consistency. The amount that you add should be based on obtaining the right consistency. You may need to add more or less than stated based on temperature and other factors. **Where an amount of epoxy is specified in the directions, it is the amount of unthickened epoxy. The amount of additives will increase the final volume, potentially to more than double.**

Straight Epoxy - Used with no additives, just resin and hardener. The epoxy included with your kit uses two parts resin to one part hardener (2:1).

Joint Gluing Mix - Add at a total volume approximately equal to the volume of epoxy (100ml epoxy + 100ml filler). Gradually add the filler while mixing until the desired consistency is obtained. Mix the fillers into the epoxy well, stirring for one to two minutes. The epoxy should be the consistency of honey. If not, add a little more thickener until it reaches the right consistency. It's better to be a little thin than too thick.

Filet Mix - Add filler at a total volume approximately equal to 125% the volume of epoxy. Gradually add the filler while mixing until the desired consistency is obtained. Mix the fillers into the epoxy well, stirring for one to two minutes. This mix should be thickened enough that it does not run, similar to the consistency of peanut butter.

Using Syringes and Caulking Tubes

Two syringes and an empty caulking tube are included in your kit for applying epoxy. These are used for getting epoxy into joints and filleting seams, respectively. The tip on the caulking tube will have to be trimmed to apply a 1/4 inch bead.

It is intended that you reuse the syringes and caulking tubes. To clean uncured epoxy from the syringes after use, remove the plunger and replace it fully several times to clear epoxy from the tip of the syringe. Then, carefully wipe the epoxy from the plunger and inside of the tube. You may need to use a tooth pick or other small implement to finish cleaning epoxy from the tip of the syringe. To clean the caulk tubes, use a small (1/4" diameter or smaller) dowel to push the plunger back out of the tube. Use the dowel and a couple pieces of paper towel to clean the plunger and the tip. Don't worry about the thin film of residual epoxy left in the tube.

Safety Precautions

Epoxy is a wonderful material for use in boat building; however, it is not without its health risks. Every precaution should be taken to make sure that you do not get epoxy on your skin or in your eyes. If you do get epoxy on your skin use a waterless hand cleaner to remove it. Never use acetone or other solvents to remove epoxy from your skin. Your kit includes disposable gloves that you should use whenever you're handling epoxy. You should also use safety goggles that prevent splash and an apron or Tyvek® coverall whenever using epoxy.

The second hazard of epoxy is breathing the vapors while it's curing. We strongly recommend that you wear a respirator with an organic vapor cartridge (paint cartridge) whenever you're using epoxy, or

working around curing epoxy. Good ventilation should always be provided when using epoxy. Sanding dust from epoxy can produce similar reactions to un-cured epoxy. A dust respirator should be worn whenever you're sanding epoxy.

Acetone can be used to remove un-cured epoxy from virtually anything other than yourself. Be careful when using epoxy to not splash and on easily damageable items. Acetone removes un-cured epoxy but will also remove paint and other coatings from equipment and nearby objects that get slopped. Cured epoxy is impossible to remove except by sanding, filing, cutting, etc.

WOOD DUST

Wood dust is a known carcinogen. Whenever sanding or cutting wood, a dust respirator should be worn. The amount of cutting involved in building your kit boat is not enough to warrant use of a dust mask. However, you should wear a dust mask when sanding wood or epoxy.

PAINTING / VARNISHING

Whenever painting or varnishing, an organic vapor respirator should be used. It is well known that the vapors from paint or varnish can be hazardous your health. Good ventilation should also be used whenever painting or varnishing. Please follow manufacturer's recommendations on the label for the paint and /or varnish that is provide with your kit.

TIMING

Due to the bonding characteristics of epoxy, some stages in the building process require that certain steps be followed in a timely manner. Where a time frame it is listed it must be followed without failure or the boat may not be structurally sound. Please make sure that you plan ahead when starting each step to make sure that you'll have time and will be available to complete any additional required steps within the listed time frames. Each time that is listed covers all the steps to the preceding time. All of the steps included in each time frame must be completed together as a continuous process. Allow yourself extra time in the event that things don't go as smoothly as you would hope.



CAUTION!

This last step is critical. The importance of proper bonding between epoxy layers cannot be over stressed. If there is not a good bond between layers of epoxy, fiberglass or parts will delaminate resulting in potential structural failure of the boat.

UNPACKING

Carefully unpack the materials that were shipped to you (you have selected the area to use for building, right?). The large wooden box contains the wooden panels and most of the other materials that you'll assemble to make the boat. Your epoxy and varnish will be shipped separately because they are hazardous. If you chose the option to build your boat with forms you will have a second box that contains the wooden form parts. If you decided to paint the outside of your boat, the paint will have been shipped with the varnish.

Panels

- ' Unpack the box with the wooden panels. Take the panels out of the box and lay them out on the floor of your work area. Place the panels in the appropriate order as shown in the plan included with the manual. All of the panels are shipped with a label on the inside face corresponding to the



Figure 1 - Panel layout

- plan.
- ' Your forms will be packed with the boat panels. The forms will be labeled as shown on the plan. Two of the forms become bulkheads that remain in the boat permanently.



Be very careful when handling these parts as the scarf joints that are precut are very delicate. It is very easy to break the ends of these joints before assembly.

- ' You may notice that the panels have some fuzz and wood shavings hanging off the edges. You can clean this up using some 150 grit sand paper and lightly going over the edges.
< **Time: 2 hrs.**
- ' At this point, we strongly recommend that you sand the faces of all the panels using 150 grit sand paper. Doing so will provide a much finer looking finish on your final boat.
< **Time: 2 ½ hrs.**

Other Materials

A packing list is included with this manual for the items included in your kit. Please refer the packing list and check off each of the items as you unpack the box. After verifying that all of the materials are present, carefully re-package everything except the form pieces and hull panels.

JOINING PANELS USING SCARF JOINTS

This section describes the method used to joining the scarf joints in the hull and deck panels. The scarf joints are used to join sections of wood forming single panels the full length of the boat. We use stepped scarf joints that are self aligning to make your building easier.

MATERIALS REQUIRED

- ' approximately 90 ml epoxy, in all
- ' joint glue epoxy filler
- ' mixing sticks
- ' mixing cup
- ' clamps
- ' wooden clamping blocks
- ' plastic wrap
- ' foam brush
- ' gloves
- ' respirator
- ' apron/Tyvek® coverall
- ' sander with 100 grit paper

OVERVIEW

- T Prepare area.
- T Align panels.
- T Prepare plastic wrap and clamps.
- T Apply epoxy to joints.
- T Apply joint glue mix to joints.
- T Lineup joints.
- T Clamp overnight.
- T Clean joints.

PROCEDURE

1. Prepare area

" To help properly align the joints you can join the panels on the floor and use weights to hold the joints together.

' **Time: variable**

2. Align panels

" Panel alignment is critical to having tight seams on your boat. If the panels aren't aligned they will vary from their intended shape allowing gaps spreading from the joint that wasn't properly aligned. Fortunately, with the stepped scarf joints that we use, panel alignment is fairly easy. Lay out the panels on a flat surface. Line the panels up with the scarf joints overlapping, press them together and they should butt tight. If the seam at the end of the scarf joint doesn't close completely tight, check to see what's holding the joint apart. It may be possible to carefully sand some wood away to get the joint tight. If not, the epoxy will help hide any line.

' **15 - 60 min.**

3. Prepare panels for epoxying.

" Tear off pieces of plastic wrap large enough to wrap around each joint. You'll need a piece of scrap wood that you can place over each joint to apply even pressure with the weight. Place clear tape along each edge of the joint (on both sides of the wood) to be joined. Four pieces are required per joint, 2 for each side (see Figure 2). Epoxy that squeezes out of the joint will be on the tape rather than glued to your wood. You want to have everything ready once you apply the epoxy. If you're messing around to find clamps and plastic wrap after the epoxy is mixed it will start curing and you'll end up with a weak joint or wasted epoxy.

' **Time: 30 min.**

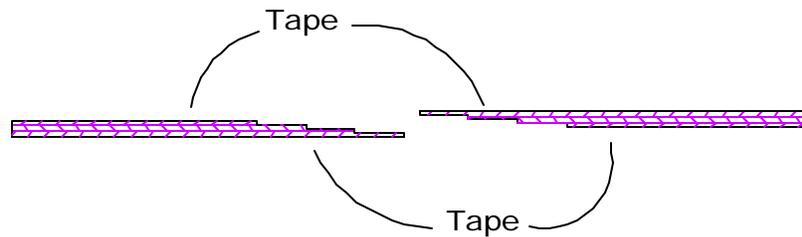


Figure 2 - Scarf joint prep



CAUTION! Make sure that you have your materials laid out before mixing the epoxy.

4. Apply epoxy to joints

" Mix about 30 ml of epoxy (20 ml resin and 10 ml 350 hardener). Use a mixing stick or foam brush to spread this on both sides of the scarf joint that will be joined. Let this epoxy soak into the wood for 30 minutes (by the time you get done coating all the joints and mixing the next epoxy, 30 minutes will be up). This saturates the wood so that joint glue mix won't soak into the wood leaving you with a dry joint. Don't leave this coat of epoxy for more than 60 minutes or will start curing. Lay the plastic wrap under the ends.

" Mix 60 ml of epoxy in a joint glue mix (instructions are provided in the introduction section). You may want to mix the epoxy in 30 ml batches. Using the wooden mixing stick, spread a thin layer of epoxy over one side of each joint.

" Realign each of the joints and press the panels together. As you press them together, slide them back and forth a little bit to work the epoxy around making sure any air bubbles are squeezed out. Don't press the joints together too hard or you'll squeeze out too much epoxy and have a dry joint. You're better off ending up with a slight thickening of the wood at the joint because will be stronger than if you squeeze out too much epoxy.

" Fold the plastic wrap over the joint and place the block of wood over joint. At this point you need to make sure that the joint is aligned then carefully set the weights on them. Make sure that the panels are not bumped once they're clamped.

“ You may want to stack the matching sets of panels on top of each other to help ensure alignment (i.e. the keel panels from both sides of the boat). Join the first set, cover with plastic wrap then set the second set of panels on top of the first as you join them. Check alignment carefully.

' **Time: 2 hr.**

▪ **Allow the epoxy to cure for 18 to 30 hours before continuing to the next step.**

5. Clean the joints.

“ Remove the plastic wrap and tape from the seams. Hopefully there is very little epoxy left on the joints. Use a random orbital sander to remove the residual epoxy and smooth the joints being careful not to sand through the joints.

HULL ASSEMBLY

This section describes the assembly of the hull panels using the stitch and glue method.

MATERIALS REQUIRED

- ' hull panels
- ' form panels
- ' approximately 150 *ml* epoxy, in all
- ' joint glue
- ' wire
- ' pliers
- ' wire cutters
- ' mixing sticks
- ' mixing cup
- ' empty caulking tube w/ ½ inch opening
- ' plastic wrap
- ' foam brush
- ' gloves
- ' respirator
- ' apron/Tyvek® coverall
- ' sander with 100 grit paper

OVERVIEW

- T Cover floor with plastic sheeting (optional).
- T Plastic wrap form and bulkhead panels.
- T Lay hull panels together in matching sets.
- T Drill keel and top side of chine panels using drilling jig.
- T Cut wires to 5" length.
- T Wire panels together beginning with the keel, installing forms as you go.
- T Insert transom at stern.
- T Tighten wires (except transom).
- T Epoxy and joint glue the outside seams.
- T Build up stem and forefoot with epoxy.
- T Remove wires.
- T Sand outside of hull smooth.



CAUTION!

Placing plastic sheeting on a floor can make it very slippery, especially if it gets wet or is not securely anchored. Another potential hazard in using plastic sheeting is tripping over loose edges. Use extreme caution if using plastic sheeting to protect your floor. Use duct tape to fasten sheeting securely to the floor on all edges.

PROCEDURE

1. **Plastic wrap form panels.**
 - " Use plastic wrap to cover each of the form panels to prevent epoxy from sticking. Make

sure to cover all surfaces and edges near where the hull panels will sit. It will help if you use clear tape to hold the plastic wrap in place. Two of the form panels will eventually be used as bulkheads but they should be covered now to allow removal.

Time: 15 min.

2. Layout and wire hull.

- " Beginning with the bottom panels and working your way up (keel first followed by chine and shear), lay each of the 6 panels face together in pairs. Make sure that the good faces that will be the outside of the boat face in (label out). Your panels are cut so that the grain will match up between panels. Lineup each pair of panels so that all edges are even.
- " Using the small wooden drilling guide that came with your kit, begin drilling 1/16 inch holes along the bottom and top edge of the keel panels starting six inches from either end. The drilling guide is sized so that one edge should always be even with the bottom of the panels so that the hole drilled is 1/2 inch from the edge of the panel. After drilling the hole, while the drill is still in the wood, rotate the drilling guide to extend to the next hole position. This process speeds the drilling and makes the hole spacing more uniform.

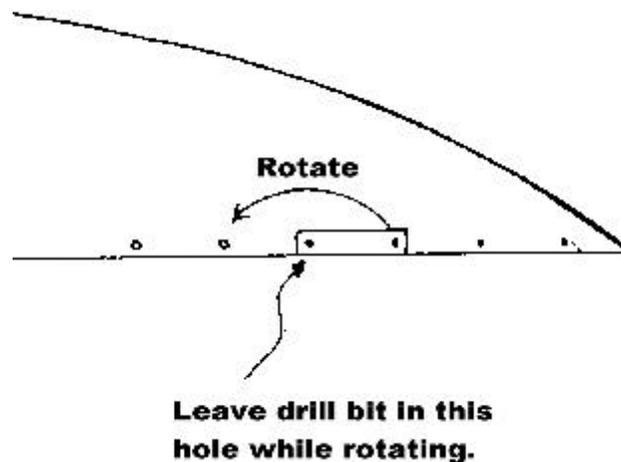


Figure 3 - Proper use of drilling guide.

- " Drill the top edge of the chine panel using the drilling guide as you did for the keel panels in the previous step.



CAUTION!

Only drill the top edge of the chine pair of panels using the drilling guide. Don't drill any holes on the shear panel using the drilling guide. You'll drill the bottom edges when you begin putting panels together. If you drill all the holes all the way around the panels with the drilling guide they won't line up due to shifts during lofting.

- “ Cut the entire roll of wire included in your kit into 5 - inch long pieces.
- “ Reverse each pair of panels so that the good sides are facing out. Wire together the bottoms of the keel pieces by inserting a piece of wire through each hole and loosely twisting it on the outside of the boat.



It will be easier to join the panels if you use sand paper or a plane to slightly bevel the edges that will butt against each other (just the outermost veneer). This provides a surface to join rather than a sharp edge. Don't bevel into the center layer of the plywood.

- “ Wire in the form pieces at the appropriate positions shown in the plan. Each of the form pieces is marked with the location, in inches from the top of the bow. The form panels and bulkheads are wired to the hull panels exactly as the hull panels are wired together. Drill 1/16 in. holes through the keel panels located about 1/2 inch on either side of the location of each form panel. Drill a hole through the form panel about one inch from its edge, matching up with the location of the holes in the keel panel. Run a wire through these holes to hold the keel panels to the form panel and twist them together loosely on the outside of the hull.

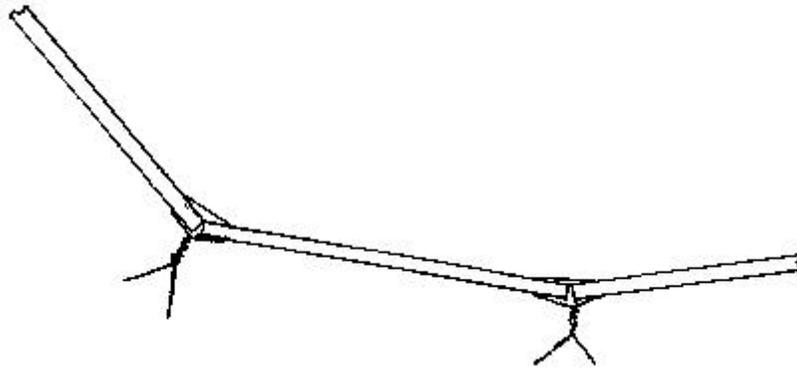


Figure 4 - Stitching the panels.

- “ Align the bottom, bow edge of the chine panels with the front of the keel panels. Drill 1/16 inch holes in the bottom of the chine panels to match up with the holes in the keel panels. Only drill about four holes at a time on both sides of the boat and wire these together before proceeding. Again, do not fully tighten the wires. You need to attach both chine panels at the same time otherwise the boat can twist. After you finish wiring the chine panels to the keel panels, wire the chine panels to the form panels. Next, align the shear panels so that the bottom bow edge of the shear aligns with the top, bow edge of the chine panels and repeat the process that you completed on the chine panels.
- “ Install the transom. You may need to use the block plane to shape the back edges of the transom so that it butts flat against the shear panels. Drill two holes along the stern to wire the transom to the panels. Don't pull these wires tight. You need to leave enough

space to squirt epoxy into the joint.

“ Began tightening all of the wires starting with the keel at amidships. Use a pliers to pull the wire tight then twist the wires snug to the surface of the wood but don't twist so hard that you break the wires. You just want to the wires tight enough to snug pieces together. Work your way to toward both ends alternating from bow to stern. By only tightening two or three wires at the bow then moving to the stern and repeating, you will bring the boat together more evenly. After tightening each seam look down length of the boat from either end to make sure that the lines are straight and fair. This is the time when corrections need to be made.

“ Next, begin tightening the wires that hold the chine panels to the keel panels. Tighten these beginning at the center of the boat and proceeding out as you did with the keel panels. You have to tighten wires on both sides of the boat at the same time otherwise the boat will twist and won't track straight.

' **Time: 6-8 hr.**



CAUTION!

At this point make sure that all the lines of the boat are fair and even. If not, readjust them. This is your last chance to make sure that your boat is right.

3. Turn the hull upside down with the help of a friend.

“ Install the spacers on the tops of the form pieces using the stitching wire. Each spacer is labeled with the form it should be installed on.

“ Set the boat upside down on the floor and check to make sure all the spacers are touching the floor. If any are not, try gently flexing the boat to get them to touch. You may need to loosen some wires to make them all touch.

4. Joining the seams.

“ Mix 60 ml of epoxy (40 ml of resin and 20 ml of 350 hardener). Use a syringe to apply this epoxy to all of the seams and the surface of the transom.

“ Mix 90 ml of epoxy (60 ml of resin and 30 ml of 350 hardener) joint glue mix. This mix should be thickened more than usual so that it does not run. Using the 1/4 inch caulking tube, fill all the seams on the outside of the hull. Make sure to get the epoxy down into the seams rather than just on the surface. Lay the bead of epoxy so that it sticks up a little bit beyond the edge of the plywood panels. You'll sand this back later to make a smooth curve between the panels.



Figure 5
Fairing the outside seams.



The purpose for filleting the seams is twofold, 1) to fill the seams for cosmetic purposes, making them blend with the surrounding panels, and 2) to help strengthen the seams and make the fiberglass lay flat over them.

5. Build up stem, forefoot, and transom.

" The stem is the fore most part of the bow (where you added the spacer previously) and the forefoot is the continuation of that on the bottom of the boat. Where the hull panels end with an exposed edge, the area needs to be built out to provide strength and good appearance. You can do this by laying a heavy bead of epoxy along the exposed section.

" If you have epoxy left over from filleting the seams continue to use it to build up the stem and forefoot areas at the bow and the edge of the transom. If you need to mix additional epoxy, mix it as you did for filleting the seams.

" If all goes well you'll be done filleting the seams at this point. However, you may need to smooth some of them.

' **Time: 2 hrs.**

' **Allow at least 18 hours before proceeding to the next step.**

2. Sand the seams fair.

" Remove the wires by cutting them on the inside of the boat and pulling them out using a pliers. You can rock the pliers against the hull for leverage. If the wires won't release, heat them gently using a soldering iron.

" Preferably, using a random orbital sander with 100 grit paper, begin sanding the outside seams fair. Be careful to keep the sander flat on the plywood panels rather than tipping up onto the seams. Sand all the seams flat with the plywood panels using the random orbital sander, then complete sanding the seams round by hand.

' **Time: 2 - 4 hrs.**

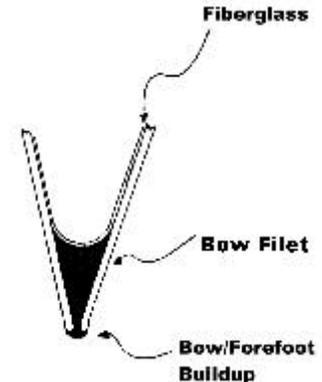


Figure 6 - Stem build up

Unless you're very experienced with a random orbital sander we would discourage you from using it to round the seams over as it's easy to takeoff too much and dig into the joint result in a weak joint and possibly sanding through the surface layer of plywood.