

or

How to choose the best materials when building with flat panels

Comparing cost and weight of flat panels

By Jeff Wright

Many WEST SYSTEM® customers appreciate the benefits of cored composite construction. They understand that it creates a part that is lightweight, strong, and stiff. We often receive calls from these customers inquiring about using a composite panel when building or repairing something that would normally be made of plywood. Such projects may include a new center console for a fishing boat or the replacement of flying bridge side shields. Determining the best material requires consideration of many aspects of the project, but often comes down to cost versus weight.

Panel types

Plywood Panel construction requires that the panels be cut to fit and then sealed along all the end grain with epoxy. The panels need to be fastened in place with screws, wire ties, or nails. The panels are then bonded together by applying a fillet of thickened epoxy in the joint and possibly applying fiberglass tape.

Composite Panel construction requires the panels to be cut and assembled the same way but with the additional steps of laminating the panel. The lamination process requires a molding surface to be prepared with a mold release and the materials need to be cut to the required shape. The materials are wet out, possibly vacuum-bagged, and then allowed to cure. After the panel is cured, it is removed from the mold and sanded to remove any sharp edges. Any mold release is removed with the appropriate solvent, and the panel is sanded to ensure good paint adhesion. Finally the needed shape is cut from composite panel, just as it would be from the plywood panel.

A variation of composite construction, often referred to as a “one-off construction,” is to build the part using rigid sheets of foam or balsa core material, and then laminate reinforcing fabric to the shaped core. After the laminate has cured, the part will likely need to be faired, before it is sealed with epoxy and painted. The advantage is that one-off construction eliminates the need for a molding surface.

You can reduce the labor and time involved in using composite panels by purchasing prefab-

ricated panels. Baltek Corporation, ATL Composites, and others offer fiberglass balsa-cored and fiberglass foam-cored panels that are available in various thicknesses with polyester or epoxy laminated skins. They can be machined with normal woodworking tools. These panels may cost more than laminating your own, but labor will be reduced.

Composite panels should have the edges treated in a manner similar to plywood. The foam or balsa core should be sealed to prevent moisture from entering. Low-density cores often require thickened epoxy to be applied to the exposed edges to protect them from damage and to provide a good surface for the final finish.

Cost

Before taking on any project, it is always a good idea to budget for the materials. Generally speaking, a composite panel will cost more than plywood. You will need to purchase the core material, reinforcing fiber (usually fiberglass), and epoxy. Some core materials, such as balsa, will absorb more resin than many of the foams, which will also affect the cost of the composite. A simple plywood panel only requires the wood and enough epoxy for three coats of moisture protection. If you use higher quality marine plywood and protect the plywood with fiberglass cloth, the cost difference is reduced. Laminating fiberglass will require more epoxy than simply coating the wood.

Weight

Weight reduction is the most common motivator for replacing plywood with a composite panel. The weight advantage of a cored panel over plywood increases as the panel gets thicker because the lightweight core material increases while the same amount of fiberglass and resin are maintained. When the thickness of plywood is doubled, the weight is doubled. However, if a ½" thick balsa core with 10 oz fiberglass on each side is increased to 1" thick balsa, the weight only increases 60%. On panels less than ¾", a composite panel may not have a significant weight difference over plywood.

We compared the cost and weight of four panel types:

- Epoxy coated XL Plywood Boat Panel
- Epoxy coated Okoume Marine Plywood
- Epoxy/fiberglass/balsa cored composite
- Epoxy/fiberglass/core cell foam composite

Material	Epoxy Coated Plywood Boat Panel	Cost	Epoxy Coated Okoume Plywood	Cost	Balsa Composite	Cost	SAN Closed Cell Foam Composite	Cost
Panel / Core	XL Plywood Boat Panel	\$12	Okoume Marine Plywood	\$21	Contourable Balsa	\$27	Core Cell Foam	\$38
Fiberglass*					2x745 (12 oz) Glass	\$30	2x745 (12 oz) Glass	\$30
Epoxy*	105 / 206	\$9	105 / 206	\$9	105 / 206	\$11	105 / 205	\$10
Total Cost		\$21		\$30		\$68		\$78

Figure 1—Cost comparison of 3/8" x 2' x 4' panels

Material	Epoxy Coated Plywood Boat Panel	Cost	Epoxy Coated Okoume Plywood	Cost	Balsa Composite	Cost	SAN Closed Cell Foam Composite	Cost
Panel / Core	XL Plywood Boat Panel	\$18	Okoume Marine Plywood	\$36	Contourable Balsa	\$42	Core Cell Foam	\$54
Fiberglass*					2x745 (12 oz) Glass	\$30	2x745 (12 oz) Glass	\$30
Epoxy*	105 / 206	\$9	105 / 206	\$9	105 / 206	\$11	105 / 205	\$10
Total cost		\$27		\$45		\$83		\$94

Figure 2—Cost comparison of 3/4" x 2' x 4' panels

*prices based on proportion of 745-10 size of Glass Fabric and B Group of epoxy used to build a 2' x 4' panel.

A cored composite panel can often perform as well as plywood, even though it is significantly lighter. When the face of a panel is loaded with perpendicular force, the outermost surface of the panel experiences the greatest load. This principle is why a lightweight core with thin fiberglass faces can carry significantly more load than the core material alone. The combination of thin skins and lightweight core can result in a panel as stiff and strong as plywood but with a lower weight.

Stiffness

Increasing the thickness of a panel will increase the stiffness exponentially. You can see this with a yardstick. In the flat direction, it is very easy to flex; on edge, it is nearly impossible to bend by hand. Using a core material to increase the thickness will increase the stiffness very effectively.

The type of core material and the fabric used for the skins will also affect the overall stiffness. Using carbon fiber instead of fiberglass will increase stiffness when the core thickness cannot be increased. Different core materials also affect the stiffness. The density of a core material often indicates its stiffness. Foam cores with very low density are not as stiff as foam that is higher in density. The densities of foam can range from 2.5 lb/ft³ to over 30 lb/ft³, giving a wide range of properties. The high-density foams may make for a stiff panel, but the weight advantage over plywood is lost.

Remember that there is a difference between stiffness and strength. Stiffness is often used as the primary measurement when composites are designed for boats. When a panel is stiff enough for an application, in many cases it is strong enough and will have a long fatigue

Material	Epoxy Coated Boat Panel Plywood	Wt.	Epoxy Coated Okoume Plywood	Wt.	Balsa Composite	Wt.	SAN Closed Cell Foam Composite	Wt.
Panel / Core	XL Plywood Boat Panel	8.5 lb	Okoume Marine Plywood	7.5 lb	Contourable Balsa	2.4 lb	Core Cell Foam	1.25 lb
Fiberglass					2 x745 (12 oz) Glass	1.3 lb	2 x745 (12 oz) Glass	1.3 lb
Epoxy	105/206	1.0 lb	105/206	1.0 lb	105/206	2 lb	105/206	1.3 lb
Total Weight		9.5 lb		8.5 lb		5.7 lb		3.85 lb

Figure 3—Weight comparison of 3/8" x 2' x 4' panels

Material	Epoxy Coated Boat Panel Plywood	Wt.	Epoxy Coated Okoume Plywood	Wt.	Balsa Composite	Wt.	SAN Closed Cell Foam Composite	Wt.
Panel / Core	XL Plywood Boat Panel	16 lb	Okoume Marine Plywood	15 lb	Contourable Balsa	4.75 lb	Core Cell Foam	2.5 lb
Fiberglass					2x745 (12 oz) Glass	1.3 lb	2x745 (12 oz) Glass	1.3 lb
Epoxy	105/206	1.0 lb	105/206	1.0 lb	105/206	2 lb	105/206	1.3 lb
Total Weight		17 lb		16 lb		8.05 lb		5.1 lb

Figure 4—Weight comparison of 3/4" x 2' x 4' panels

life. Swim platforms, decks, and hardtops are situations where a stiff panel is needed to resist flexing and eliminate the perception of being soft or spongy. In these cases, the panel is probably so stiff that the strength is higher than needed to avoid a failure.

When composites are used for critical or highly loaded areas, such as bulkheads, stringers, and hull bottoms, strength needs to be considered. Calculating the needed strength requires a good understanding of the loads applied and the mechanics of cored construction. Before using a composite panel, step back and analyze the situation. Then determine how the panel is loaded and what the consequences are of a failure. In many instances, the project is straightforward, but if there are any concerns, contact an engineer or designer.

The Details

Since weight reduction is the most common reason for using a cored composite panel, it deserves a little more attention. Spending some time to calculate the weight savings will help you determine if the results will be worth the time and money.

Earlier we looked at how to calculate the weight of the new panel and compare it to plywood. This may only be part of the overall weight of the entire structure. For example, if the component being built is a seat, then you need to consider the hardware, seat cushion, and insulation on the back to determine the percent weight reduction for the entire assembly. A 40% weight reduction in the panel may only be a 20% weight reduction of the entire assembly. Also be sure to consider any additional hardware backers that you may need since many light cores will not hold screws as well as plywood.

Plywood that is completely sealed in epoxy will last for many years and offers good balance between weight and strength. However, if weight reduction is a priority, cored composite panels may be the ideal material. Be sure to closely examine the time and money required and how much weight will be removed. With careful planning, you can use this method of construction successfully to help lighten the boat. ■

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