The finishing of a centre board

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Since half the cost of a centre board is in the finishing, it pays to do the finishing yourself. Others may argue the entire board can be made by a good DIY person. I shall try that next time. This time I started with a professionally glued and milled board.

This text describes step by step how to finish a centre board. There are many ways of accomplishing this task depending on sailing needs and size of your wallet. For example my previous board was finished with two component boat paint simply because I had that available from doing a hull paint job.

This time I wanted to do a job with clear epoxy because it looks much better, especially since I decided on a beautiful Ibachi / Cedar, planked board. This type of board is much stronger and stiffer than a plywood board because all wood fibres are in the same direction. The down side is the planks are glued together and the glued area is very small compared to plywood. This means the planks could break apart more easy than layers of plywood would. I decided, following good advice from fellow Wayfarers, to add a layer of glass fibre to strengthen the bond between the planks. As a side effect the board gets stiffer yet.

Requirements

- A planked Ibachi / Cedar centreboard, professionally glued and machine milled to Wayfarer specifications. The board comes a little smaller (in all directions) than the official drawing to allow addition of glass fibre and epoxy.
- 150 grams per square meter, woven glass fibre, which is much stronger than flaked cloth. Woven fibre has fibres running across the planks to strengthen the bond between the planks and along the planks to give more stiffness.
- Clear Epoxy, The beautiful wood stays in sight and due to its properties (thick like syrup and settles within half an hour) it is easier to use than polyester, especially by amateur users.
- Since I usually sail in shallow water and running aground is no exception, a protective strip shall be added.

Aqua dynamics dictate a board should not have a razor sharp trailing edge, The trailing edge should be flat, but only a fraction of a millimetre. This can not be done in wood; the edge would be too fragile. The trailing edge has to be kept blunt, often up to two or three millimetres. However, glass fibre and epoxy allows us to create a razor sharp trailing edge. When finished one or two rubs with sand paper will give the minimal flattening required for minimal resistance in the water. The board manufacturer has accommodated for this and made the trailing edge a couple of millimetres short compared to the official drawing (measurements are still within class specifications). The wood ends in a flat trailing edge of about 3 mm thickness. With epoxy and glass fibre we can add an extra few millimetres and create a razor sharp edge within the limits of the official drawing and class rules.

Tip protection can be made of brass, copper or stainless steel, the latter being the hardest to work with. Since I could lay my hands on piece of stainless steel 316 easy, I choose to use that material and not continue my search for brass. Stainless steel can be worked like brass, it only takes more time.

Measurements

Before finishing the board the pivot hole for the centre board bolt needs to be measured and drilled. Also I wanted to add a stopper block before finishing with epoxy to avoid cutting holes through the protective epoxy layers. A stopper block limits the maximum centre board angle to 83 degrees as required by the class rules.

Maximum depth

First the pivot hole for the centreboard bolt was measured according to the instructions by Kjell Gjære (W4878) (see:http://www.wayfarer.dk/teknik/senkekjol%20-%20placering%20bolt.htm).
Following his advice ensures the board will be at the maximum allowed depth.

Maximum angle

A little help line drawn with a pencil on the centreboard (later removed) showed the keel line at the maximum allowed angle of 83 degrees. As soon as the pivot hole was drilled the board was into the boat. With the help line lined up with the keel I made a stencil on a piece of cardboard that fitted exactly the top of my centreboard case. On this stencil I drew the contours of the horn of the centreboard. Back home the stencil allowed me to cut away a small part of the centreboard horn so it follows exactly the contours of the top of the centreboard case. Then I shaped a piece of hardwood to the contours of the centreboard (see photo's). This stopper block was temporary fitted with a screw. After this job I put the centreboard in the boat again and re-measured all dimensions. The maximum depth and maximum angle allowed were spot on!

Tip protection

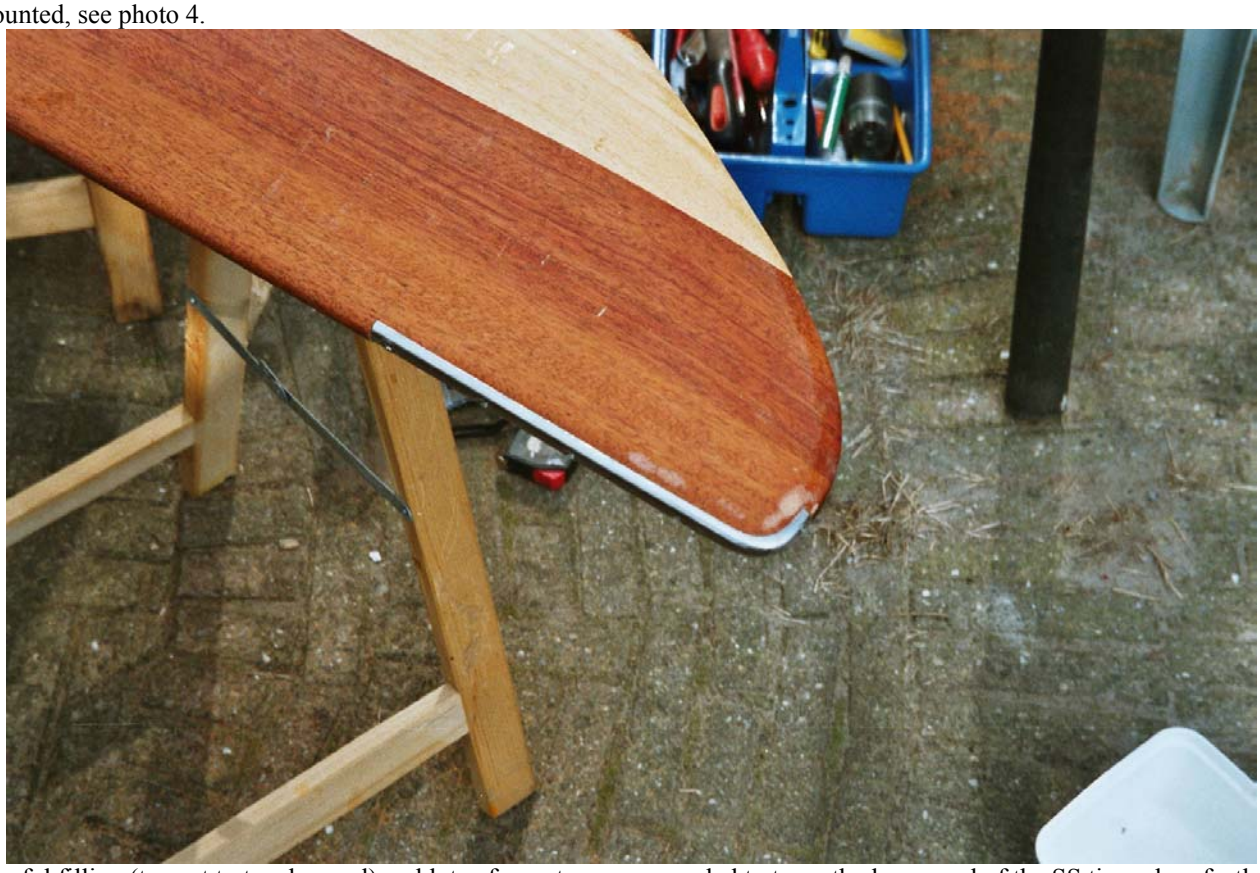
As stated above, I wanted to add stainless steel tip protection. The photos 1 and 3 show the 11 x 5 mm, half round, rod I used. The shape fitted the existing curvature exactly! The first job was bending it into shape. This can not be done during a later stage. Once the mounting holes are drilled it will be impossible to bend it evenly. The steel will bend where it is weakest, over a drill hole.

Photo 1 shows the bending setup I used. Luckily I had a piece of round wood that matched the tip curve on the centreboard drawing exactly. Others may have to use an iron pipe or some other round material. Important is to use material with a diameter that results in a curve that matches the official drawing. The photo also shows that the legs are too long. It is impossible to bend accurately with one of the legs being only 30 mm long. Once the bend fits the drawing / centreboard exactly, the legs are cut to length and the screw holes are drilled. Finally the drill holes are treated with a 90 degrees drill to receive the countersunk screws and no screws stick out of the finished centreboard.

Next the cut-out in the centreboard is made. Don't try to fit the steel to an existing cut-out; it is far easier to do it the other way around, fit the wood cut-out to the bend steel. The cut-out was made with a fine file and a lot of patience. Bear in mind it is easy to remove material, adding material is much harder. Photos two and three show the finished cut out.

This photo clearly shows the shape of the SS316 rod I used.

When a perfect fit was achieved the screw holes were carefully drilled into the wood and the protective tip was temporary mounted, see photo 4.



Careful filling (try not to touch wood) and lots of sweat are now needed to taper the lower end of the SS tip and perfectly match it to the official centreboard drawing. (Note the marks where the file touched the wood). After this task the SS tip is removed to add a protective epoxy layer in between the wood and the SS tip. The epoxy also hardens the inside of the screw holes so they hold better and in the event water leaks in there is some protection inside the screw holes too.

Sanding

It is needless to say that a good finish requires lots of sanding. It starts with the sanding of the bare wood. The advice given by the epoxy manufacturer told me to use sandpaper with grain 280. Sanding needs to done careful for we don't want to remove too much material and alter the shape of the board. On the other hand the board must me smooth and have a silky touch. It is all a matter of sand paper and lots of feeling, a little sanding and a lot of touching. Once the surface is as smooth as a baby's bottom and all imperfections are gone it is time to start with the epoxy.

The epoxy system

The system of choice was the epoxy system from “de IJssel”. The “West” system is also a good system but much harder to mix in small quantities. The system from “de IJssel” has a two to one ratio between resin and hardener. This ratio makes it easy to mix in small quantities. The downside of this system is that it is available only in tins of 1 kg or more while the West system is sold in smaller quantities. Photo 5 shows the materials and tools I used:

- Special Xylene based solvent for degreasing. Never use organic solvent with epoxy! (E.g. toluene based thinner, white spirit, etc.).
- A special injection resin. It is not required but it penetrates the wood better that the thicker laminating resin. I figured that on the total expenses another type of resin would not make much difference. The wood is better conserved and the bonding of the other layers is better. I know that many Wayfarers use only one type of resin and have no problems at all.
- A laminating resin. The injection resin is too thin for laminating; it will run out of the glass fibre. After mixing the resin can be handled for about 15 minutes, after that, though still liquid, it should not be touched to obtain maximum strength according to the manufacturer’s specifications. Large surfaces I handled in two or more stages, using the cups to mix amounts that I could handle within the 15 minutes time frame.
- Plain weave glass fibre fabric of 150 grams per square meter. Heavier fibre will be visible after finishing the board. When the fibre that is totally invisible it means it has no effect on the final layers and guarantee a smooth surface with minimal thickness. Plain weave roving fabric is preferred for it is much stronger than chopped strand fabric of the same weight. Another advantage of plain weave is it drapes easy around corners without tearing or breaking.
- Throw away gloves; we are working with toxic materials after all.
- A number of brushes; I bought the cheapest I could find. It is impossible to clean the brushes (too expensive), they are best thrown away after every layer. Since only one side of the board can be done at a time you need two times more brushes than the number of layers of epoxy.
  Do not use a roller; the resin is sticky like syrup and a roller will lift the glass fibre. Use the brushes to “push” the resin in, do not “paint” for you will tear the glass fibre fabric apart.
- A plastic bowl to mix the epoxy; plastic cleans easily the old epoxy is broken out the next time it is needed.
- A number of 25cc measurement cups; I got them from my pharmacists; they are so inexpensive that he did not want to sell me less than 20 at a time.
- A roll of kitchen paper (not shown) to degrease. For good degreasing it is important to use a clean towel often to remove instead of move contaminations. Using a roll of kitchen paper is a cheap way of having lots of clean towels available.

Applying the injection resin

Before applying the injection resin, the surface needs to be degreased thoroughly with the special Xylene based solvent. Do not use organic solvents such as Toluene (Thinner) or White Spirit. These products do not agree with Epoxy as long as it is not cured. A roll of Kitchen paper allowed me to use a new, clean towel often. Using a single towel will move, not remove, contaminations. The Xylene based solvent is also used to remove the sticky surface, that seems to be a by-product of the epoxy hardening process, before sanding. The injection resin is applied much like varnish. Make sure it penetrates into all screw holes for the protective strip and stopper block. Since the epoxy is sticky it is impossible to get a smooth, even surface like with varnish. One can only give it ones best shot within the 15 minute time frame allowed by the manufacturer. Apply the resin with the board in a horizontal position to avoid it running off. This means only one side can be done at a time. With the pharmacists cups it isn't hard to stay close to the manufacturer advised mixing ratio of 2:1. The cups are about 25 centilitre and 2 cups of resin with 1 cup of hardener is more than enough to do one side. At first it looks as if there is too much resin on the board, but after 24 hours, the minimum settling time, it somehow gets all sucked up by the wood. Leave the epoxy for at least 24 hours before doing the other side. This means it takes at least 48 hours before the next layer can be applied. After the epoxy has settled and before sanding, remove the sticky layer of the epoxy surface using kitchen paper and Xylene based solvent. Then use sandpaper 280 to regain equal thickness and smoothness again.

Mounting the protective strip and stopper block

Because of differences in thermal behaviour I decided to use a rubbery mastic in between the steel and wood. This will provide a good seal no matter what happens. A popular brand of PU-sealant is "Sikaflex" but I prefer an industrial grade PU-sealant for it is much cheaper and hardens slower, avoiding air bubbles to get trapped inside the seal.

The protective strip and the cut-out are first thoroughly cleaned with Xylene based solvent before the SS tip is screwed on with PU-sealant in between the board and the strip. Once the PU has settled, the screws aren't really needed. The main function of the screws is to keep the protective strip in place until the PU has settled. Provided the surfaces are thoroughly cleaned and degreased, the PU-sealant is strong enough to hold the strip in place. Because there is a layer of injection epoxy on the board already, the PU-sealant bonds much better to the board than it would on bare wood.
Once the screws are tightened, excess sealant is easily removed with kitchen paper and Xylene based solvent. Photo 6 shows the result, after the sanding the surface of the board.

Note there is a little PU left on the screw heads, I left it there to avoid small depressions in the glass fibre / Epoxy later on. PU-sealant is also a two component product. The accelerator is water (water vapour from the air). Leave the PU for at least 24 hours exposed to the air before continuing with epoxy

The stopper block is screwed and glued with some "West system" 5 minute epoxy glue that I had left over from another job but it can just as well be glued on with the epoxy resin we use for the rest of the board. (24 hour cure!) A bit of wood filler

finishes the screw head. Photo 7 shows the result.

On the photo two screw holes for a stainless steel bracket can be seen, just behind the stopper block. These holes were drilled before the injection resin was applied. Needles to say that this phase was finished again by cleaning the surface with Xylene based solvent and sanding.

Cutting the glass fibre cloth

Cut the glass fibre fabric with sharp scissors, larger than the size of the board. It will be cut to size later. In my case the cloth was not large enough to cut one piece. When more than one piece is used, it is important to have an overlap between the pieces. I decided to have the overlap over the keel line for that is the part of the board that has the most stress. A double cloth will give some extra protection where it is needed most.

Photo 8 shows the overlap where the screw driver disappears underneath the lower cloth. Don't worry about the cloth not being perfectly smooth or square. Too much handling may take the cloth apart.

Laminating the fibre

Experienced persons may be able to do a whole side of the board in one go; I did it in two stages. For each stage I mixed one cup of resin with half a cup of hardener. Remember that for maximal strength the resin may be worked maximal 15 minutes. After applying the first one and a half cup, I immediately mixed the next one and a half cup and finished one side of the board at once.

With the board in a horizontal position, apply the resin with a brush. Carefully push out any trapped air bubbles and work the cloth around the leading edge. Don't worry if the ends don't stick to the leading edge. As long as they are over the middle, the cloth on the other side will cover the rest of the edge. In my case I made sure there is a little overlap of the cloth from both sides but that is not really necessary. Never try to brush any imperfections out; it will ruin your work. Only push with the brush. Leave the cloth on the trailing edge sticking out, more or less in the same plane as the board. It is later used to build up the epoxy trailing edge. Some self adhesing tape applied to the other side of the board may help in keeping the cloth and resin in place. Photo 9 shows the result after applying the first layer of epoxy. The glass fibre can still be seen but it will disappear after the next layer of Epoxy.

Before applying another layer of resin the excess cloth is cut away, except on the trailing edge. The surface was cleaned, sanded and cleaned again using sandpaper 280 and Xylene based solvent. In some places, where the glass cloth bubbled up I used a power sanding machine for the fibres are very hard to sand away by hand.
After 48 hours (two sides) a second layer was applied. The result is shown in photo 10. This layer completely hides the glass fibre cloth. The second layer is applied exactly like the first but you can brush it now like varnish. There is no risk anymore of ruining the glass fibre cloth. This second layer is finished again by cleaning, sanding and cleaning.

Finishing the trailing edge

Cut away the excess epoxy / glass fibre from the trailing edge but leave whatever you need to extend the trailing edge by comparing it to the official drawing. Then fill all imperfections with a mixture of epoxy resin and glass powder. Glass powder will turn the resin into a clear filler. The glass powder is invisible. Mix the powder and the resin before adding hardener to get the maximal time to work with it. Keep adding powder until the resin becomes thick like clay. Small imperfections can also be filled with pure resin without the glass powder. In that case use some self adhesive tape to keep the resin in place. Make sure the trailing edge is thick enough to allow filing and sanding into the desired shape.

When the epoxy has settled, use a file and later sandpaper to shape the trailing edge. Check it on the official drawing often and feel with your hands if it becomes smooth with the rest of the boards surface. Also look at it from the rear and make sure both sides are symmetrical. If you filed or sanded away too much material, just add some more filler and repeat the process.

Finally rub once or twice over the now razor sharp trailing edge at a 90 degree angle to the boards surface to flatten it just a fraction of a millimetre. While sailing, this will create a tiny area of low pressure behind the board that helps the water to run of without turbulence. A razor sharp edge may also be dangerous to the crew when the board is lifted. Because there is glass inside, a sharp edge is as dangerous as a knife and it will stay sharp. Only when you are fully satisfied with the result, start with the finishing of the board. Once there is varnish on the board we can not use Epoxy anymore.

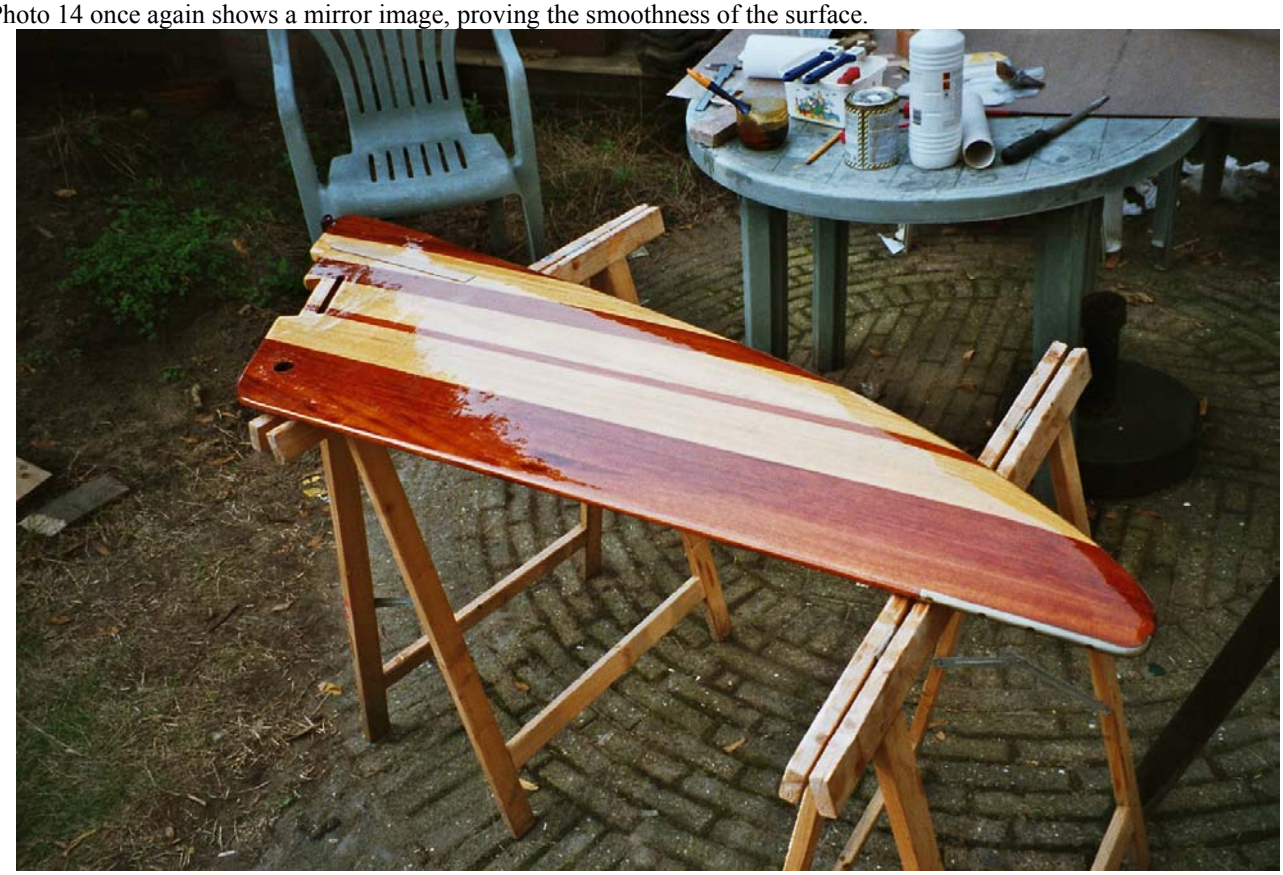
Finishing the board

Finally the board is finished using a normal boat varnish with UV protection. This is done like any other varnish job. Apply as many layers of varnish with gradually finer sand paper as needed to get a smooth surface. I used “Epifanes” clear boat varnish. This varnish needs at least two layers to get enough UV protection. Epoxy gets brittle from UV rays and may crumble. Then again, how much sunshine does a centreboard get once mounted? A more importand reason to use varnish is it allows us to create a much flatter and smoother finish than Epoxy wood due to its sticky characteristics.
On my board I put four layers of varnish, sanded in with wet sandpaper (grain 600) in between. The result can be seen in photo 11. In this photo the protective strip shows through the glass fibre / epoxy coating.

Photo 12 shows the “Duropal” strip I glued on with epoxy, before the varnishing, to get a tight fit in the centreboard case. The varnish on the strip was later sanded of to create a clean surface to add more “Duropal” strips until the board was tight in the centreboard case.

In photo 13 the stopper block shows that is now also covered with glass fibre and epoxy, guaranteeing it won't come loose when it bumps hard against the centreboard case. A mirror image of a wall can be seen. I used this straight line to check for maximum smoothness. I kept on sanding and varnishing until the mirror image of a straight line wasn't wobbly anymore.

Photo 14 once again shows a mirror image, proving the smoothness of the surface.



Finally photo 15 is a close up of the “Danish” pivot bolt solution. A Nylon insert, about one millimetre wider than the centreboard, allows the centreboard bolt to be tightened without any risk of jamming the board. It is needless to say that the inside of the pivot hole is well epoxied.

Before the board was finally mounted in the boat I finished it with sandpaper grain 1200 followed by a treatment with car cleaner and finally a layer of Teflon wax. The nice glossy shine disappears but all small imperfections like dust grains are removed. A small piece of dust may disturb water flow over an area of several square centimetres! No photo was made for the board did not look as nice anymore, but it sails better!

Maintenance

To keep the board in perfect condition it is advisable to take it out during winter and let it dry thoroughly.

Once dry, repair damage with epoxy or epoxy filler after sanding away the varnish and cleaning with Xylene based solvent. When done, restore the varnish layers.

Every year; give the board a new coat of varnish after lightly sanding it with grain 600 paper. Then repeat the 1200 grain sanding and waxing.