

Keel Repair (11/3/2011)

Keel Rabbet

If you visit the link (Hull) you will find pics and commentary about the poor condition of the rabbet in the keel on the port side. My first thought was that someone had previously repaired the keel with some form of scarfed insert, but after removing the deadwood it became clear that the keel was severely checked in this area. So substantial repair was called for. The plan is to plane away the section of keel below the middle line of the keel rabbet and epoxy in a replacement piece - sort of a long narrow Dutchman. The first thing, however, is to record the shape of the bottom of the keel before I start planing. For this I make a template.



I used Luan underlayment, which is cheap and works well. I just clamped the Luan to the bottom of the keel and drilled down through a few of the vacant bolt holes to register the template's location. Then I just traced the shape of the keel onto the template, removed the template from the boat, rough cut the curve with a bandsaw and planed to the line.

Because of the length of the repair, the template consisted of two pieces. In the picture above, the two pieces are laid together with the longer forward section in the foreground and the short aft section in the background. The keel curve is towards the bottom of the photo.

A number of options were available in choosing what part of the keel to remove. The surface where the planking meets the rabbet starts out horizontal aft but rolls almost to 45 degrees toward the bow. If I removed all the wood below this rolling surface, I would end up removing a lot of good wood forward. Also the replacement piece would have to twist at it went forward with no easy way to clamp it. Ultimately, I decided to just remove wood vertically, so that the planed surface would be perpendicular to the bottom of the keel plank.

The following pic shows where the previous rabbet was planed away. A power hand plane is a great labor saver for a job like this but you must be careful not to remove too much or in the wrong place. In some places I neglected to keep the power plane perpendicular to the bottom of the keel, which required some adjusting with a hand plane (taking a bit more wood than I would

have liked). I also inadvertently cut some shallow grooves in the back rabbet (painted yellow), which I later filled with epoxy. All in all it worked out ok.

By the way, the yellow paint on the back rabbet was so that I could tell where the rabbet meets the back rabbet (the middle line) after planing.



Now with almost an inch of wood removed, you can really see the extent of the checking.



As the following pic shows, I had to remove a fairly large chunk of keel to get down to reasonably good wood. Note the rather odd shape of the repair - sort of a scarf at an angle. It might not look like it in the picture, but those surfaces have been planed flat with no noticeable twist. A lot of hand planing to get this right! I would use the longest plane possible to keep the surfaces flat but a regular plane can't reach where the two surfaces meet. So I had to use a bullnose plane to clean up that section. (I subsequently learned that a large chisel, called a slick, is the better tool for this job. When I face this problem again, I'll get one.)



And here is a pic of the replacement piece. I just had to be sure that the faying surfaces were right and just a tad oversize. After epoxying it in place I planed the bottom surface flush with the bottom of the keel and the adjoining surface perpendicular to the bottom.



Here you can see the finished repair.



Now for the piece to replace the rabbet ... I didn't have a piece of H. Mahogany long enough, so first I had to scarf (10:1) two pieces together. The following pics so the process.

I use a method for cutting scarf joints that pretty much guarantees a good fit. First, look at the grain of the two pieces to be sure that the grain will be running the same direction when the two pieces are assembled. Otherwise you end up with grain tear out when you later plane the finished piece to shape. Then clamp the two pieces together as shown in the pic below - the top piece set back the length of the scarf (12" in this case, since the piece is about 1-1/4" thick). Now draw a diagonal line starting from the bottom left hand corner of the bottom piece to the top of the top piece, 12" back from the front of the top piece. You can just see the line in the pic below.



Now plane down to the line, regularly checking that the top surface is square to the sides. A power plane is handy for removing the bulk of the wood in a hurry. Use a jack or jointer plane to finish to the line. Note that I've clamped the bottom piece right at the edge of my bench so that the feather edge will be supported.

The pic shows the process almost complete. Even with a long-bodied plane, it's possible that the tapers on the top and bottom pieces can differ. There are two visual checks that allow you to keep the tapers the same. The first is the thickness of the feather edges on the two pieces. Keep these thicknesses the same and uniform across the width. Also keep the lengths of the tapers the same. In the pic below, you can see where the bottom taper ends by the change in color.

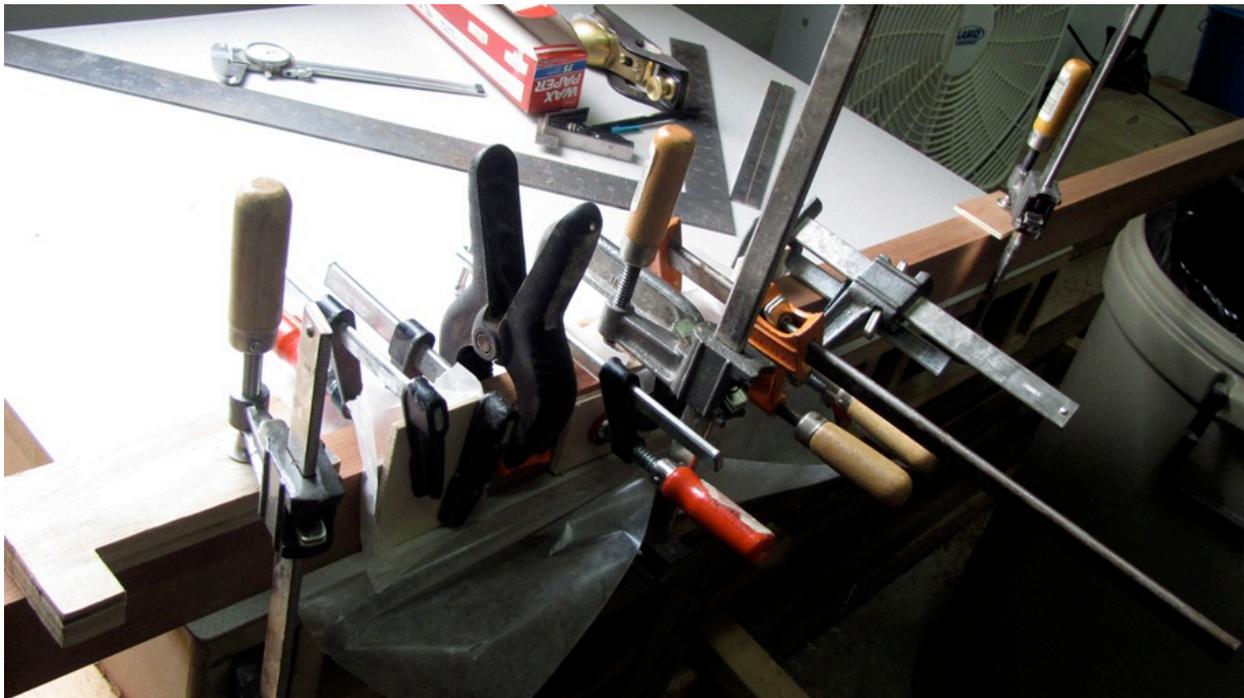


If you maintained these visual checks, you should end up with a continuous taper as shown in the pics below.





Here the two pieces are being glued together. If you've been careful, you will have little or no trimming to do when the glue dries.



The next two pics show the finished scarf.

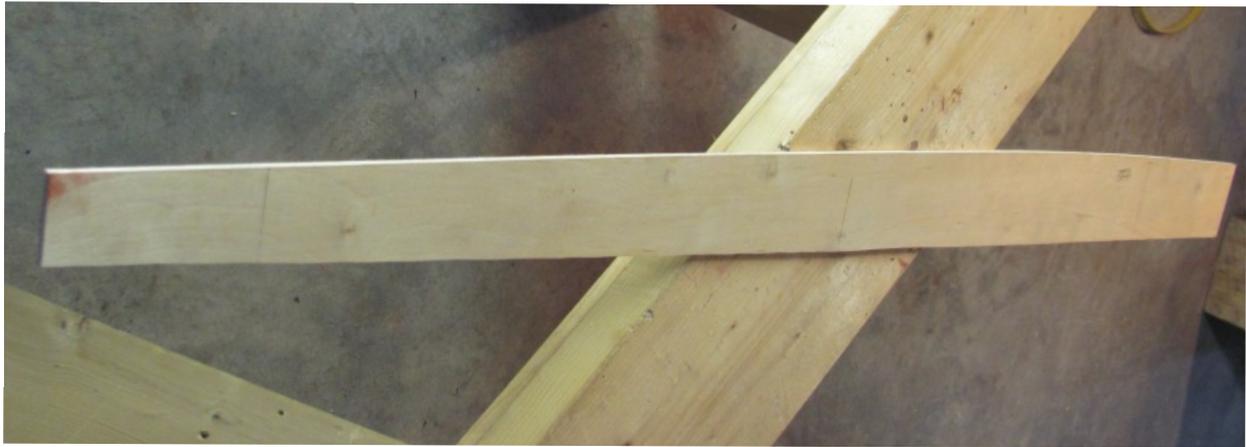


Ok, so now it's time to glue the replacement piece to the keel, but there is a bit of fitting to do first. To see why this is necessary consider the shape of the keel plank viewed from the top. A picture of the keel is provided below.



In summary, the keel is very narrow aft, widens to a maximum somewhat forward of amidships, and then tapers towards the bow. The repair does not extend the length of the keel, however, so the repair must be tied in to the original/remaining keel rabbet. Typically, this would require two scarf joints (one at either end), but the geometry of the keel leads to a simplification. I need a scarf joint aft but because the keel tapers towards the bow, I can just let the repair run out to a feather edge.

Normally, I would use a typical 10:1 scarf aft. In this case, however, removing the damaged wood aft with a plane left me with a curved surface rather than a straight taper. I could have opted to remove some additional wood to make a traditional flat scarf joint, but I decided it was easier to just make the repair fit the curved surface. So I made a template of the curve (just clamp a piece of template stock to the bottom of the keel and run a pencil along the keel), traced it onto the repair piece and planed to to shape. The template and the tapered repair piece are shown in the next two pics.



Clamp the repair in place.



Sometimes custom clamps are required.



The repair glued in place. Now the hard part - trimming the repair to shape.



The repair piece was intentionally made oversize in all dimensions - it's just too risky to try to cut the repair piece to shape before gluing. Therefore, trimming the repair was a three-step process: (1) trim the bottom of the repair flush with the bottom of the keel, (2) cut the top (rolling) bevel forming the rabbet, (3) trim the width of the repair to 1" wide at the top surface and the bottom surface matching the shape of the deadwood. Recall that before removing the old rabbet, I made a template of this shape.

Trimming the repair flush with the bottom of the keel was fairly straight forward using a jack plane. Cutting the bevel was next. Here are some tools that I used.



I used the Fein Multitool to plunge cut a pair of saw kerfs about 1" apart and then cleaned out the wood between the kerfs with a chisel, being careful to maintain a 90 degree angle between the two surfaces (rabbet to back rabbet).



After that, I used a shoulder plane to clean up the rough spots. The pic below shows the process about 1/2 done. The left side has been planed smooth while I continue to cut slots to the right. The shoulder plane is visible at the bottom of the photo.



Next I trim the repair to the correct thickness. First I trace the shape of the top of the deadwood onto the bottom of the repair, using the template I made earlier. Then I draw a line 1" from the middle line. These are my two reference lines. I make a pair of saw kerfs connecting the two reference lines and chop out the wood between. These slots make it easier to judge the depth of cut when removing the bulk of the wood with a power plane.



The pics below show the finished repair.



Looking aft.



Looking forward.



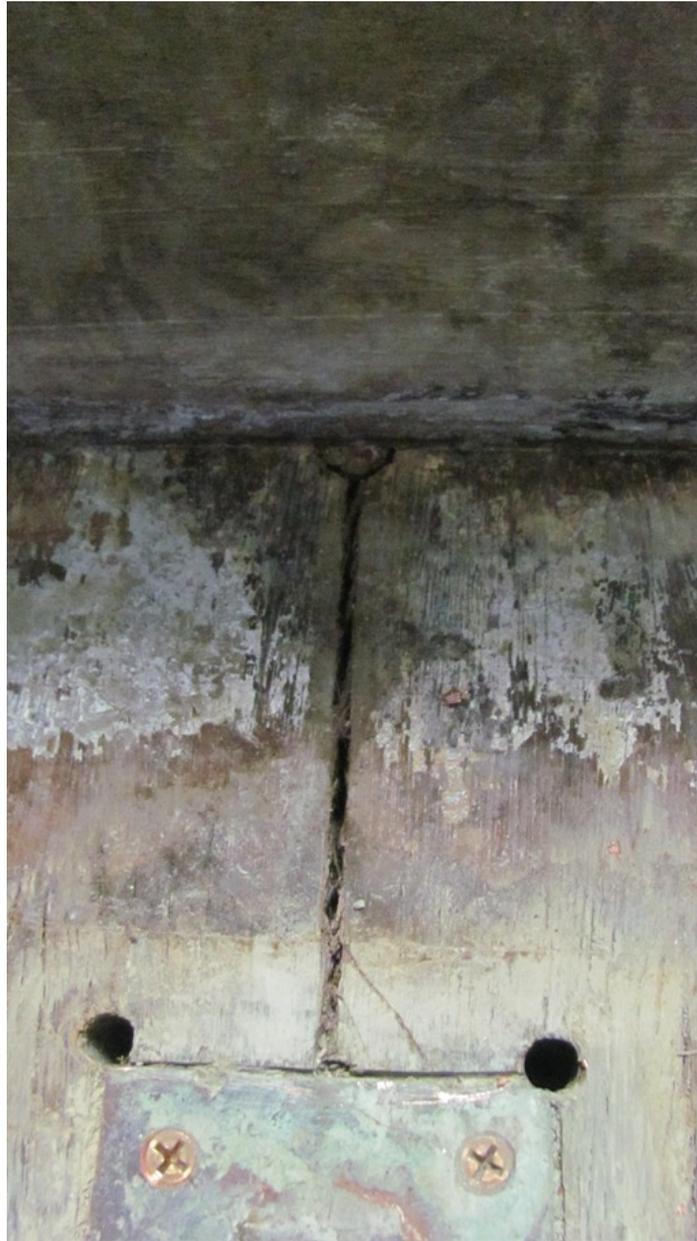
Check in Keel

11/14/2011

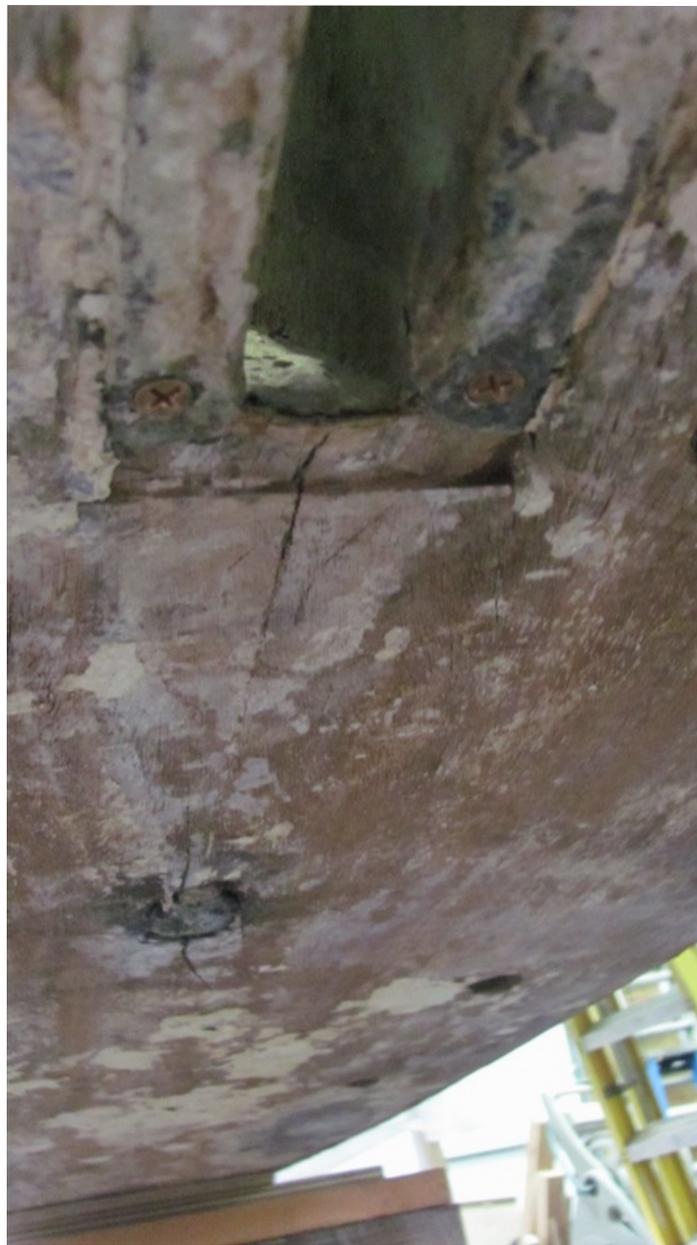
The keel had one other problem that needed attention - a check along the centerline. The pic below shows the top of the keel plank with the centerboard trunk removed.



At the top of the picture, you can just see a check along the centerline of the keel that starts at the floor and travels aft to the slot for the centerboard. This next pic provides a closeup of the check.



The centerboard slot contains a copper liner that cannot easily be removed, and this liner obstructs one's view of the check. So you can't really tell whether or not the check extends to the CB slot. The following pic shows the bottom of the keel at the forward end of the centerboard slot. Again it's not clear if the check extends to the slot.



It's possible that this check could swell shut after the boat is launched, but I'm considering installing a stopwater just in case. Looking at the first pic above, I would install the stopwater just in front of the liner so that the centerboard trunk flange would rest on top of the stopwater. In that way, any water that travels from the centerboard slot forward would encounter the stopwater, travelling upward it would stop at the flange of the trunk.

On a related note, take a closer look at the first and second pics above. Note that the check extends forward to the floor. Observe that a stopwater has been inserted there. A view of the bottom of the keel (below) shows that the stopwater runs adjacent to the bolt that secures the floor to the keel. In fact, there are three bolts securing the floor and all three have similar stopwaters. Why was this done?



12/15/2011

I believe that the "stopwater" question has been resolved with the help of advice from the Woodenboat Forum. Since there are "stopwaters" in the same relative position in all three floor bolts, it seems likely that the original bolt holes were drill incorrectly and that these "stopwaters" were used to plug the holes.

As for the keel check, the best advice appears to be to use refined (so that it won't go rancid) tallow to fill the gap. This will stop any leaks and will extrude out if the crack swells shut. I found a source for the tallow on line.

11/18/2012

After much thought, I decided to fill the check. I was advised against filling the crack with anything solid for fear that it might produce a wedging effect causing the crack to enlarge. Filling the check with tallow was also mentioned. Ultimately, I decided on the following strategy. Using a drill bit somewhat larger in diameter than the widest part of the check, I drilled a series of holes along the crack, maybe $\frac{1}{4}$ " deep. I then connected the holes with a chisel forming a trench slightly wider than the original check.



I then filled this check with 3M5200.



My rationale for this approach is as follows:

- Since the trench is wider than the check, if the check closes up there will still be room for some sealant – the excess will simply extrude upwards.
- The making of the trench should provide fresh wood for the sealant to bond to.
- This process should provide some protection against a possible future leak.

Unfortunately, there are some negatives ...

- 3M5200 is not solvent resistant, so using it in the bilge is questionable (I didn't realize this until after I'd finished).
- The check passes under a wood floor and one of the floor's bolts pass directly through the check under the floor. Ideally, I should have removed the floor to make a proper repair, but this would have been a major undertaking. Instead, I attempted to inject sealant into the check on both sides of the floor. Whether or not this will be effective remains to be seen. I shudder to think of how difficult it might be to stop a leak in this area after the boat is finished!