

CRACKS IN THE WING by Fred Keip

As most of you know, my Sonerai IIL is "old". On June 8 of 2011, she celebrated the 25th anniversary of her first flight. She's also turned more than 1300 hours on her Hobbs meter.

So, I guess I wasn't too surprised (a little disappointed, perhaps, but not surprised) to find a couple small fatigue cracks in the left wing skin just outboard of the wing walk area. They actually showed up as two small cracks in the Superflight polyurethane paint next to two of the rivets that attach the upper inboard skin to the #2 wing rib. The interesting thing was that the cracks did go thru the rivet holes, but followed around the edge of the dimple. Now, I wasn't overly concerned about the structural integrity of the wing, but I wanted to know the cause, and if there was any underlying damage to the #2 rib.



The cracks are just to the left of the wing walk pad at the 5th and 6th rivets from the rear spar. The paint was removed to show the cracks. The paint removed at the rear spar rivets is due to some corrosion that was under the paint.



A close-up of the skin cracks. If you look closely, you can see a third crack at the top rivet.

So, with a little help from a friend, I pulled the three LH taper pins, pulled the wing, and set it on a pair of saw horses. What I found right off the bat was that the fitting that attaches the root rib to the rear spar was cracked, twisted, and one of the rivets that attached it to the rib was pulled thru the rib. Also, the rearmost top skin rivet in the root rib had pulled thru the top flange of the rib. Inspection of the #2 rib showed no cracks in the rib flange under the skin cracks, nor at the attachment to the rear spar. And there were no cracks or distortion of the wing walk structure.



The failed root rib attach bracket. Note that the top rear rivet has pulled thru the rib.

I should probably digress a bit here and describe my wing walk arrangement. When the low wing version of the Sonerai II was first offered, there was nothing in the plans relative to building a wing walk. I decided that it would be a good idea to have one to make it easier to get in and out of the cockpit, particularly when I got "old", so I designed the structure. It consists of five C-shaped formed channels made from 0.025" 2024-T3 alclad that are equally spaced between the main and rear spars, and attached to the #1 and #2 ribs with small angles fabricated from the same material. I also riveted a 0.025" sub-skin from the front channel to the rear channel to provide additional stability to the channels. The main wing skin covers all of this. This whole arrangement was designed to carry well more than my weight.

The one thing I didn't adequately consider when designing the walk was how the loads would get transferred into the rear spar, and that was the cause of this problem. The wing ribs are attached to the rear spar with a single rivet in each rib. What happened in this case is that when I stepped up on the wing, the rib would push down on the attach bracket, and since the rivet was offset from the center of the rib, the rib tried to rotate around the rivet. At some point the fitting cracked allowing the rib to move downward. Because the rib moved downward, the top wing skin was forced to bend over the #2 rib. And the cracks were the result.



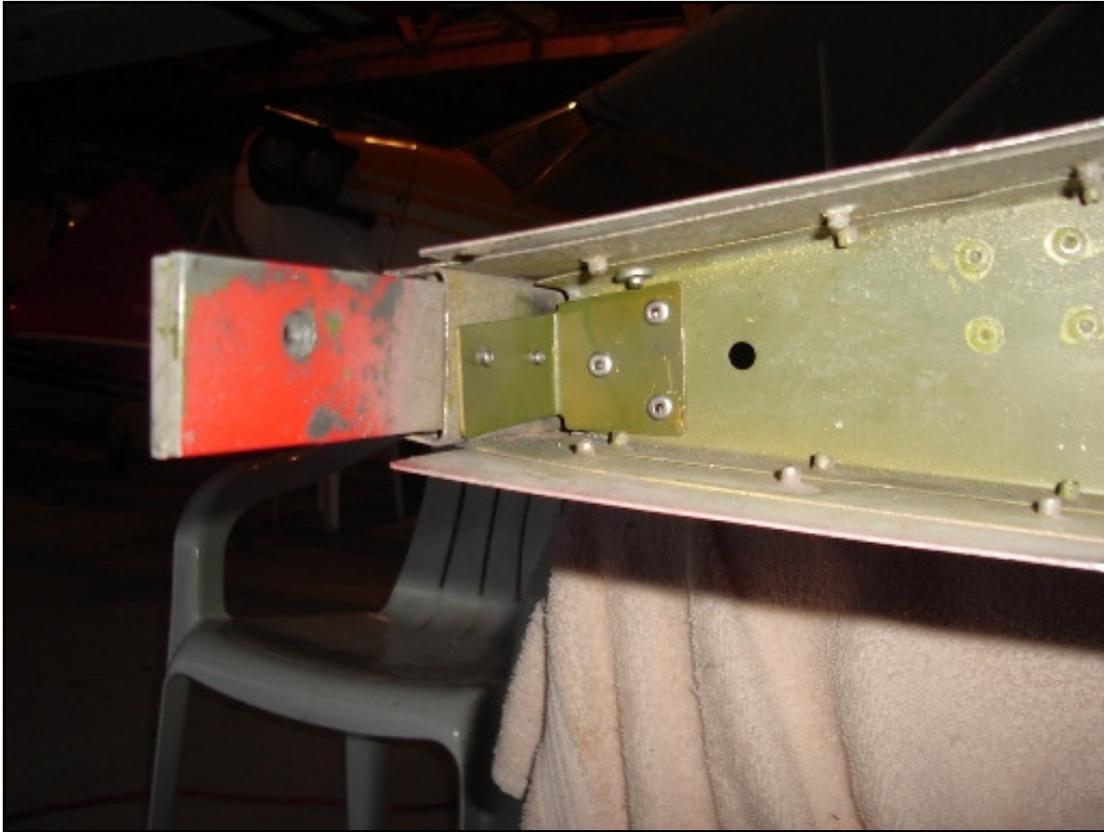
With the original bracket removed.

But the airplane only has 1263 hours on it. Why did the cracks form? As I thought about it, I started thinking about how many times that I've gotten in and out of the cockpit. Each time I fly, I get in and out of airplane once, so that's two load cycles for each flight. If each flight was an hour long, that would come out to 2526 cycles. Now, I often fly flights that are less than an hour, plus I often go to other airports for breakfast, and so on, that are less than an hour away, so I could easily double that number to over 5000 cycles. And then there's getting in and out for maintenance, etc, so the number could be even higher than that. It's not hard to put on a lot of cycles. And it's cycles that cause fatigue cracks.

The fix turned out to be fairly simple, and didn't require a lot of wing disassembly to install. I decided to do three things: 1) install a new root rib attach bracket that was stronger and picked up two rivets in the rear spar to prevent it from rotating, 2) replace the rear top rivet securing the skin to the root rib, and 3) stop-drill the fatigue cracks.

I started out by drilling out the two rivets that secured the original bracket, plus the inboard-most spar rivet.. I then fabricated the new rib rear attach bracket from 0.040" 2024-T3 alclad (actually a piece of leftover spar channel stock). The three 1/8" holes for the rib attachment rivets were predrilled. I clamped the bracket to the rear spar, and drilled the three holes in the rib using the three holes in the bracket as a guide. With the bracket clecoed to the rib, the two holes to the spar were drilled. I then riveted the

bracket using three CCP-42 and two CCP-46 rivets. The top skin rivet was drilled out and replaced with a CCC-42 rivet and an 1/8" back up washer to accommodate the damaged hole in the rib.



With the new bracket and top skin rivet installed

The final step was to stop-drill the three cracks in the wing skin. I did this by carefully chipping away the paint around the three cracks, and lightly sanding the area to determine where the ends of the crack were. The ends were then punched with an automatic center punch, and then drilled with a 3/32" drill bit.



The stop-drilled cracks

To finish things off, I filled each of the holes with a dab of JB Weld to seal the holes. Once the epoxy dried, I sanded the area and applied a little touch-up paint. At the same time, the corrosion above the rear spar was cleaned, prepped, and touched up, too.

Once I put the airplane back together, and stepped up on the wing, I could tell that the wing felt stiffer. Hopefully, these cracks are fixed, and no new ones will appear.

So, what does this all mean? Well, in my humble opinion, if you are building, or have built a low-wing Sonerai, and incorporated a wing walk structure in the left wing, take a look at the number 1 and number 2 wing rib attachments to the rear spar, and check for distortion and damage. And at a minimum, replace the connection with something similar to what I've done. With a proper load path into the rear spar for the wing walk loads, you won't see skin cracks like I did.