

Production methods – core installation



ALCAN COMPOSITES CORE MATERIALS
2009

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1. Hand Lay-up



The oldest and still most common form of core installation is to lay the core into the open laminate by hand. Most commonly, this involves bedding the core into a resin rich layer of at least 1-1/2 oz of chopped strand mat. This can be done in either a three stage process, or a single stage process. The three stage process is the correct way to do it and is used by higher end laminators, often of larger boats. The three stages are, after applying the gel

and skin coat – 1. Outside laminate, 2. Core adhesive layer and core, 3. Inside or closing laminate. That is, the core is bedded into a bonding layer that is applied to a still “green” outside skin laminate. Since we are focused on the core, we will focus on this installation. The key here is to make sure the core is “primed” with catalyzed resin before it is placed into the bonding layer or adhesive. This priming of the core will force resin into the kerf system, improve the bond and the strength of the laminate, and reduce or eliminating the possibility of water migration through the kerf system. The priming also ensures wet out of the core, filling of any open cells in the core, and a better bond to the mat or core adhesive bedding layer. Priming is best done by a thick nap roller with the core bent over a curved jig to open the kerf system when the resin is applied.

In a three stage lamination process, after the installation of the core and after the core bedding layer gells and approached full cure, it's possible to confirm the bond of the core to the outside skin by “sounding” the core with the handle of a screw driver or putty knife, or even a quarter, in order to listen for hollow areas of poor bond. The core can then be removed from these areas and rebonded. At this point the scrim can also be removed, further testing the integrity of the bond.

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For hand lay-up it is common to use a CK configuration, even on flat surfaces. The individual blocks can be individually forced into the bedding layer, with excess bedding resin or putty, as well as entrapped air forced up into the kerfs. You can visually check for good contact by seeing the priming resin and core bed layer being forced to the surface of the core. CK configurations also don't suffer from "spring back" after lamination, leaving gaps and voids under the core.

After the core is installed, then the closing layer of glass can be applied, with care to fillet all core edges and segregating the core from all openings.

The single stage lamination process, wherein the outside skin, core, and inside skin are applied in one continuous process, without waiting for the previous layer to gel, although common in open mold production boat building, is fraught with potential problems. Air entrapment under the laminate is the most obvious potential ramification, as the closing layer is often applied before all the air has been forced out from under the core. Obviously, the initial bond to the bedding layer has not been tested, resulting in the potential for "never bonds" and resulting voids in the laminate. The vast majority of what surveyors often call "delaminations" in the field were in fact already in the laminate when it left the shop. This is especially true in hot southern climates where the bedding layer can sometimes gel before the core is installed. I have walked around shop floors picking up deck plugs from hole-saw cutouts, and have been able to easily remove the outside layer from the core. Not good.

2. Vacuum Bagging

In order to ensure superior bond to the bedding layer, a vacuum bag can be used to apply as much as an atmosphere of pressure to the core. However, that much pressure has the potential to squeeze out all the bonding adhesive, so generally about half a vacuum is used to bed core. That still amounts to 7 psi or over 1000 Lb per sq.ft. of bonding pressure. When vacuum bagging, it's always advisable to use a

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Core Bond Adhesives, as opposed to bedding the core into mat and resin. The higher viscosity of the adhesive will ensure that it stays in place under that much pressure, and the gel time can be better controlled. With that in mind, when vacuum bagging a core, it's always wise to start with a "core block test" to confirm the working time of the adhesive and priming resin under exactly the same conditions of temperature and catalyzation. The priming resin specifically needs to cure in the smaller masses in the

knife cut kerfs. Vinylester resin has trouble curing in such small masses and should be avoided as a priming resin when vacuum bagging. General purpose (GP) resins are best.

Vacuum bagging can be used to only bed the core (dry bag) or to consolidate the whole laminate (wet bag). However, if the latter, control of the laminate gel time becomes crucial. Therefore, often epoxy resins are used for wet bag applications. In wet bags, the core is generally bedded in the still wet outside skin, rather than using core bond adhesives. Wet bagging can also be staged, with the bag being applied after the core is placed into the wet outside skin. This approach is often taken when laminating over a male plug.

3. Vacuum Infusion

Once vacuum bagging has been conquered, then vacuum infusion is the next logical step. With vacuum infusion, a full atmosphere (14.7 psi) is applied over the whole laminate which has been installed dry. Because you are working with dry fabrics and core, there is no time constraint to lay the fabrics and core in exactly the orientation

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desired. Once the dry full laminate is installed, a vacuum bag is drawn over the full part, and resin forced (sucked) under the bag under a full atmosphere of pressure, wetting out the whole laminate. In vacuum infusion, there are no voids anywhere in the laminate and no “never bonds”, and always exactly the same amount of resin used each time, achieving optimum glass to resin ratios, and consistent predictable physical properties. Vacuum infusion has allowed composites to be treated as a true engineered material, much like steel and aluminum. This is what has allowed the US Navy to infuse the deck house on the DDG-1000 destroyer currently being infused with balsa core and carbon fiber by Northrop Grumman Ship Building in Gulfport Miss.



Because vacuum infusion applies such high pressures to laminates, single skin (uncored) laminates can be greatly compressed. This will result in a substantial reduction in panel flexural stiffness, in spite of the fact that the mechanical properties of the laminate increase. That is, the increase in “E” cannot compensate for the dramatic reduction in “I”

because of the thickness cubed factor in $BH^3/12$ formula. The use of cores in infused laminates greatly reduces this laminate compression factor, restoring the “I” factor to the stiffness equation.

4. Resin Transfer Molding

RTM is not often seen in boatbuilding, except perhaps in the manufacture of small parts such as hatches. The only significant exception is the VEC system developed by Genmar for the building of hulls under 22 ft overall. In RTM, catalyzed resin is driven into laminates at greater than atmospheric pressure using reinforce matched molds. If the mold is heated, rapid turn around of the part can be achieved.

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5. RTM Lite

In RTM Lite, the lighter molds are clamped together using atmospheric pressure, rather than the high clamping pressure of RTM, and the resin itself is forced into the cavity containing the dry glass and core at slightly higher than one atmosphere. The core can be used as the resin transfer media, or special fabrics can be used for this purpose.

6. Prepregs

Epoxy resins have the unique ability to maintain a “B” stage of cure when held at low temperatures. This film of partially cured resin can either be pre applied to a fabric or applied as a separate resin layer in the lay-up process. The laminate is then subjected to high pressure and increased temperature to force the resin through the laminate and affect a cure. This increased pressure and temperature puts some demands on the core. The temperature and pressure have to be low enough that the core does not compress in the curing process, In addition, the core cannot give off gasses in the case of foam cores, or steam or water vapor in the case of balsa cores. PVC cores specifically are prone to out-gassing if not “aged” properly, while some linear cores can be prone to thermal instability. Balsa, although thermal stable at high temperatures and pressure, must be properly conditioned to reduce the moisture content when prepregged.