

INVISIBLE BUTT JOINTS (By Dave Carnell)

In 1978 I first used a plywood butt joint of fiberglass cloth and epoxy resin to avoid having to make a scarf joint (not easy and loses length) or use butt blocks (hard to work around). The joint is so thin that careful feathering of the edges makes it invisible.

In 1986 I wrote about the joint in *Small Boat Journal*. About the same time "Dynamite" Payson wrote in *Boatbuilder* about a similar joint concept. Years later I discovered that Joe Dobler had used the principle well before our publication, as had Jack Chippendale in England.

A piece of plywood bent around the side of a boat is carrying most of the load in its outer and inner plies. The load (stress) on the convex side (usually the outer) is a tension load trying to pull the wood apart. On the concave side (usually the inner), the load is compressive—the wood is being pushed together. The invisible butt joint makes two pieces of plywood one by building a skin of fiberglass and epoxy on each side. When you flex the joint, the load is carried entirely by those two skins you have built.

I made joints in various thicknesses of plywood and tested them by breaking them in flexure with the maximum stress applied at the joint. Joints that passed were ones where the plywood, not the fiberglass-epoxy resin joint broke. My design basis for invisible joints in plywood is: for 1/4" plywood, 1 layer of 6 oz. fiberglass cloth on each side; for 3/8", two layers on the top (outside of bend) and one layer on the bottom; for 1/2", three layers on top and two on the bottom; for 3/4", four layers on top and two on the bottom. Make the first fiberglass strip on top 2" wide and each succeeding one an inch wider. On the bottom side make the first strip 2" wide and the second one (if used) as wide as the widest strip on the top side. After you lay up the joint cover it with a piece of 4 mil polyethylene film and squeegee or roll it out. This presses the cloth layers together and feathers out the excess epoxy onto the plywood. Peel the film off after the joint cures and the surface is smooth and faired so that very little filling or sanding is required. If you use woven tape instead of pieces cut from cloth, the selvage may make a ridge at each side of the joint. A joint with a single layer of 6 oz. cloth on each side is about 0.020 in. thicker than the plywood at its thickest point and tapers off to zero at each side. Two layers on each side adds about 0.030 in. at the thickest point. The joint in 3/4" plywood with four layers outside and two inside is only about 0.045 in. thicker at its thickest point.

These joints are designed to use a minimum of material to get the ultimate strength. I would only make them with epoxy resin (not polyester resin) because: 1) epoxy bonds the glass cloth to the plywood in a stronger joint that will not peel apart; 2) epoxy will always eventually complete its cure; 3) there is no fire hazard with epoxy; and 4) there is less of a toxic hazard with epoxy.

Originally, both Payson and I made the joint on one side and turned the piece over to complete the joint. The turning over is fraught with danger of destroying the joint that is very weak at that point.

I have gone to laying polyethylene film on a smooth surface, laying the wetted out fiberglass tape (I use cloth to avoid the selvage) on that, epoxy coating the face of the plywood that goes against that, laying the plywood on the wet tape, filling any least void between the plywood edges with thickened epoxy (this is critical, as any voids between the butting plywood edges can make the joint weak), epoxy coating the upper plywood joint surface, laying on fiberglass and wetting it out, covering with poly film, laying on a smooth board, and weighting the assembly with concrete blocks. In fact, the last time I did it I laid up a

sandwich of two 16' by 20" pieces for the side planks of a sailing skiff and cured them all in one operation.

If you are making joints in plywood thicker than $1/4$ ", make the bottom side of the layup the one with the fewer number of fiberglass strips.