BUILDING THE HARDWARE FOR YOUR STRESSED PLY MOTH HULL.

Phil Stevenson August 2000

Introduction

This has been written to accompany my article on building stressed ply moth hulls, there being sufficient interest in that article for people to need the next step towards completing their Moth. The information should be equally useful for any other narrow moth hull.

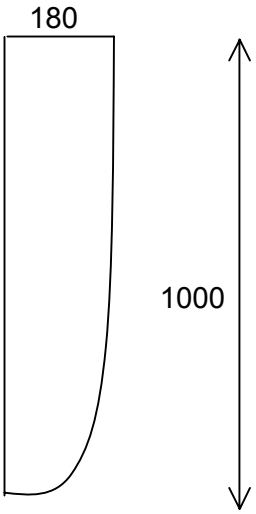
The article is based on extensive use of low cost materials with minimal use of expensive stuff except where it offers great value in terms of strength gains or weight saving. I will however refer to use of high tech items such as carbon tubes, where this is common practice in the Moth class and where my methods are equally appropriate.

Fin and Ruder Blades

I believe that these are more important than the sail in getting a boat to go well. The foils must balance all the sail forces at minimal drag, maximum efficiency and do the job equally well at all speeds and on both tacks. You get only one chance to get this all correct and that is when you build them.

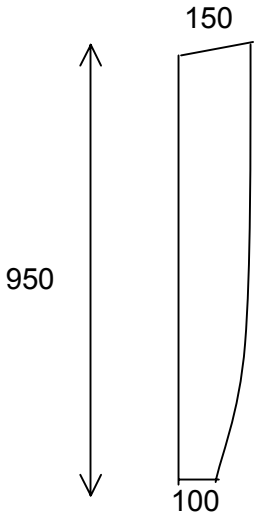
For the home-builder it is simpler to build from wood, because most people have woodworking tools and some understanding of the stuff. Western Red Cedar (WRC) is readily available from plantations and is pretty easy to work with. When WRC is given a light coating of Carbon and epoxy it becomes stiff and durable. Because the wood is harder than foam you can use a thinner layer of carbon so the end result is very little difference in weight.

You need to start by laminating your blanks. Use strips of wood 50 to 75 wide, the more pieces the less likely the blades will warp before they are skinned. See sketches for dimensions.



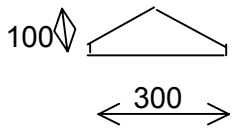
Fin:

NACA 010



Rudder Blade:

NACA 015

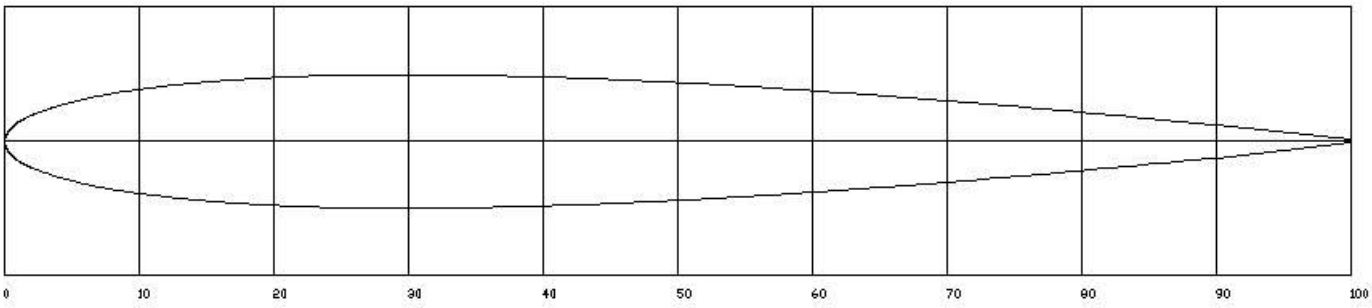


T Foil

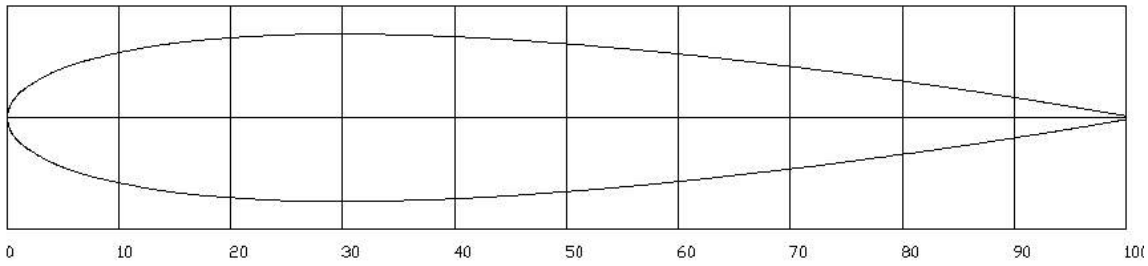
NACA 010

Use these full size templates to make ply profiles for each section. You need a half of the section which will fit one side of the finished shape.

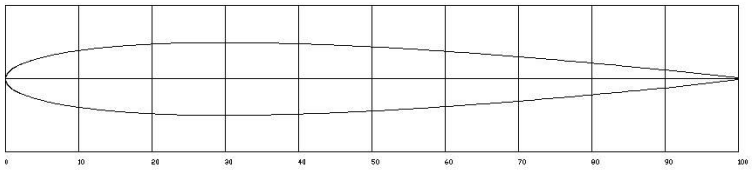
NACA 0010 for Fin



NACA 0015 for Rudder Blade



NACA 0010 for T Foil



Laminating and shaping:

Use medium weight, knot free WRC in strips 50 to 70 mm wide. Glue together with epoxy and sash clamps. Allow to cure.

Cut to the required outline and plane the edges smooth. Mark the centre line all around the edge. Check there are no twists. Then using the templates and a sharp plane remove the wood until the template fits right down one side. Then turn the timber over and do the other side. You need to end up with the LE and TE straight and the profile like the template, and the TE very sharp.

Sand smooth with coarse paper and a large sanding block. Tidy up and you are ready for carbon.

Carbon Skins:

Set the foil up so it is supported on edge, Leading edge up. I nail a piece of 20 x 20 to the top and hold that in the vice so the foil is cantilevered out over the workshop.

I use 90gsm carbon with a square weave. The top half needs two layers while for the rest one will do. This weight is good because it will fold around the leading edge (LE), so you use one piece for each layer. Cut the two pieces of carbon to size, and put aside. Dust the foil, then squeegee on a layer of epoxy thickened with fibre, about 50% as much as you use for gluing. Get a good thin but even coating and use this stuff to fill any small holes in the timber.

Then fold the big piece of carbon in half and drape it over the leading edge. Squeegee it down tight staring about halfway down the LE and working down each side slowly towards the top and bottom and the trailing edge. Squeegee out all the bubbles by wiping diagonally. Add only small amounts of resin to wet out the dry bits. When it is all down flat do the same with the sheet which goes only half way down. Finish by applying some more resin to ensure there are no dry spots. Let this cure, then clean up the edges. Leave about 5mm carbon overhanging the trailing edge of the wood. If you feel that the back edge is too fragile put another strip of carbon on each side, but this will need more filling and may result in a blunt edge.

Now you need to fill the grain of the carbon. Sand off the large bumps of goo but do not sand the carbon or it will go furry. Mix resin and spheres and smooth on a thickish layer. You probably need to do one side at a time and leave it flat. When cured hard sand it smooth and paint it.

The T Foil needs only one layer of carbon for durability. It is glued to the bottom of the rudder before final finishing. You need a couple of 40mm widths of carbon to reinforce the joint.

If all that seems daunting take the shapes to a Professional and get some classy ones. Otherwise you will decide, after you have done your own, that their prices are very fair.

(Anyway, now you will be able to make the fin case and complete the hull.)

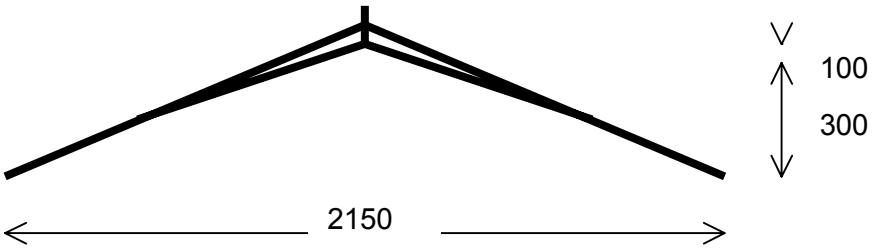
I will not cover the rudder box as everyone has a preference. Go and look at a few and work it out.

WINGS

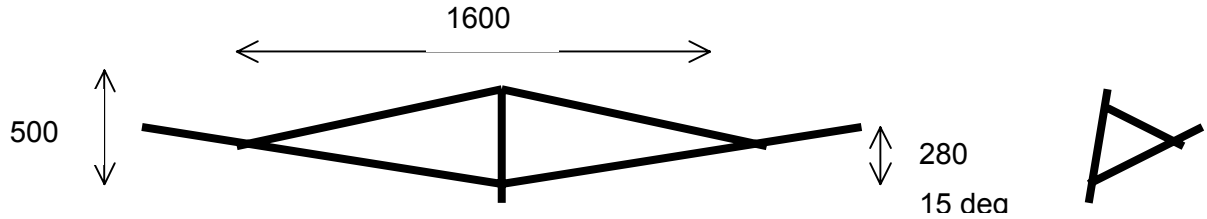
This section will outline how I do it. It is not the only way, but after doing it wrong a few times, I have learnt a few things. This will describe how to use aluminium tube wings. You can use carbon if you have it, the geometry and joints are much the same. Sorry I do not have dimensions for carbon tubes.

The wings come in 4 parts: The main front frame, which takes most of the rig loads, and the rear bar and side seats, which take the crew loads. The front frame is most important and most complex so we will cover it first.

Front Frame



plan



front side

This is the shape. Note how the mast post or stump is raked back about 100mm. This is important so that the vang does not jamb up.

I have used 45mm by 1.2mm wall thickness tubes for the front and back frames. These are thin and I used some doublers about 400 long where the tubes cross the hull gunwales. For the fore and aft 'seat' tubes you need at least 60mm to be stiff enough, but the loads are low so the thinnest wall the better. If you have some thing like 100mm aluminium down pipe it works OK.

I have used glass and carbon to join the aluminium together. These build up to be about 2mm thick and extend about 200mm along each tube. But there are a few important points you need to be careful of:

- Carbon, aluminium and salt water make a great galvanic cell (battery) which will corrode the aluminium away very quickly.
- Epoxy is not good enough to bond to the aluminium tubes.
- You need to be able to pull the whole thing apart, so provide loose joints on the end of each cross beam by wrapping the tubes with plastic before glassing.

So:

- Insulate the aluminium from the carbon with a layer of chopped glass mat. The fibres in the mat help everything bond better.

- Roughen the aluminium where the glass is to go so as to improve the bond. I use an angle grinder with a coarse disk.

- Also use some stainless pop rivets in the bare tube to help key into the glass. The rivets need to be in strategic locations though, where the stress is less, like on the underside of the front main beams, not on the top where the chainplates and crew weight induce high tensile stresses. All the other areas are near the end of the tubes so the rivets can be anywhere under the glass.

- About 4 rivets at each location will do.

You might find it easier to hold the front frame together using some riveted strips of stainless. These can be covered with the glass and carbon to stiffen the whole frame.

The alternative is to get the whole thing welded. It depends on what tools, or skills you have available. If welding, be wary of the stress concentrations around the chainplates and stump joints, you may need thicker tubes.

If you go for carbon tube the diameters are smaller, and the thicknesses larger. I have no experience so go and ask some one who has built some.

As for the actual building, try to make a jig for the front and back frame. When these are assembled fit them to the hull, trim the ends and then make the seat tubes and the joints, remember the plastic on the cross tubes so you can pull it apart.

Wing Mounting

The wings are attached to the hull art the gunwales and locates at the top and bottom of the stump.

The base of the stump sits on a piece of 10mm ply glued into the front of the cockpit floor. It is about 100 x 200 long and shapes to fit the disk in the deck. On top of this is glued and screwed a round 10mm ply disk which fits up into the stump tube. Do not glue this on until you get everything lined up.

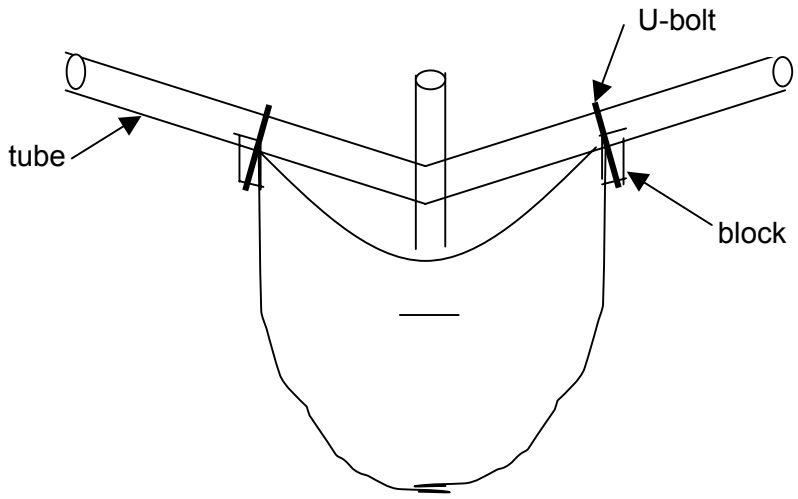
The top of the stump nestles into a U shaped recess cut into the foredeck. This stops the frame being pushed out of alignment by the vang. The piece of foredeck behind the top half bulkhead is doubled up to 4mm to take this load. If it still looks fragile, put some glass or carbon under the centre area to take the stump loads.

The gunwales need some small round recesses to accept the wing tubes. Cut these slowly and carefully, you might need to trim the bottom of the stump at the same time.

All this time keep checking that the frame is square and true. Measure back from the bow to points equidistant out on each bar, and check that they are close to the same height each side.

When you are happy you still need to add some blocks outside the gunwales to bolt the wings to. I used some pieces of very hard Brushbox wood, about 150 long by 20 x 50. These need to be recessed to match the recesses for the wings, and they can be tapered to each end. They need the bottom face flattened to be parallel with the top of the tubes. This is so nuts from the U bolts can be tightened against a firm surface.

These blocks are screwed and glued to the side of the hull. Use two good solid crews long enough to bight into the doubler block on the inside. About 4mm dia by 50mm long. Do not put them where the U-bolt holes will go.



At this stage you can drill all the holes for the trampoline lasing and the hull is ready to paint.

A hint here. We have found that the tramp lacing damages the edge of the gunwale. If you drill the lacing holes in pairs say 20mm apart, you can push the lacing up one and down the other and then there are no strands going over the gunwale to cause damage.

Mast

A skiff moth mast is about 5.2m long, about 50mm dia, with the hounds at 4m and spreaders at 2m. It has a cross hole for the gooseneck and a solid base plug with a 12mm rotation pin. A sail track is an option in some areas, but a pocket luff sail does not need one and is faster to sail and easier to rig single handed.

This is the one place where there is a need to go high tech. A carbon mast can weigh as little as 2 kg, where an aluminium one weighs 4 to 5 kg. That is a lot of weight waving around up stairs and the difference makes a world of difference in learning how to keep your moth upright.

They also need to be stiff. To check how stiff suspend the mast between a chair at each end and suspend a 30kg mass from the hounds. If it bends less than 150mm it will be good. If it bends a lot more than 150mm it needs more carbon. If it weighs 3kg and bends too much, then find something else.

The best cost $A1100. You can find a stiff carbon sailboard mast and add more carbon, sometimes you need to add more length as well. This can cost up to $A700. Adding carbon also adds weight, 250g per layer of carbon and double that in resin, so if the mast is soft it will be a kg heavier to get it stiff.

Putting the extra carbon on is a trick worth recording:

- Get some heavy Uni carbon about 150gsm. You need 4 or 5 m depending on how much of the mast you need to stiffen. It comes in 300mm widths which is roughly twice what you need for one wrap of a 50mm mast, so cut it down the middle.
- You probably need to use the two layers if the mast bent more than 200mm with the 30kg test above.
- Sand the mast with 80 grit, wear a mask, goggles, gloves and long sleaves. Carbon itch is much worse than fibreglass itch. Clean up the dust and wipe the mast down with Acetone or Metho. Support it on two chairs.
- Lay out 5m of plastic sheet on the floor, you might need to put something flat on the floor if it is rough. Lay out the carbon on the plastic. Them mix your resin. If you are using 4m of the 300 wide 150gsm fabric you will need about:
  150gsm x 300mm/1000mm x 4m x 2 = 360 grams or 0.36 litres of resin
  any way try that amount, you may need a bit more.
- With a brush and a squeegee, spread the resin onto the fabric while it is flat on the plastic sheet. Aim to get all the carbon just wet with resin, no dry bits and no wet bits.
- Then take each 150 wide strip and roll the mast into it so it wraps right around. You might need a few pieces of string or something to hold it in place.
- Aim to keep the carbon tight with the fibres straight along the length of he mast.
- Do the same with the second layer if you decided you needed it.
- Now you need some Peel Ply which is some sort of porous synthetic fabric which resin does not stick to. Cut it in strips about 100mm wide. It comes about 1.5m wide but buy 3m length and cut about 10 strips 3m long.
- Wrap the carbon staring at one end of the mast, in a tight spiral, overlapping each strip about 30 to 50mm. As you wrap you should be able to squeeze out excess resin. Do the whole mast and then come back and squeeze out as much excess resin as you can. This reduces weight and packs the carbon tight.
- When cured peel off the peel ply. It should leave a slight texture on a smooth finish. Do not sand much, but if there are dry spots brush in some more resin before you use it and get splinters.

Hounds and spreader fittings

I have used standard stainless fittings, glued on and bound in carbon. Remember which way the loads are, straight down the wires, so put a fair bit under the hounds to stop the fitting sliding down.

Choose a hound fitting with a solid tang and a 7mm hole to take a ¼ inch shackle. Avoid the ones with an eyelet in the large hole.

For the speaders there is a small deck mount block which works great when the sheave and pin are removed.

The base plug can be a nicely turned piece of nylon, but a hand carved piece of oregon works for me. A SS pin is needed, get a 100mm 12mm bolt, cut off the head and round the end. Drill and tap the nylon or wood plug and screw in the bolt with a nut and washer to spread the load. I use a 50mm washer to take the load right out to the carbon walls of the mast.

Spreaders:

These hold the middle of the mast stiff. They can be made from aluminium, but carbon is lighter. Pressed carbon plate is best, but my compromise is strips of timber with Uni carbon covering. The timber starts as 10mm x 20mm but I round it of to an oval section before applying carbon. It needs one layer, use the same stuff and technique as for the mast.

Join the bits together in this configuration with an extra two layers of unis at the joints.