BUILD YOURSELF A FOAM BOAT

How To Build Skiffs, Cats, Dinghies in Foam Sandwich

Since rigid PVC foam sandwich construction was introduced to the 18ft skiff class in 1977, both professional and amateur builders have looked to this style of construction across a diverse range of classes - Cherubs, NS14s, Paper Tigers, Fireballs, Flying Dutchmen, Sabots, Flying Ants, Moths, 12ft and 14ft skiffs, and Javelins.

When looking at the advantages of foam sandwich construction, home boat builders in these classes have often only considered increased performance through weight reduction and increased stiffness. But the advantages of simplified construction, increased durability, and greater resale value are often just as important. In this article we will look at the reasons for these advantages, as well as go through the step by step procedures for construction of a foam sandwich craft on a male-moulded, one-off basis.

Planning Phase

Before beginning on such a project with a restricted class, you must first determine whether there are any limitations on materials used in construction which may affect your choice of fibreglass skins, and what effect weight and construction technique restrictions will have on your project.

While Herex rigid PVC foam is not considered an exotic material, some reinforcing materials such as Kevlar and carbon fibre may be prohibited under these controls.

The next decision is the choice of core thicknesses and reinforcing materials and resin systems. This is an area where the staff at High Modulus can assist, but a look at other successful foam sandwich craft of a similar type and a study of the guidelines table on the last page should help you decide.

Setting Up The Mould

The construction of a male mould for most craft is not terribly different from the mould and ribs used in timber construction except that all materials are disposable and therefore cheaper timber may be used. If you are part of a building syndicate, consider using heavier materials for building multiple craft on the one mould.

The station frames are best constructed out of 12 to 19mm particle board (pineboard) used in full sections. The battens or ribs for fairing can be hardwood or pine, should be free of warp and serious flaws and vary in

dimension from 25 x 12mm up to 50 x 25mm, depending on the size of the craft.

Spacing on the mould depends on tightness of curvature and thickness of core. The usual practice is to decrease spacing in tightly contoured areas - spacing can vary from 200mm down to 25mm.

Lofting of the mould is carried out in the usual manner for timber boats but a sample of the finished sandwich laminate, with only the outside skin laid up, should be constructed and measured to determine hull thickness for lofting purposes. Battens may be let into the frames, but if there is significant tumblehome, they should be attached to the outside edges of the frames for ease of de-moulding. There are several proprietary fasteners available for fastening into the edge of particle board. Ensure that the mould is as fair as possible to avoid excessive filling and fairing in later stages of construction.

If you are using a string-tie system of attaching the Herex, build the mould sufficiently off the floor to allow access to the battens from the inside. Cover the building surface of the mould with plastic packing tape to prevent the core from adhering to the mould by resin runs.

Attaching The Herex Core

Attaching the core to the mould can be done in a number of ways, the most popular two being by brass/monel staples, or by tying the foam to the battens with a light plastic twine.

The staple method is sufficient up to 12mm core thickness and staples are used which are about 3mm longer than the core thickness. These should be driven with a compression or air stapler so that the head is flush with the foam surface. Use only just enough staples to hold the foam tightly to the mould as they must pull out of the mould later.

String-tying usually requires two people, one outside and one inside, using a curved upholstery needle larger in diameter than the string itself. Stitch down the length of the battens, jumping from row to row as necessary to conform the foam to the mould.

For hard-chine craft the foam is usually attached on the flat area in two sections, with the topsides in longitudinal sections. Work from the keel to the chine, and chine to gunwale, pulling the foam down in stages. Round-bilge craft usually require narrower sheets of foam worked from keel to gunwale. Multihulls are done with longitudinal sections.

Around the bow of most craft the sections may become too tight to cold-bend the Herex, and thermoforming may be necessary. A hot-air gun (not a hair drier) or a radiant-element heater can be used to heat the foam in place for bending. Use narrow strips, 150mm to 300mm in width, running laterally and attach them first at the keel. Heat the Herex until it becomes pliable and work

it down to the mould, from keel to gunwale, attaching it as you go. Don't try to do too large an area at a time, as the foam cools and becomes rigid rapidly.

Once all the mould is covered, fill any large gaps between sheets with slivers of foam. Tight cracks and butt joins should be filled with a resin putty only if they allow the first laminate to sag in that spot. Otherwise leave these areas for filling from the inside. At this stage, check the foam surface very carefully for fairness. Large bumps can be fixed by pulling down the battens from inside and hollows let out by easing off the foam-attachment devices.

If string is used to attach the foam, carefully fill the holes around the string created by the needle with filler (microspheres, microlight or microballoons). Allow this to cure, then cut off the exposed loops of string flush with the surface. The filler will hold the back of the loops to the mould. Sand any exposed filler spots, then sand the entire surface lightly with 150-200 grit paper. If you are laying up woven fabric direct to the foam you may want to fill the surface lightly with a spreadable filler mixture, using a rubber sqeegee for application, and applying only enough to just fill the cut surface of the Herex. Sand again and you are ready for laminating.

Laying Up The Outer Skin

The subject of fibreglass lay-up technique is broad enough to require another article itself, so we have assumed the builder either has sufficient experience, or can gain it through practice on small objects, or attendance at a commercial or trade course specialising in this subject. Most of the suggested laminates specify woven fabrics, which are generally easier to practice quality control on than chopped strand mat. For the purposes of this article we will only cover the specialised requirements pertinent to foam sandwich construction.

Most of the fabrics recommended are quite easy to drape, wet-out, and maintain accurate glass-resin ratios, but application of Kevlar and carbon-fibre cloths should be discussed with High Modulus.

All materials except Kevlar can be sanded easily but you should aim to avoid unnecessary bulk in overlaps and consequent sanding as this will reduce the laminate strength. You will need to overlap the layers of cloth at least 50mm to avoid a bump in these areas. The foam should be rebated to give a flush finish. This requires pre-cutting and trial fitting of the fabrics, which is recommended.

Easily drapable fabrics should be run longitudinally as much as possible with fabric widths to suit the craft, while hard-to-drape fabrics are run laterally across the hull.

In all instances, except with extremely light fabrics, the Herex surface should be wet-out first with resin before applying the first laminate. However, this is

done as a wet-out situation, not as a sealer coat. A mohair roller is best and resin wet-out varies from 200 to 400 g/m^2, depending on surface condition.

From this point lamination continues normally according to specifications, except that some light fabrics may be put down as two layers wet-on-wet to reduce resin content (and weight). Epoxy resins, with their longer gel times, present no problem, but as a reasonably fast gel time of around 25-35 minutes is recommended with polyesters to avoid over-wetting the foam surface, it is preferable to use a sqeegee to spread the resin and smooth the fabric.

Once the entire hull is laid up the surface can be sanded fair, avoiding excessive sanding on light fabrics, and avoiding any sanding at all on Kevlar. Apply a low-density fairing filler with a squeegee in just sufficient thickness to fill the laminate surface pattern and allow final fairing. (see Making Rough Surfaces Smooth brochure) Sand and finish the surface to the desired level of perfection with oxide paper and allow it to cure thoroughly before painting.

Personal preference determines whether you finish with paint at this stage or after the inside laminate is completed. In either case, a receiving mould needs to be built on the outside of the hull to avoid any movement once the hull is turned and the building mould removed. For a fully painted hull, it is recommended that the surface be treated with release wax and a CSM (chopped strand mat) cradle be laminated to the outside of the hull prior to turning. This cradle can later be the basis of a transporting and rigging cradle, which is necessary to prevent compression dents with some types of foam sandwich laminates.

Laying Up The Inner Skin

Once the hull has been turned in its receiving mould then, and only then, should the building mould be removed. If you used a string-tied system, just cut off the inside loops and remove the mould. If you used staples, try to break them loose from the battens by flexing them inwards until the mould can be moved sufficiently to release all the staples. Some staples will pull through the foam core with little damage, which can be patched with filler and some will remain in the core, where they can be pulled out with pliers.

When the mould is removed, secure the hull against inwards distortion with timber cross braces and determine from your building plans where any highly-loaded fittings will be attached directly to the hull (such as mainsheet blocks, mast steps, rudder fittings, chainplates). In these areas the foam core should be carefully cut out and removed and either a Herex 200kg/m^3 or a timber pad, solid glass, or Coremat insert laminated into this area to prevent compression of the core by attachment fittings.

Go over the entire inside surface and fill any visible cracks, joins, or string holes with filler. Sand and fair as necessary, and use the same laminating procedures to apply the inside laminate to specifications. Overlaps need not

be given the same attention to detail as the outside, but avoid obvious water traps as a clean floor is one of the advantages of foam sandwich. Mark compression plate areas prior to flow coating or painting the interior. A commercial anti-skid additive is recommended on open boats for crew safety. On decked boats, either timber or foam sandwich floors are installed at this time.

Deck Construction

Flat decks can be constructed separately on a flat, releasable surface such as Laminex or Formica while complex decks can either be built on a male mould similar to the hull or in a one-time female mould out of sealed hardboard or plywood. The last system allows the use of gelcoat and the incorporation of anti-skid deck patterns into the surface. Weight will be slightly heavier due to the requirement to bond the core with an adhesive to the cured outside laminate. Tanks can either be built in place or on a separate mould.

Deck/Hull Joining

There are as many deck/hull joining systems as there are builders. For very small craft a butt joint of foam sandwich to foam sandwich with filler and CSM is sufficient. In larger craft and heavily-loaded applications an overlapping flange of solid fibreglass using filler and mechanical fastenings is usually necessary. You must plan this join before starting construction of either deck or hull. A timber sheer clamp may be required in some designs to handle attachment loads. Tanks and bulkheads are glassed in using double bias tapes.

Painting and Finishing

The hull may be painted before turning, but often the hull and deck are painted after joining to cover attachment fairing. Two-part polyurethane or epoxy paints are mostly used and manufacturers' directions on primers and use should be followed. Spray application is a must for good finish. Stick with light colours to hide any imperfections in the finish. Avoid black or extremely dark colours, particularly in decks as you may exceed the resin's heat distortion temperature and the resin will soften.

Fitting Out

This is similar to other types of craft except that all attachment fittings which exert very high compressive loads on the core should be provided with large backing plates or metal spacers matching the sandwich thickness. Very lightly loaded fittings may be attached with self-tapping screws through the laminate. Where compression pads are provided, through-bolting or screws are acceptable.

Avoid glass fittings with loadings perpendicular to the skin directly to the inside or outside of the sandwich. Any large openings cut in the sandwich (self-bailers, transom flaps, and access hatches) should have their edges sealed with resin to avoid water penetration of the laminate.

Care and Maintenance

Maintenance of the finished craft is similar to most other fibreglass moulded products except that additional care must be taken to avoid compression dents by incorrect trailer or roof-rack supports, rigging on rocky ground, or dropping of heavy objects on decks and hulls. Due to the very thin nature of most of the laminates in craft of this size in sandwich construction, they will show the effects of mistreatment by denting long before they show any signs of "softness" or flexural failure.

Repairs to dents are made by filling and fairing, and large impact damage is usually repaired by replacing the outer laminate in that area. Where the core has been damaged beyond salvage, it can be removed and replaced in the area to be repaired. Full penetration of the sandwich will require re-sandwiching the area damaged.

Costs of Sandwich Construction

In terms of resale values, indications are that the foam sandwich craft, given good treatment, will bring much higher prices due to the inherent long life of the structures.

Some Suggested Sandwich Laminates for Skiff and Restricted Classes

Monohulls (3-4.5m)

EC400	400g/m^2 E-glass woven cloth
10-12mm	C70.75 Herex 80kg/m^3 PVC foam
EC290	290g/m^2 E-glass woven cloth

Alternative

EC200	200g/m^2 E-glass woven cloth
KC165	165g/m^2 Kevlar woven cloth
10-12mm	C70.75 Herex 80kg/m^3 PVC foam
KC165	165g/m^2 Kevlar woven cloth

12ft Skiffs/Cherubs

EC130	130g/m^2 E-glass woven cloth
KC165	165g/m^2 Kevlar woven cloth
5-10mm	C70.75 Herex 80g/m^3 PVC foam
KC75	75g/m^2 Kevlar woven cloth

Javlin/14ft Skiffs/Fireballs

EC130	130g/m^2 E-glass woven cloth
KC165	165g/m^2 Kevlar woven cloth
5-10mm	C70.75 Herex 80g/m^3 PVC foam
KC165	165g/m^2 Kevlar woven cloth

Notes:
1. For monohull craft with hard chines, the thicker core recommended is usually used on the bottom, and the thinner on the topsides.
2. Where any woven fabric (cloth) is used directly against the core, the use of epoxy laminating resin or vinylester is recommended.
3. Decks and tanks of monohulls are usually of lighter construction and are not specified due to great variations in individual requirements.
4. Fabrics should be wet-out with the following weight fractions (% of fibre in laminate):
E-glass 53% (eg EC400 400g/m^2 fibre, 355g/m^2 resin)
Kevlar 40% (eg KC165 165g/m^2 fibre, 250g/m^2 resin)

E-glass = 0.6875
Kevlar = 1.5152

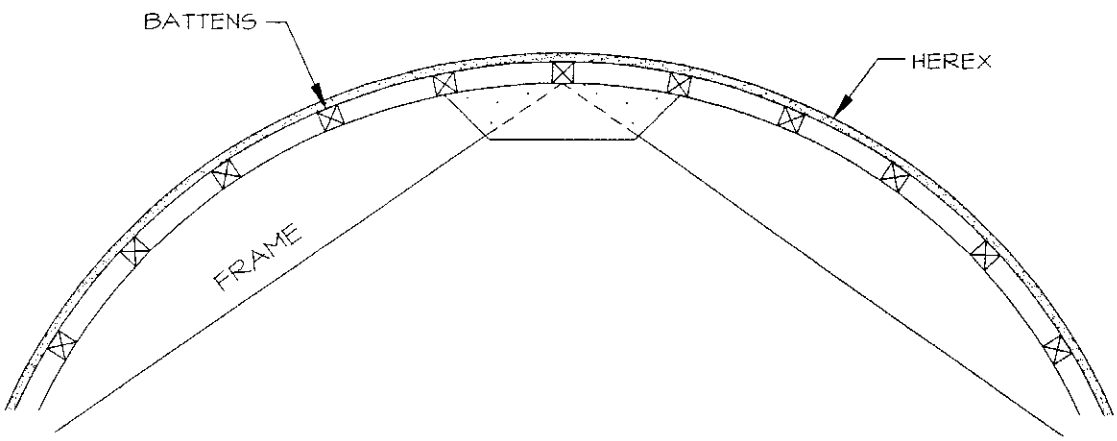

Fig 1.0 Frame & Batten Mould

Spacing of battens depends on the size of craft and the tightness of the hull contours. A rough rule of thumb is about 75mm for 5mm to 12mm Herex increasing to 150mm to 200mm with 15mm to 20mm Herex.