Corbin 39 : Repairing Damage To Keels, Skegs, And Rudders

In 2019/2020 a couple of Corbins have carried out very similar repairs to their keels, the rudder skeg, and the rudder itself, and they have kindly shared their experiences with us, along with some information from others.

We know, from written responses by Marius Corbin that the aft end of the keel is not structural:

> *The keel and the hull were built and laminated together, and so is the bottom of the keel. The center of the hull, including the keel, had additional layers put in and in order to do so, and since the back end of the keel is so narrow, we had to fill the aft end with putty (about 2 feet). Additional layers were then put in. Therefore, the aft end of the keel is not structural and is considered sacrificial. Consequently, when damaged, you only need to fill the damaged part with putty and cover the repair with a couple of layers of fiberglass. The bottom should be repaired using alternating layers of 24 ounce woven roving and 1.5 ounce mat, starting laminations with mat. There are many layers on the bottom and you only need to replace whatever was damaged. But, putting too much is better protection for future groundings (I know, I know, you never ground…). Personally, I would put a minimum of 10 layers of alternating mat and roving and finish with 2 layers of mat. At 1/32 of an inch each you should have 1/4 to 3/8 of an inch thick. The more, the better. Hope the above will be of some help, and have a wonderful day. Marius Corbin*

There is some suspicion that the reason there are similar cracks at the aft or trailing edge of the keel in a number of Corbins after 30-40-years of use is due to handling during yard moves. The base of the keel is flat, and if the boat is initially set down towards the stern then 10-15 tonnes of weight will land on a very small non-structural area.

Regarding the skeg it appears that the rudder skeg was fibreglassed into place on the hull. It is not 'keyed' internally into the hull and so this is a relatively weak joint by comparison with the remainder of the hull that is overbuilt. The repair carried out on #135, "Petit Chantier" includes a fibreglass internal key so that the final result is stronger than the original. Additional external glass fibre will also increase strength, and both #135 and #086 did this, as did the #174 "Anakena" repair by Bill Schmid. Alternatively one could drill down from within the hull and insert and epoxy stainless steel reinforcements down the skeg centre.

There is section in the Corbin 39 FAQ on keel, rudder, and skeg repairs and these notes will be added into the FAQ.

#135 "Petit Chantier" previously "Necessity"

By Eloi Maro (with Anabelle Bilodeau) carried out in Florida, USA

We have just finished (Jan 2021) all the glass repairs on #135 "Petit Chantier" previously "Necessity" yesterday which means I am done sanding and applying fiberglass woohoo! So I thought I would share the repair with you guys.

Keel repair

The keel had a crack running from top to bottom on the aft (where is seems to have been the case on a couple other Corbins). That area did not seem structurally important to the keel since the original glass skin over the full length of the crack was only about 2-3 millimetre thick and only chop strands matting.

1. We sanded all the paint and gel coat on a much larger area than the problematic area, about 15 inches on each side of the crack.
2. Drilled holes in a pattern along the problematic area (about 100 holes) luckily it was not very wet, the cracked filler material did not seem to have absorbed water like one could think.
3. I taped some bubble wrap around and on the area where the holes are, connected a vacuum and let the vacuum run for a couple of days. The idea is that the bubble wrap provides a vacuum chamber and gap between each bubble provides a channel for the air and moisture to pass through.
4. After 6 days of vacuuming, I then very liberally injected acetone in every hole with a syringe to help remove the remnant moisture and contaminants.
5. Once dry, I injected 105 West System epoxy thickened with 406 West System colloidal silica in every hole starting from the bottom and working upwards with the help of a syringe. Pressing hard on the syringe helps forcing the epoxy in every cracks.
6. We then added 4 to 8 layers (depending on areas) of 1708 biaxial fiberglass cloth on the area of the crack going further 15 inches on each side for the first patch. Done with 105 West System epoxy.
7. Lastly faired the surface smooth with West System epoxy fairing filler.

Skeg External Repair

1. The skeg had core crack only where the skeg connects to the hull (presumably the weakest point). There was no fiberglass delamination on the skin to my happy surprise. When we bought the boat I could move the skeg about 1 inch on each sides.
2. I sanded all the skeg and about 25 inches up the skeg to bare fiberglass inside and outside and had it inspected for damage. (It is much easier to see what is up without paint on).
3. Drilled hole in a pattern on the junction skeg to hull to inject epoxy in the same method has the keel repair. That partly reglued the core together as well as the core to the skin and got rid of about 75% of the flex already.
4. Applied 4 layers of 1708 biaxial fiberglass cloth and 4 layers of 1808 biaxial cloth on each sides of the repair (total of 8 on each sides) using West System epoxy from 25 inches of the junction to 8 inches. repair, going subsequently smaller and smaller. Total thickness of 1/2inch of fiberglass.
5. I then faired the surface smooth with epoxy fairing filler.
6. That got rid of 90% of the flex.

Skeg Internal Repair

1. Dug a trench about 8" deep in the middle of the skeg on its full length. I could see the crazing of the core in a spider web manner. I could see most of the cracks filled with epoxy and some that were not.

2. Laminated a 3/4inch thick board of fiberglass using 1708 and west system epoxy that in inserted in the skeg's trench. [This is the 'key' that increases the strength internally.] Then I poured slightly thickened epoxy in the trench to recore the area and fix the board in place.
3. The glass board goes inside the skeg 8 inches and sticks out about 15 inches high, following the line of the rudder stiffener
4. I cut to shape in closed cell foam (poly-umac t-60) to build bulkheads that would attach to the part of the board that sticks out.
5. Epoxied the foam boards in place and then fiberglassed everything in place with 10 layers of 1708 cloth and epoxy. (About 1/2 inch thick around everything, bulkheads, board, floor, etc.) Very strong.
6. Sanded smooth and painted with white Interprotect 2000e, doing the last coat today.
7. That got rid of 110% of the flex

Thank you to Anabelle Bilodeau for the help 😘, Romain Barrier for the technical advice and others that gave opinion. Outside repairs are 99% seamless due to proper bevel in the glass application and proper fairing. We have been in the yard for more than 2 months doing this repair has well as many other things; replacing rudder, through-hulls, barrier coat, antifouling, cutlass bearing and many more. Should be in the water next week.

Hope this is interesting to the Corbin 39 community which I am proudly part of. I am not planning to self promote on this group but I have the repairs made in video on our youtube channel (the outside repair video is done and the inside repair video will be up next week) let me know if you want to have the link to see the first part in video.

Regards, Eloi Maro

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#086, "Stella", previously "Jack Iron"

By Wouter Tooren (with Lisa Koman), carried out in Lisbon, Portugal.

(note this mk1 #086, "Stella" is a different Corbin than the mk2 #312, "Stella")

When we bought "Jack Iron" (now "Stella") in 2018 we noticed a provisional repair done on the skeg. We knew this was a red flag - but how bad it would really be we didn't know until we set our grinder to work. Here I'll document what we found and how we fixed it, with the photos as a reference.

What we found after grinding the surface away was:

- A hole at the base of the skeg at the bowside with a crack running along its length.
- Another hole and crack at the other side of the skeg, where the rudder sits. Both holes were previously repaired with polyester filler/paste that had not cured well and had separated from the fiberglass.
- Small hairline cracks and surface crazing on the large starboard and backboard [port] surfaces of the skeg.
- We noticed a crack on the bottom of the rudder and small dents and chips taken off at the corners.

- We noticed the beginning of cracks at the center split near the shank.
- We found a small crack running upwards in the fiberglass shaft where the rudder shank rotates inside.
- The back of the rudder, along its length from top to bottom, has a wooden profile that had become exposed and was partly rotten away.

The skeg itself did not move or wiggle any more than could be expected and was firmly attached to the hull. It was also properly aligned. This was a relief, because we figured it meant that we had mostly surface damage.

However, the damage was too severe to be checked off as just general wear and tear. Our guess is that at some point the skeg and/or rudder must have hit something, or it was snagged by a line or a fishing net, deflecting the hull laminate at the front and at the back sides of the fin.

We decided that we would repair the damage by dropping the rudder, removing the old repairs, grinding away and hollowing out the parts that were compromised, and than refill and rebuild the whole set with epoxy filleting and fiberglass cloth. We also wanted to make the skeg somewhat stronger than its original design to prevent or lessen damage done the same way in the future.

We didn't do anything about the crack in the rudder shaft. Although this was a giveaway that the rudder was maybe overpowered or had hit something, repairing it meant rebuilding entire parts of the hull and rudder assembly, and we judged that the damage was just not big enough to justify it.

This how we did it- the abbreviated version. What I remember I will add as descriptions to the photos.

1. We sanded off all antifouling.
2. We dropped the rudder. To do that first we raised the boat a bit and dug a hole beneath the rudder to make enough space. We used the boom to attach a strap to the tiller top part at the shank. We removed the heel shoe and the rudder quadrant. Using a winch we gently lowered the rudder until the rudder was on the ground and the shank was out of the shaft.
3. We grinded and drilled out all the cracks and the voids until we reached solid fiberglass everywhere. We than thoroughly cleaned and rinsed all surfaces with acetone.
4. We filled all the holes with epoxy, made into a thick filleting paste with Colloidal Silica. We than grinded and sanded everything to make a smooth, faired surface.
5. We cut long sections of fiberglass cloth in ever wider degrees. to apply to the top section of the skeg. I think we added about six layers in total. We used light, twill woven material about 160 gram/m2. We used this so we could perfectly follow the round curves of the skeg and the bow. We applied the cloth with epoxy resin.
6. We cut long section of fiberglass cloth and applied it to the rudder and bow and sides of the skeg where necessary.
7. We made a new hardwood rudder end profile, and using epoxy glued it in place. We then used fiberglass matting and epoxy to protect the wood from seawater.
8. We re-attached the rudder and using a winch raised her into place. We than re-attached the heel shoe and the rudder quadrant, not forgetting to use a water resistant grease when we attached the gland assembly. We re-used the bronze bolts that were used to bolt the heel shoe back into place, because we could not find replacement bolts.
9. We added two layers of white Epoxy Barrier Coat as a prevention for osmosis on all bare surfaces.
10. We finished with three layers of red antifouling.

We used West System epoxy for all materials. Don Casey's "Complete Illustrated Sailboat Maintenance Manual" proved to be a great guide. It really paid off to buy a couple of technical handbooks and do a proper google search. We also learned a lot by looking at similar repairs done to other boats. And we enlisted the advice of the great people at the Tagus Yacht Center in Lisbon - which is an excellent place to repair your boat. This repair took about 4 weeks, and we did it in September 2018.

Explanations of each photo:

1. The backside of the skeg, looking towards the bow, after our initial grinding. We marked all the holes and bored everything out.
2. The heel shoe, with the bronze bolts removed, before repairs.
3. The backside of the rudder and skeg, before repairs after initial grinding.
4. One of the four bronze bolts holding the shoe in place.
5. Frontside of the skeg, looking towards the rear, after initial grinding. We marked all the filled in holes and proceeded with grinding everything out.
6. Another photo looking at the skeg towards the rear, with a bit of the prop in the bottom right corner. All the old repairs had to be removed.
7. Surface crazing of the rudder and skeg. We were not worried about this.
8. Front of the skeg after initial grind. You can see how the old polyester filament had not stuck properly to the fiberglass and broke apart.
9. Rudder, looking at the backside with the wooden profile taken off.
10. Some more grinding and sanding around the stern and bottom of the boat, so we could apply fiberglass cloth later.
11. The crack in the fiberglass rudder shaft, looking upwards into the shaft. We did nothing about this crack, as we judged the cost of the repair being higher than the proceeds.

    (A comment from Olly James of #311, "Abenaki": I had a suspected crack / leak in my stern tube. I removed the P-bracket, removed the propshaft, then cleaned using an extension on an electric drill with sander, then applied 20 layers of West System over a period of weeks. Leak fixed!)

12. The rudder, frontside, with the beginning of a crack at the split where the two sides of the mould would have been glued together. We sanded and grinded down the crack, faired it with epoxy and reinforced it with fiberglass cloth, cut to size.
13. Another photo looking at the backside of the skeg after more grinding, with the rudder shaft visible at the top.
14. The dropped rudder, before repairs. We did an initial grind to assess the damage. The white stuff is dust.
15. The original look of the skeg and rudder, with surface cracks visible.
16. Original look of the rudder and skeg, before repairs.
17. Situation before repairs. You can see damages to the rudder, but that was just old thick antifouling. You can also see parts of the old skeg repair.
18. Close up of the skeg before we started our initial grind. We knew where we were getting into when we saw this - but how bad it would be, we did not know at this point. It turned out to be bad - but not too bad.
19. Another close up before repairs.
20. Lisa applying the epoxy filler to the backside of the skeg. We used a thick, paste like mixture, and pasted it into all the corners, then smoothed it out. The more you can reach a smooth finish, the less sanding and grinding later.

21. The front side of the skeg before filling in the holes. We went about 6cm deep into the skeg, until we felt we reached a solid enough bedding.
22. The rudder with the now re-attached hardwood profile at the backside. We glued it in place with epoxy, then added a smooth fiberglass cloth over it to protect the wood.
23. The backside of the skeg with the filled in hole, but before we added the fiberglass.
24. The frontside of the skeg with the filled in hole, but before we added the fiberglass.
25. Lisa applying ever-wider broad fiberglass cloth swaths to the hull and skeg. We wanted to reinforce the skeg, but we also did not want to overdo it. We figured the skeg still needed to be flexible enough to bend with the water and wave forces. [Actually one wants as stiff as possible a hull-to-skeg joint].
26. Other side of the skeg, with our second or third fiberglass cloth layer applies to the skeg. We used a light cloth so it would perfectly follow the shape of the hull.
27. Before we applied the cloth, we first drew and cut out all sections.
28. Here is the finished skeg with the barrier coat applied and the rudder rehung, but without the shoe.
29. Other side with the rudder reattached. The white stuff is the barrier coating. The shoe still needed to be placed back in position.
30. Bottom side of the skeg and rudder, before replacing the shoe.
31. The finished work with antifouling. Hopefully good for another forty years.

Regards, Wouter Tooren

#174, “Anakena”

By Bill Schmid

During the course of these projects Bill Schmid informed us that a few years ago he had suffered skeg damage from impacting a large log in British Columbia. He fixed it with an external fibreglass repair as shown in these photos.