A Simple Reinforcement for the 601XL Rear Spar

There has been some concern about the unexpected in-flight failures of various 601XL's. As an experienced (Ph.D. + 25 years) aerospace engineer, I am tempted to brush these off as "cause unknowable" due [1]to the large number of unknown variables in construction, maintenance and operation of the accident aircraft, and [2] the lack of available data about the accidents themselves. That is my "official" opinion.

A few people have asked me about this, however, so I took a good look at the 1/2 built wings in the garage. Knowing that the wings have passed static proof tests, I looked mainly for what you might call "less than optimal" design features, including places in the design where a reasonable error in construction might lead to a more serious condition.

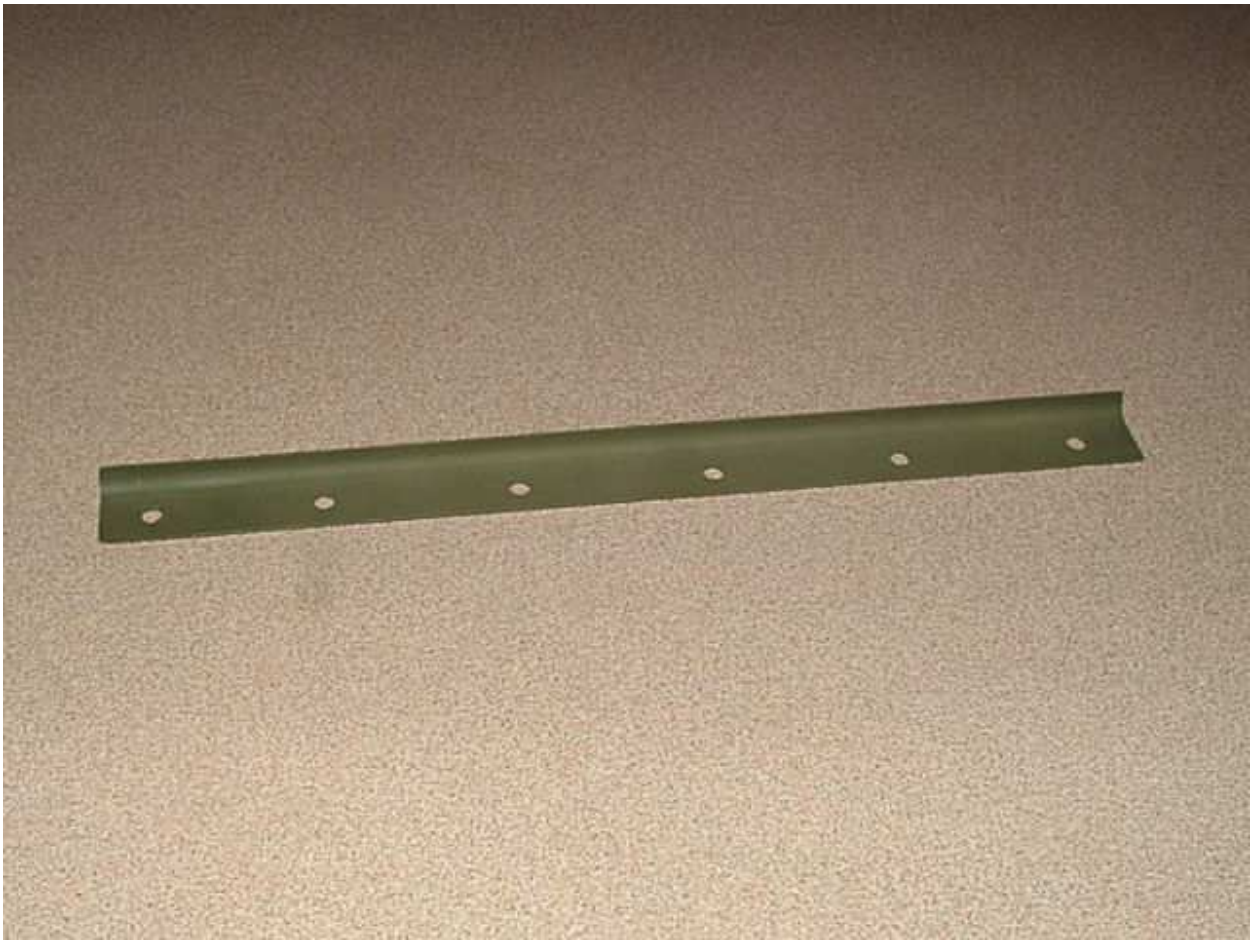
The only thing I found was that the clearance hole for the aileron pushrod is rather large and is located rather close to the rear spar lower flange. It would be easy during construction to make this hole closer to, or even touch the flange. Since the top and bottom of the spar carry the large part of the wing bending load, this *could* weaken the spar.

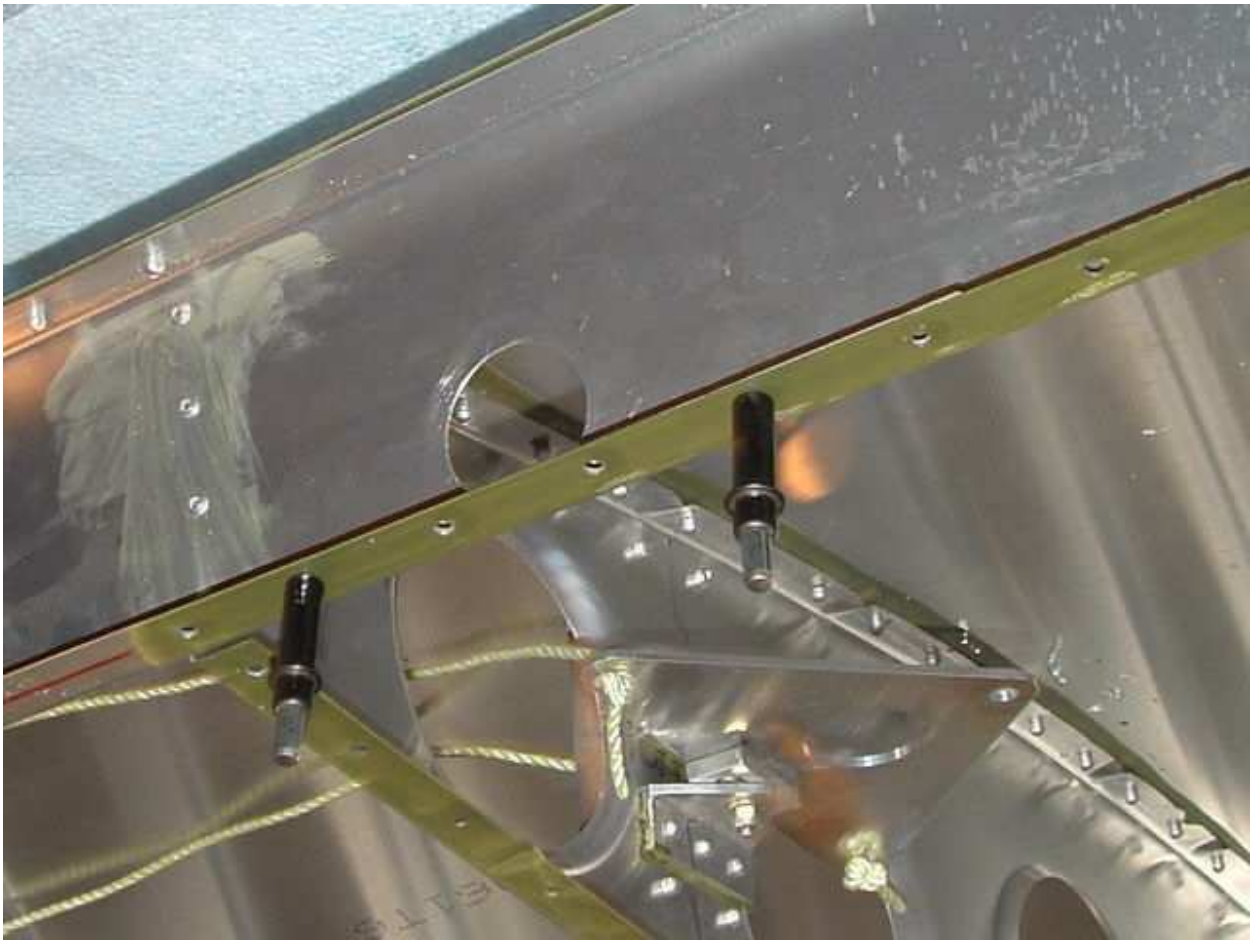
It would also be easy to nick the edge of the hole when smoothing it out. This could create what is called a *stress riser* and over time, metal fatigue could cause a small crack to form and that could grow into the flange and be a problem. That could also be caused by the pushrod rubbing against the hole edge, especially if you have the flex ailerons (as opposed to hinged).

NOTE: This is an analytical discussion, not support by experimental evidence.

However, in engineering one often lacks complete data, and in those cases you can often look for ways to mitigate risk. If the cost of mitigating the risk is very large, then may decide to do more extensive analysis or experimental testing. If the cost of mitigating the risk is small, you might decide to go ahead and do that regardless. That is what I chose to do here.

I cut a piece of .025 standard angle to a length will cover the three A5 rivet holes in the bottom flange on both sides of the aileron pushrod hole. I bent the piece to match the angle of the spar flange, then trimmed it to fit flush with the flange and also to clear the exit hole. Finally, I match drilled it to the spar, then deburred and primed.





This small doubler strap reinforces the flange in the *hypothetically* weaker section of the spar, and thereby helps transfer wing bending loads across the hole. It has many good characteristics (below)

- It takes about an hour to make and install.
- Installed, it is invisible.
- It does not interfere with aileron operation.
- It weighs approximately nothing.
- It costs approximately nothing.
- It can be easily retrofit to completed wings.

and no bad ones that I know of, and therefore fits the requirements for risk mitigation, IMHO. So I'm putting them on my plane.

Continuing Maintenance Notes

It should be straightforward to inspect the strap doubler on a regular basis for working rivets or cracks. So an additional good characteristic of this type of risk mitigation is that you can use it to get some real data on the hypothetical problem. If people install the strap and report no damage over time (maybe 50 hour intervals?), then either there was no

problem there or the minimalist fix worked like a charm. If people later report that they are finding evidence of strap fatigue, then we have identified a "real" problem and can work out a "real" fix with Zenith.

If you install such a strap, you should note it in your builder's log and consider putting an inspection item in your annual checklist like *"Visually inspect strap doublers on rear spar lower flange in area of aileron pushrod for any evidence of cracks, fatigue or working rivets."* Over the years, as evidence builds, you will gain (or lose) confidence in the design and/or strap.

It was brought up to me by one respondent that for scratch builders, there is an option to use a 2-piece rear spar, and that this design has a larger, heavy-duty splice in the same area. If people with that design built and flying can inspect the doubler and report its apparent condition, those would be additional data points.

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