

The development of a light weight centreboard.

As I am sure some of the Phanmail readers will be aware, I have been renovating my recently purchased Claridge hull, number 906. She was a fair bit over weight – a certificate in 1998 stated 68kg – and I am rather over zealous with these things so she HAD to be to weight when she was returned to racing trim. This article is intended as a long-winded guide to how I have got on with that campaign. As the rules declare that you are not allowed to remove constructional materials, the fittings and attachments were the main targets. An obvious place to start (as I was removing layers of paint and varnish) was the centreboard.

The existing board looks like the original article, made in wood with a glass fibre coating. It weighs about 4.5kg. I remember from my previous time in Phantoms that Bloodaxe made a centreboard in carbon with a foam lay-up for another Claridge #903. So it is possible to get something light, stiff and workable the only downside is cost. This was a major consideration as the agreement with my wife that I could buy the boat in the first place was that I did not spend any money on it. Oh well.

I also wanted to play with the shape (I am a Naval Architect so these things interest me). Recent thoughts in the class have seen boards narrowing to around 250mm at the hull exit. I wanted to develop along these lines, so I got a colleague at Work (Sunseeker) to scan my existing board into our CAD package and use that as a starting point. The head profile and the length of the board were retained but the foil shape and profile was modified considerably.

Section

On the Claridge boats the centreboard slot is approximately 28mm wide. So the foil could be no wider than this, but a 28mm thick foil would have been too thick for my liking. A fair amount of time on the web revealed a number of useful articles which supported the thoughts running through my head. The Farr 3.7m Class web site in New Zealand has an excellent article and this was my prime source of information. You can find this article by following the links from <http://www.sentech.co.nz/farr37/>

I am also a fan of the thoughts of Frank Bethwaite, as outlined extensively in his book “High Performance Sailing”. I can’t really understand the bits on weather but my grasp of the rig, foils and hulls sections convinced me that he was talking sense. So I wanted to apply this to my foil. Anyone familiar with the book will understand the concept of a “drag bucket”, i.e. a foil as small angles of incidence will develop lower drag if it is in the presence of laminar flow than if the flow is turbulent. For this to be the case a laminar flow aerofoil section has to be used. These have the maximum thickness of the foil further aft than the normal NACA 0009 type sections that are used for rudders.

Frank also came to the conclusion that the ideal section shape (through years of practical experiments) was one of 9-10% chord thickness. This would fit in well with my intended chord length (distance from foremost to aftermost points of the section through its centreline – for symmetric foils!). So what section ... luckily I came across another web site (the UIUC Airfoil Data Site - <http://www.aae.uiuc.edu/m-selig/ads.html>) which contains all manner of foil section data, so it was simply a matter of finding the one to use. The NACA63010 section seemed to fit the bill, as a low speed, laminar flow section. The co-ordinates were downloaded and then stretched to fit into my foil profile.

Profile

It is widely held that the best wing profile is an ellipse, as typically exemplified by the Spitfire wing. The Farr 3.7m article above contains some detailed discussion about optimum planform taper and aspect ratio. I actually used my University training for the first time in years and remembered that if a foil is at right angles to a top plate, the foil is fooled into thinking that it is actually twice as long as it is. This is the situation where a centreboard exits the hull. So whereas the Far 3.7m article author stepped back from the optimum taper ratio, I did not feel so constrained, so my foil tapers from 250mm chord at the hull exit at the optimum ratio of 0.4. This produces a very narrow looking foil. Trailing and leading edges are elliptical.

As I wanted to maintain the existing balance of the boat, I tried to put the centre of effort of the foil in approximately the same position (fore and aft) as the existing board. This has meant that the foil is off centre, relative to the head, but on an aesthetic level, it does look rather funky!



Finished foil, images taken from our 3D CAD package (RHINO).

All that was then left was to get the thing made.

Making It

I thought long and hard about making it myself, but when it came down to it I did not have the time or money to do it, so I resorted to the web again and came across Phil Locker (<http://www.philsfoils.com/>) in Ontario, Canada who can take my RHINO model and cut the core on his 3 axis CNC machine, then do the lay-up too. Excellent, the quoted price was even about half that of an equivalent board in the UK (before taxes, which I am still waiting to find out about!). Off went the design and a week later the core was cut, then a carbon fibre lay-up vacuum bagged onto it, and there was my foil.



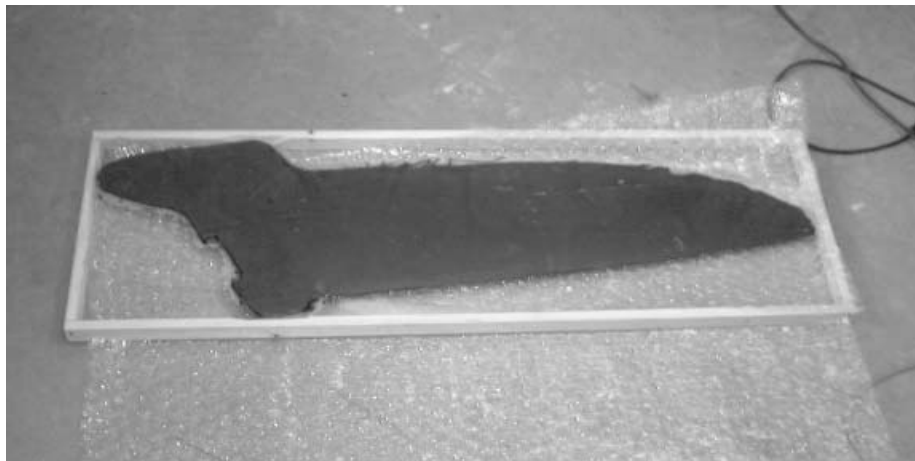
The foil blank (core) shaped out of 5/8" thick 80 kg/m³ PVC foam (foam saved about 150g compared to western red cedar). The foil is made in two halves, which are epoxied together before over laminating.



The foil being vacuum bagged.

The lay-up was defined with the assistance of a number of articles. There is an excellent reference site on the UK Cherub Class Association web site (<http://www.sailingsource.com/cherub/chframe.php?menu=build>) for all matters relating to building foils, masts and hulls. There is also a good article on the SP systems web site describing tests on a centreboard with carbon onto western red cedar (<http://www.spsystems.com/pdfs/appl%20guides/Foil%20Construction%20Guide.pdf>). Both these articles indicated that a lay-up of 200 g/m² uni-directional carbon to 100%, 60% and 40% of foil length, with a woven (0/90° 200 g/m²) carbon cloth would be a suitable lay-up. The discussions and theory of laminates, etc. is far too in depth for this type of article, but I can lend people the books! I then cheekily asked a well-known foil maker for his thoughts and came to the conclusion that the woven carbon was not required. It is only there to maintain the uni-directional carbon layers in column and as there was a layer of woven E-glass going over the whole thing it could be dispensed with/ Good thing too – woven carbon cloth is expensive! A problem arose as the foil maker can not obtain any cloth of a suitable weight, but he can easily get hold of something a little heavier, so the lay-up was modified to take account of this.

I elected to use foam for the core primarily due to trying to extract the maximum weight saving (so 150g was saved!), but mainly to reduce the time it takes to manufacture. The foam can be cut in one stage as it comes from the supplier. A wooden core would have taken considerably longer to make – cedar cut into strips, turned end for end to reduce warping, laminated, etc. – hence would have been considerably more expensive.



The foil in its transit case before her journey to Blighty.

The rough finished foil (still to be sanded and painted) came out of it's bag at just under 1kg or about 22% of the old one. I have not seen it yet as it is now in transit, but I'll let you all know how we get on and what the final price was.

I would be happy to discuss this with anyone interested. As far as foils go, I am intending on tackling a rudder next, and have already had people interested in that – commissions welcome. The centreboard design is now on the Phils Foils web site (<http://www.philsfoils.com>) and I have found Phil to be extremely helpful and friendly, especially with what was a call out of the blue for something that he had not done before.

Watch this space for my thoughts on hull, hull shapes and finishing, which should be published in the next edition of Phanmail as the renovation of 906 continues.

See you out there

Andy
Phantom 906 – “Default”