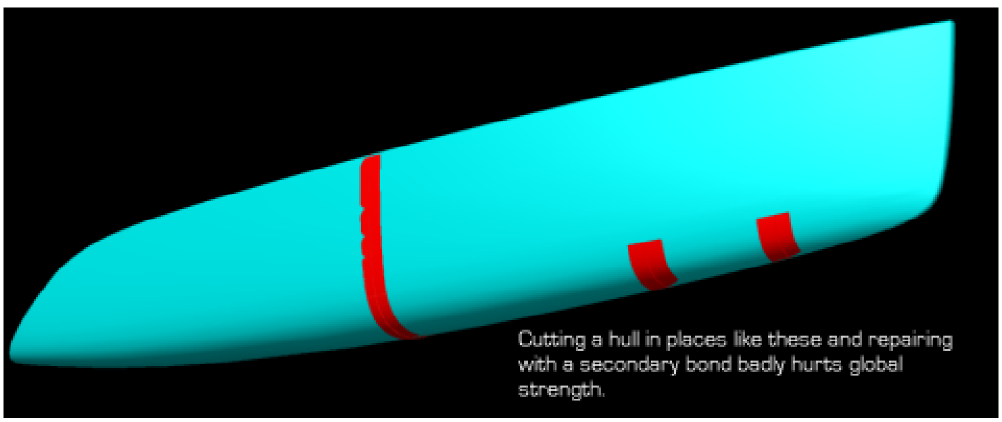
LOOKING AT IN-PLANE PROPERTIES OF GRP LAMINATE REPAIR CONSTRUCTION

There has been considerable discussion of secondary bonding and construction systems that depend on secondary bonding for primary structure lately. I understand that some designers actually bond major globally loaded parts together using secondary bonding. I believe that is a serious mistake. A look at some actual primary source data on secondary bonding might be informative.

A 1996 study of GRP laminate repairs done by Loc Nuyen of the US Navy, Art Wolfe of Structural Composites, and Dr. Ron Reichard, also of Structural Composites shows that the tensile strength of secondary bonded repairs is lower than previously thought. This paper was presented at the 1996 Marine Applications of Composite Materials conference in Cocoa Beach, Florida, USA. Here and elsewhere a repair is defined as any in-plane secondary GRP bond.

This study particularly applies to modern multihulls as they often have long slender components that are heavily globally loaded. The result is much greater in-plane loads than those from out-of-plane such as water pressure. A global load is understood to be one loading the entire hull, such as rigging load or falling off of a wave onto one end of of a hull.

Some of the results noted in the paper were: That 24 oz (800gsm) woven roving repairs performed as well as 40 oz (1350 gsm) ones. Scarphed joints gave results very close to those of stepped ones. No real advantage emerged either way. There was very little difference between hand layup and vacuum resin infusion repair strength in either tensile or flexural. The length of the scarf however had considerable impact. A 20:1 scarf gave about 35% better flexural properties than the worst, a 12:1 scarf. A single lap showed very little difference in flexural and tensile strength compared to a double lap. The choice of resin had great impact on strength. An isophalic polyester resin repair gave tensile strength results of just 33% that of the surrounding laminate. That means that if a multihull part were joined in the middle by a polyester woven roving repair with a 12:1 or worse taper and it did not fail, the surrounding laminate would be at least three times overbuilt. Just cutting the extreme longitudinal fibers, like along the bottom of a hull, and then repairing, will seriously compromise strength. Even the best case, vinyester resin only achieved 66% of the tensile strength of the surrounding laminate. The study was not funded for the testing of epoxy resin but it was expected that epoxy will perform as well or slightly better than a toughened vinylester.



Be careful where you put those repairs! Designers need to understand that in the best case two parts bonded together by a repair or secondary bond will only have about 66% of the global tensile strength of the surrounding laminate. In the worst case it would have only 33% the global tensile strength of the surrounding laminate. That assumes a 12:1 scarph. Less of a scarph or taper could give even worse results. One often hears the argument that “it hasn’t fallen apart yet” to justify lax laminates. That only means that the surrounding structure is wastefully overbuilt.

Designers who disregard this sort of testing do so at risk of failure or waste and excess weight.

I have summarized a 15 page paper into much less space.

I suggest that those interested in the results of this sort of testing contact Structural Composites

Inc. for copies of this paper.