Propeller loss on a Sonex

By Robert E. Barber

Builder/Pilot of Sexy Hexy (N157SX)

On a recent business trip to Madison, WI, I decided to return via Minnesota, North Dakota, South Dakota, and Nebraska, just so I could add them to the list of states I have landed in. During the trip, I lost the propeller in flight. In the hopes that someone will benefit from this experience, the following is a short description of the event and crude analysis of the failure.

The Aircraft: 2008 Sonex powered by a Jabiru 3300A (S/N 299) Solid Lifter engine. The engine and airframe has about 845 hours on them. It has Rotec water cooled heads, and was running well at the time of failure.

I had flown through Minnesota, stopping at 55Y (Rushford) for fuel, then on to BWP (Stern) with a headwind and low ceilings, then turned south toward South Dakota. I was only managing about 1500 ft AGL over much of the trip to this point. The ceiling broke up soon after leaving North Dakota, so I climbed up to 8500 ft where I found a nice tailwind and was cruising at 175 MPH ground speed on 2950 RPM. Nice! The Jab was just humming along like it usually does. About 10 miles northwest of Sioux Falls (FSD) noticed the abrupt onset of a vibration, so I decided to land and investigate. The nearest was Sioux Falls, SD (FSD), a Class D airport. Just a little to the south was Skie-Lincoln Co (Y14) in Tea, SD. I opted for Y14, since it too was easily within gliding distance. I changed course and started the decent, throttling back to about 2550 rpm. The vibrations slowly got worse. Not terrible, but noticeably worse. I entered downwind a bit high and throttled down to about 2000 RPM. Leveled off and slowed to ~110 mph IAS. The vibrations are still getting worse. When I am abeam the numbers, and throttle down to idle, as usual for me, but also getting seriously concerned about the increasing vibrations. The vibrations are still not awful, but definitely not normal for the normally very smooth Jabiru. The act of going to idle was apparently enough to do the trick, and whack!, off went the propeller! I flew up and to the left in a wood colored blur. I did not watch it land as I was a little concerned about flying the airplane. I announced an emergency, and a guy on final made the appropriate hole for me (Thanks, whoever you are!). I flew a normal approach and landed as usual (actually not usual, as it was a very good landing!), and coasted all the way to the ramp before shutting off the engine (forgot it was still running). For what it is worth, the Jabiru 3300 idles crazy smooth without a prop on it. I got out, and pushed the plane about 100 ft to put it in front of the FBO. I finally walked around to see the damage. The picture below is what I saw.

Figure 1. Note the missing prop hub and the fatigued screws still in the crankshaft.

The Socket Head Cap Screws had fatigued and failed. Note the rust on the screw remains in the picture. This has been going on for some time. I had no idea it was failing. The cap screws were factory installed and wire tied, and could not tell they were failing. The cowl was mangled, and the prognosis was not a quick fix. I decided to haul it home, and rented a 20’ Uhaul truck to do it. A disassembled Sonex will fit, but just barely!

Figure 2. I had about 2" to spare. If the propeller was still attached, the tailcone would have to be stuck up in the "attic" to fit. Horizontal Stabilizer would not quite fit through the door.

After a 1000 mile trip in a Uhaul truck, she was back home. I still don't know if the propeller will ever be found.

The post inspection revealed that the prop really smacked the cowl pretty hard, as it was hard to remove and some of the internal baffling was smashed. The screw remains were easily removed. After measuring the runout I found no damage or anything else. The screws came straight out with a left handed drill bit. There was no Loctite on them. It was a bit of a surprise, and apparently only occurs on the first batches of engines where they used safety wire. I also noted that there is no fretting on the face of the crankshaft, indicating that the failure was one where the prop flange did not slide around at all on the crankshaft, so the screws were holding tight up to the last few rotations that caused the vibrations.

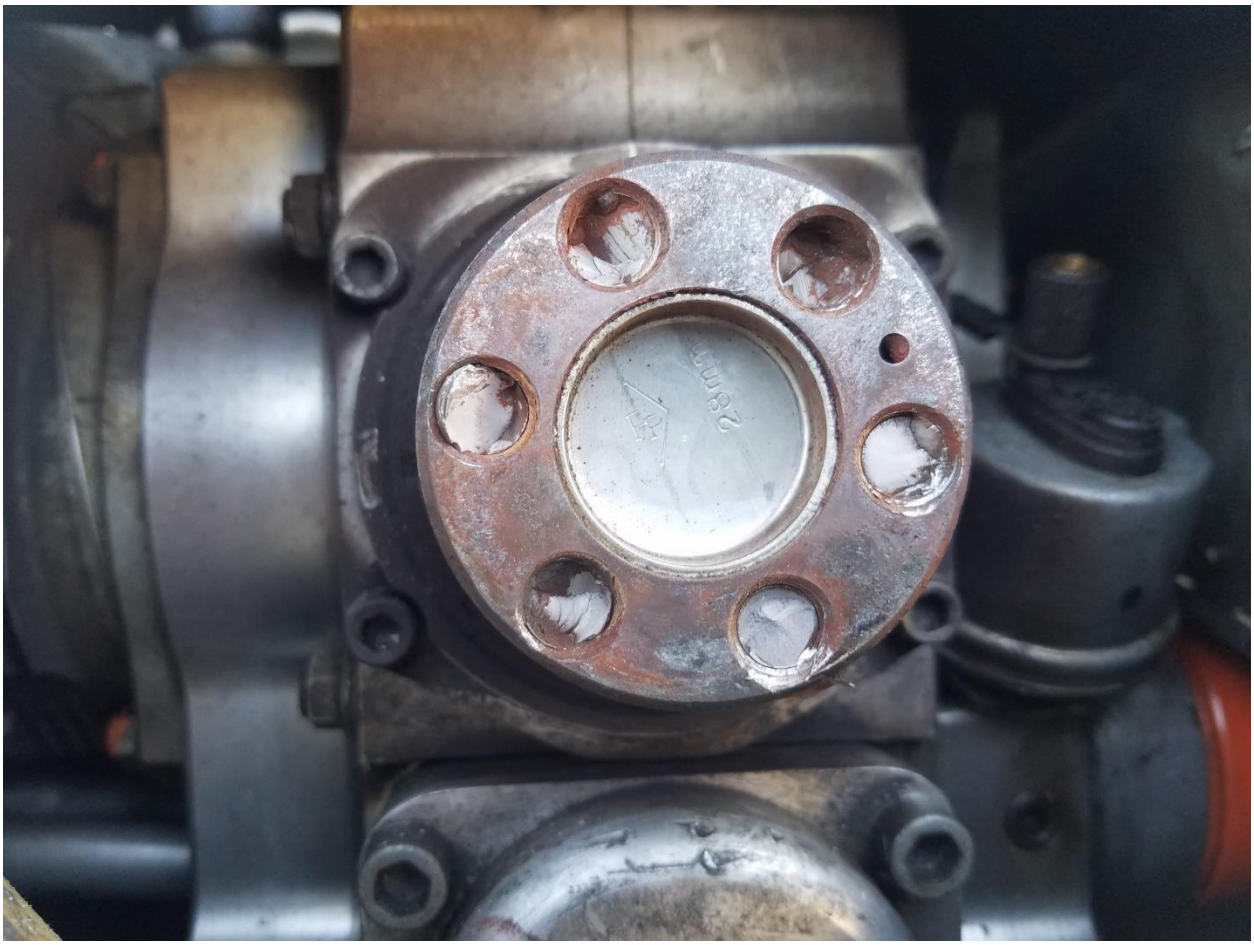

Figure 3. A close-up of the failed screws. Some cleanup of the rust on the face so I could measure with confidence was done. There was no fretting on the face, but some impact wear near the last screw to fail (bottom right).

Analysis

I am of the opinion that the fatigue was caused after some stress corrosion cracking (SCC) initiated the failure, eventually reducing the cross sectional area, and therefore increasing the stress to the point where fatigue can take over. One screw failed in tension as can be seen in Figure 4. The remaining show clear signs of internal rust and subsequent fatigue, which indicates the likely path to failure. After a bit of research, it was found that SCC can occur in high strength steel with the right conditions are there; appropriate stress levels, an appropriate corrosive environment, and a stress riser.

The stress level can only be speculated since it was done at the factory, but if they used the currently specified torque (30 ft-lbs), it would have been roughly ¼ of the proof test limit of 16800 lbs at 4800 lbs of clamping force per screw. This would have produced an adequate stress of 49 ksi. The corrosion was evident, but not clear what the source of corrosion was. Just moisture? I can only speculate here. The stress riser? The threads were rolled, and should have been the best choice for strength and fatigue resistance, but that does not eliminate any chance of stress risers at the bottom (minor diameter) of the threads.

According to Pete at Jabiru NA, this is a very unusual failure. In all cases of a prop loss, there were non-standard props or prop extension being used.

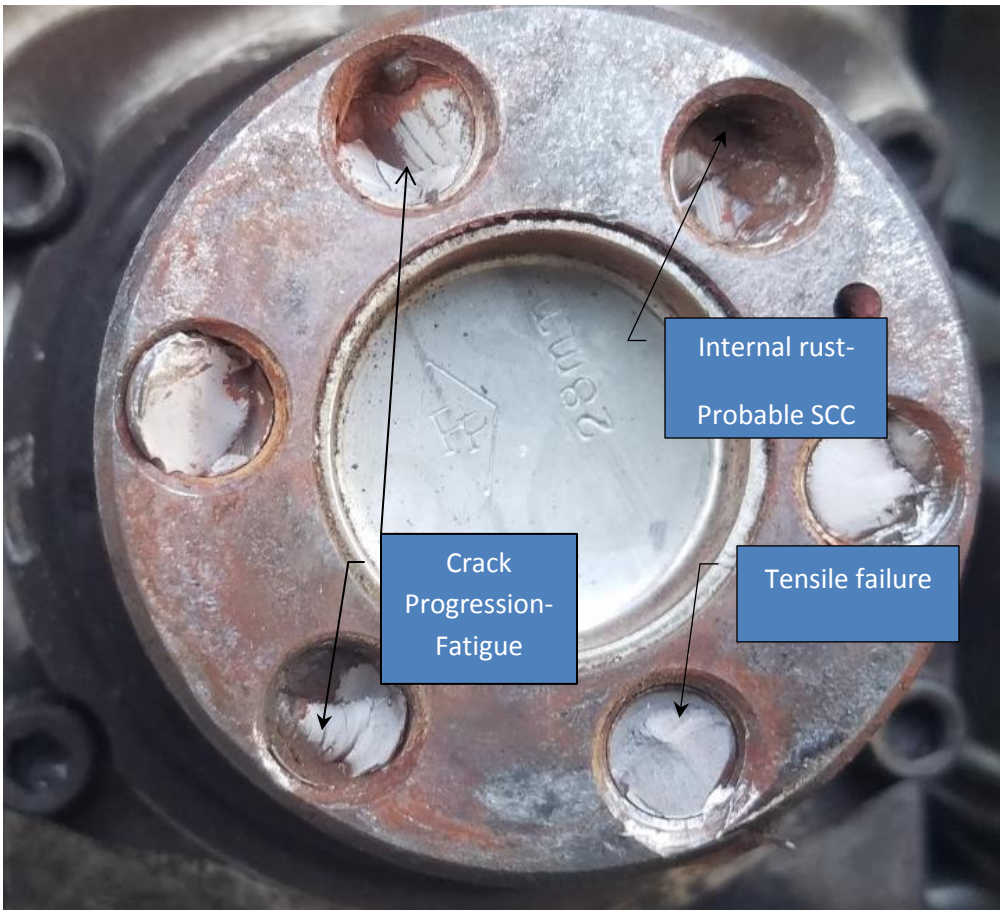

Figure 4. Close up of screw fracture surfaces.

How will I address this problem?: Replace the screws every 300 hours. Also, always try to be abeam the numbers when the prop is scheduled to fly off!

I hope this incident saves someone some grief. Much easier to learn from reading about this than direct experience…