Plank S18

Except for trimming the bungs, plank S19 is now complete, so it's on to the next plank down; i.e., S18.

December 26:

Measured the distance between the bottom of the new S19 and the top of S17. This gives me the width of the new S18, which is slightly different than the old S18 (because S19 was not a perfect replacement). Portions of S17 had already been removed, so I used the old S18 to fill in the gaps.

Removed the old plank S17 to make room for the new S18.

- In removing the old plank fasteners, only two of them broke off. I was able to remove them with an Unscrew-um (well at least most of the screw). These fasteners were in good shape – no reason for them to break, except that they are right where the bilge stringers attach to the frames. I now suspect that a bilge-stringer fastener wedged against the plank fastener preventing it from turning.
- Sawed the plank in half where there was a significant gap between S17 and the plank below. This made it easy to split the inner plank releasing the outer plank. A bit more splitting with a putty knife, hammer, and pry bars and the plank came loose.
- I then measured the width of the old S17. I'll need this to locate where the top edge of S17 intersected the frames (used to compute location of bottom edge of S18 inner).

December 27:

Cleaned up the frames. One frame is split slightly along one edge. I'll just fill this with epoxy.

Enlarged the fastener holes to .24" in preparation for plugging.

Made 100+ H. Mahogany 6mm plugs.

Trimmed the bungs in plank S19.

December 28:

Plugged the fastener holes

Repaired the split frame. I just drilled a small hole at the top of the crack and injected 105/205 into the hole while lifting the split piece slightly with a small wedge. After some fussing I got the glue to run down the split. I then clamped the split with duct tape. Worked pretty well.

Separated the spiling batten into sections.

December 29:

Trimmed plugs flush with frames, sanded, painted (2 coats Primocon).

Before painting frames, I clamped the spiling-batten sections in place, except for the forward most section. This was replaced by a better fitting template.

Cleaned and painted the spiling-batten sections

December 30:

Marked the frames for the lower edge of S18 inner. The lower edge is computed as the width of S18 outer + ½* width of S17 outer.

Replaced spiling batten hood ends with templates that fit. Clamped all sections of spiling batten to the boat and glued the butt blocks.

Spiled for the top and bottom edges of S18 inner.

December 31:

Lowered the spiling batten to the floor with ropes from the deck. Worked pretty well.

Reverse spiled for the center section and cut out the plank. Lower edge cut ½" outside the line, but the upper edge was cut and planed to the line. This a bit different than my normal procedure. Normally, I would cut both edge ½" outside the lines to account for possible stress relief; however, since I have not had problems with this in the past, I skipped that step. In any case, the extra width allotted for the lower edge provides some insurance in any case. Note that I used a pencil line to define the lower edge since the cut was rough anyway. For the top edge, I used a marking knife, which leads to a closer fit. I use my smooth plane on its side on my planer bench (works like a shooting board) to get close to the knife mark and follow up with my apron plane to just remove the knife mark. (I subsequently realized the using a marking knife is overkill – a pencil line is just as good and faster. The problem is that errors in spiling (whatever the cause) tend to be greater than the width of a line, and these errors are eliminated during fitting.)

The width of my AYC planking stock is 8" and 10". This plank has only modest curvature, so a 6" plank would be enough. The 10" isn't quite wide enough for 2 sections, so there is quite a bit of waste.

Initial fit was pretty good, but to my surprise the bevel angles weren't right – as much as 1/16" to the outside with inside .010" or less. After some reflection, I realized the problem. The inner plank is being forced to conform to the curvature of the frames (rather than scrubbing). In principle, this means that the edge of the planks should be

perpendicular to the face of the frames. In practice, it's not possible to force the ends of the plank to lie against the frames – you can't generate a bending moment at the ends. So some flairing is to be expected. I was able to compensate for this with only one fitting cycle. Ultimately the inside edge was closed to <.022" with the maximum outside opening of <.030".

The curvature of the frames is substantial at this position on the boat. The plank now is about .5" thick and eventually will be planed to 3/8". At .5", I don't know if I could force the plank against the frames. I hoping things will look better at 3/8". If not maybe steaming will be required, or heating the plank with a hot air gun. (Subsequently, I tested this with a piece of 3/8" thick scrape. I was able to force the piece against the frame with only moderate clamping pressure. But as well see later, the bending stress is still quite high – close to the limit.)

Reverse spiled for the forward section.

January 1:

Cut out the forward section and got a good fit after just one fitting cycle. The hard part is finding a way to clamp the plank as the bilge stringer is in the way for most of its length.

This section of the boat is mostly flat forward of frame 12, so the bevels matched the previous plank quite well. Aft of frame 12 the curvature increases and the seam tends to open up a bit, but easily remedied by planing the back edge during fitting.

Cut out and fit the aft section.

January 2:

Redefined the bottom edge of all three sections by transferring the plank width at each frame (bottom of S19 inner to the mark on frame). Since the fitting cycles required very little reshaping the plank edge, the old bottom edge marks were very close to the redefined ones. In any case, it's more important to have a fair bottom edge than one that matches the marks.

Cut and planed the bottom edges of all three sections.

Thickness planed all three sections for final thickness (nominal 3/8"). I learned another lesson about my thickness planer. I believe that it provides more uniform thickness if the cut is more aggressive rather than less. I suspect that the rollers hold the plank down more securely with a heavier cut. As it was, my final cut was only about .020", which left me with plank thickness that varied from slightly less that .375" to slightly more than .385". (I now realize that my planer knives are not adjusted properly, so one end takes off more than the other. I found that flipping the stock running it through the planer again fixes the problem. I also now use my dial calipers when adjusting for depth of cut. If the planer head moves down 0.032" and cut will be close to that.)

January 3:

Clamped each section on the boat individually. Marked on the boat where the sections overlap (3 marks, about equally spaced, per overlap). Had a bit of a scare when I clamped the middle section to the boat. The plank didn't seem to fit as well as I remembered. Also, the plank extended too far aft when positioned at the reference mark. After some stewing, I realized that the plank needed to be flipped end for end. That's what happens when you plane away all your marks!

Cut the scarf and glued the forward section to the middle section.

January 4:

Cleaned up the scarf and then cut the scarf and glued the aft section.

Started to refasten the two laminated frames (40 & 41) on the port side. The refastening consists of the plank fasteners from the sheer strake down to plank P20 (planks below P20 will eventually be replaced) as well as the bolts through the sheer clamp.

I also repaired damage from where a toe rail drift exited the sheer strake. This I bored for a ¾" plug and epoxied the plug in place.

January 5:

Cleaned up the scarf and then painted S18 inner with two coats Primocon. There is still a little cleanup on the front side of this scarf, but I'll wait until after painting so I don't have to flip this 40' plank more than necessary.

Continued refastening port-side laminated frames. The bolt through the sheer clamp at frame 40 still needs to be installed. I need to clean up the 5/8" counterbore, but I have to wait on the cutter. I could enlarge to ¾" but then the hole would intersect the adjacent plank. (After receiving the cutting, I cut the counterbore and made the plug. I install it when I'm set up for bunging S18 outer. 3/10/2016: this is now complete.)

One of the mizzen chain plate bolts is very close to the plank surface at the seam between P20 and P19. So much so that it won't hold a bung. So the plan is to remove it and counterbore it deeper, but I'll wait until after I remove P19 as part of the port-side replanking.

January 6:

Cleaned up the front side scarf, clamped the plank to the boat with the help of numerous ropes, and fastened it in place. Hood ends bedded in Sikaflex 291 LOT sealant.

All that remains is to fair the transition from the previous inner plank to the new one.

After a couple of days I noticed that the plank had a hairline longitudinal crack between frames 29 and 30. This happens to be where the scarf joint falls and is at or near the point of maximum frame curvature. After some thought I suspect that the problem relates to the rigidity of the resorcinol scarf. If we assume that the glue line has a compression modulus much greater than the AYC, then where the glue line appears near the inside surface of the plank the neutral axis shifts to the glue line thus increasing the tensile stress at the outside surface, initiating the crack.

In the future I'll try to locate the scarfs away from areas of high transverse curvature. Also using a more flexible adhesive might be good too. Also heating the plank. Keep in mind that the existing inner planking consists of simple butt joints, so structurally the scarf is still better. The only problem would be if the crack propagated to the inside, which I doubt. In any case I plan to cut a groove along the crack and trowel in some sealant before placing the outer plank. (I decided just to install the outer plank bedded in sealant – no special treatment for the crack.)

I did some calculations on the tensile stress on the outer face of the plank, and even without the scarf joint and actual stress is very close to the max. allowable!

January 11:

Sick for past 5 days, so not much done.

Planed and sanded the inner plank to eliminate any step at the seam.

Started to make the scrubbing templates. The contour gage works well.

January 12:

Finished the scrubbing templates. Seven of them were needed to represent the range of hull curvatures for this plank.

Using the templates, I measured all the bevel angles and recorded them on a bevel board. In doing so, I found a better method of extracting bevel angles from the templates.

Here we have the scrubbing template for plank S18 at frame 12. This template is also suitable for frames 8 though 13, but the plank widths differ as indicated by the tic marks on the template. Typically, the top of the template is cut at an angle matching the bottom edge of the plank above (S19). The angle that we're interested in is between the face of the S18 and the bottom edge of S19. Because of the curvature, it's difficult to measure this angle directly with a bevel gage. To circumvent this problem I place a piece of tool steel along the template so that the end intersects the tic mark at the appropriate plank width. Now the face of the tool steel is parallel to the plank face and I can measure the angle using my bevel gage.

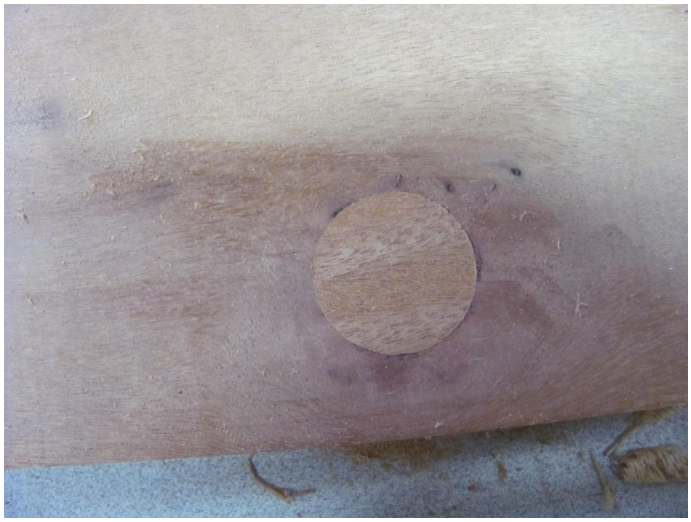
In some cases, the top of the template does not represent the correct angle. Instead a line, representing the correct angle, is drawn on the face of the template. Because the face of the plank is defined by the tool steel and is independent of the position of the bevel gage, the technique described above, works for this case too.

January 18:

Laid out S18 in three sections on my planking stock.
Two sections out of one board and the third out of another.
Planed the rough-cut sections to finished thickness (.750" to allow for scrubbing).
Planing uncovered numerous defects. Spent a lot of time fixing these defects.
Defects take on three different forms, each requiring a different treatment:

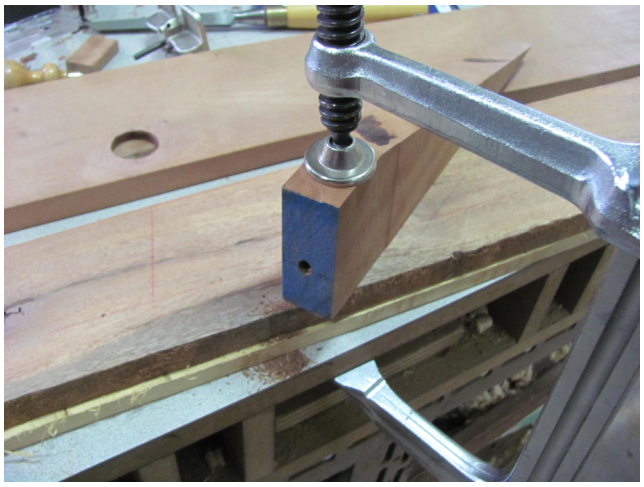
- Bad knot. Most of the knots that I've encountered are solid, but occasionally I'll run into one that is either rotted or cracked. For those, I drill them out with the appropriate size Forstner bit and plug them with a bung set in either G/flex epoxy or resorcinol (depending on what's handy at the time). In some cases, it's hard to

get the Forstner bit started – it tends to wander if the point isn't constrained. In such cases, I make a fixture to hold the bit in place (just a piece of scrap that I pre-drill to the size of the bit).



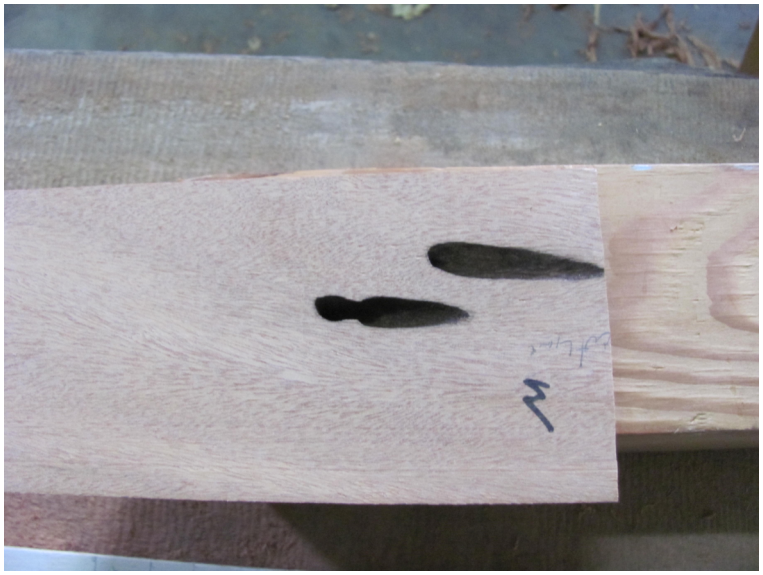
- Worm hole. This is a small diameter hole that passes trough the plank.

The goal is to clean out the hole with a drill bit and then plug the hole with one or more bungs. The problem is that sometimes the hole is at a significantly oblique angel, which makes starting the drill difficult. In that case I make a drill guide out of scrap wood, clamp the guide to the plank the drill.

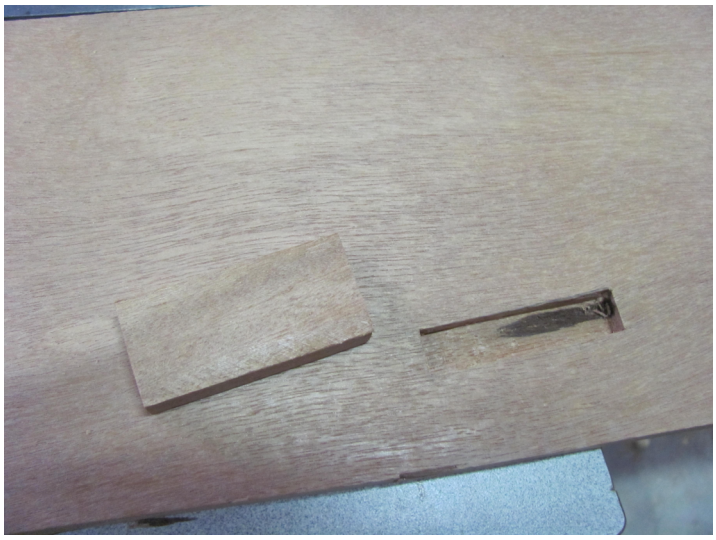


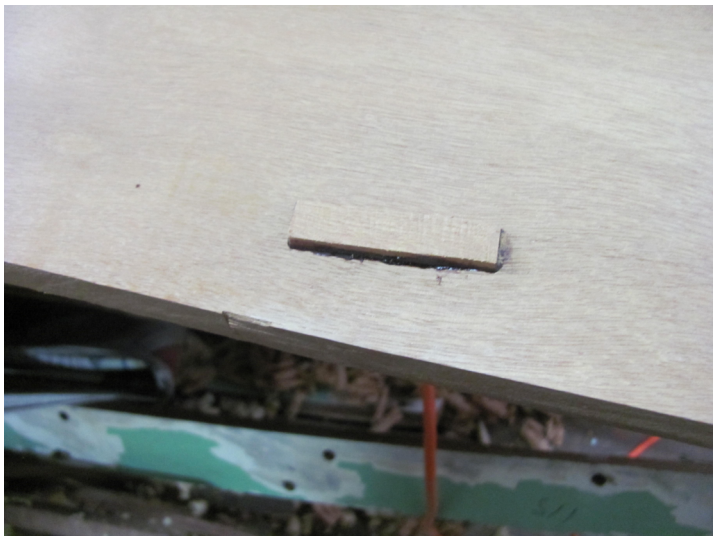
To make the guide, I insert a dowel into the hole and measure the angel (relative to the face of the plank) with a bevel gage. I also trace the angel that the bevel gage makes along the face of the plank. I then drill a hole in my guide matching the angel of my bevel gage. Then I align the guide along the tracing on the face of the plank. Then inserting the dowel into the guide, I slide the guide along the tracing until it enters the hole. I'm then ready to drill.

- The third defect is either a sap pocket or worm hole that lies at the surface of the plank but not through it.



For these, I use a Dutchman repair; i.e., a rectangular plug much like a mortise and tenon joint.





I used a marking knife to outline the hole and then used a mortising chisel to cut the hole. (bottom of hole cleaned out with small hand router.) I then sawed and planed a plug to fit. I suppose that fitting the ends as a scarf would be better structurally, but probably overkill for such a small repair.

I had to make about ½ dozen repairs, but even then I had to replace a 4-foot section of the forward section because of the extent of the defects (became a structural concern). So I cut off the offending piece and scarfed on a replacement.

After making all the repairs, I reverse spiled for the aft section. The bevel angles are all obtuse, so I had to adjust my spiling accordingly. I then cut close to the line at the top edge and left about ½" excess at the bottom edge. I then planed the top edge square to the line and then cut my bevel angles. The bevel angles vary along the length of the plank (rolling bevels), so I drew a bevel limit line on the plank to guide my work. Using a bevel gage, I also check the bevels against the bevel angles on my bevel board.

After cutting the bevels, I then scrubbed the inside face of the plank to match my scrubbing templates. The largest curvature for this section occurs at the end of the plank as can be seen in the pic below. The outside face also needs scrubbing, but I'll wait until after scarfing all three sections together so that I have a flat surface for scarfing.

The first fit was a bit disappointing (more than .085" gap in one spot). But after just two cycles the maximum gap was less than .022".

I noticed that the bevel angles seem to match the bottom edge of S19 quite well (visible at end of plank and at other locations a feeler gage seems uniformly tight when slid along a seam – doesn't grab at the back or front of the seam). So I'm pleased with my method of measuring the bevel angles.

Because of all the plank defects, I wasn't able to achieve a 3-frame overlap between the aft and middle sections. (Actually, I can get the overlap if I allow the scarf between forward and middle sections to occur near the scarf for S19, but I'm trying a keep a 2-frame separation.) (In the end, because of plank twist near the scarf that I needed to remove, I could only get a 1-frame separation.) So, I'm going to try to get by with a two-frame overlap. The advantage of a 3-frame overlap is that the curve at the middle of the overlap should be an accurate representation of the shape of the plank, because you have at least one data point on either side of the middle. So aligning the two sections should be accurate. With just a two-frame overlap the curves will not match as well (curve flattens out at the last data point).

To alleviate this problem, I'm going to temporarily extend the plank (with a piece of scrap) to get one or two more data points for the curve. In that way I should have an accurate representation of the shape of the plank between the two overlapping frames. (I now realize that extending the plank doesn't accomplish much. Since the plank section will be fitted to the plank above, the shape of the curve will ultimately be correct regardless of the initial cut.)

January 31: (out of town for 10 days)

Cut, beveled, scrubbed, and fitted the aft plank section. Just 1 fitting cycle and a bit of edge set at the aft end and the fit was good.

Cut, beveled, and scrubbed the middle section. The initial fit is not very good (almost 3/16" gap in one area). Not sure how this happens. The bevels and scrubbing seem to be right on. Took over 4 hours to do the scrubbing, however.

February 1-2:

Fit the middle section. The large gap proved to be problematic. It took quite a few cycles to get a tight fit. The problem has to do with having to remove a lot of material from a long edge – it's difficult to keep the bevel angles correct.

Scarfed the middle section to the aft section. Here the overlap is only two frames, but it seems to be enough. We'll see when I put the glued up sections on the boat.

February 3:

Removed clamps and cleaned up the scarf joint. The top edge was almost perfect – just had to remove the squeeze out. The concave area was a bit rough. Since the concave face

was face down during the glue up, there was no way to apply clamping pressure to the concave feather edge. Just a bit of clean up with the scrubbing plane was all that was need.

Redefined the cut line for the bottom edge. Note that the reference for the cut line is to the inside edge, so because of the obtuse bevel angles, the layout for the cut line was done on the inside face. But it will be better to make the cut on the flat outside face, so I used a combination square to copy the reference marks to the outside face.

Using a fairing batten, I faired the points for the bottom edge (inside face). With this line as a reference, I checked that the scrubbing templates fit between the top edge and this reference line. Some adjustment was needed at several stations.

After making the scrubbing adjustments, I clamped the plank to the boat. With the combined aft and middle sections, the plank was too long for me to move it by myself. I also used two ropes from the deck to hoist the plank in place.

With just a couple of wedges, the plank fit just fine – no gaps as large as .022". So using just a two-frame overlap seems to work ok.

March 10:

I was skiing for 4 weeks over the last month, so progress was slow. I did finish plank S18, however. Here is a summary:

- Scarfed the forward section to the combined middle/aft sections. Cutting the scarf was problematic because the middle/aft section would not lay flat. So I cut the two scarfs separately. The end result was less than perfect (feather edges a bit high; bottom edges don't quite match), but the joint was tight and the alignment marks lined up, so after some trimming the joint was acceptable.
- Scrubbing the outside face. Marked edges at 5/8" with red pen and scrubbed to these marks using my templates.
- Checked fit and made reference mark at frame 22. Cut caulking bevels while plank in position on boat.
- Applied primer, applied sealant, clamped plank in place and fastened with 2 screws per frame. Finished fastening next day.
- Installed 7/16" bungs set in red lead, trimmed bungs with chisel and apron plane.