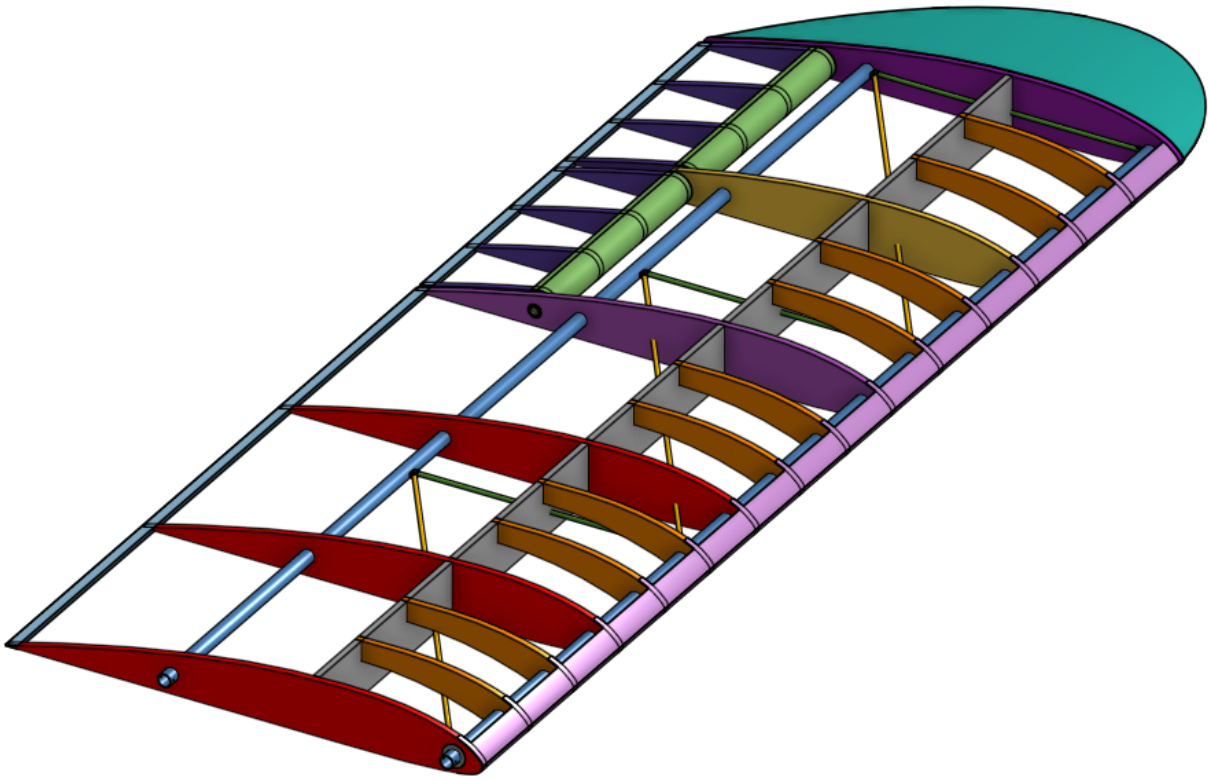
Leading Edge Testing (Halloween 2020)



Leading edge sheet metal (purple)

The leading edge (LE) of our wing is a thin sheet of 2024T3 0.016” aluminum sheet to support the poly-fiber wing covering fabric between ribs. Without this support, the taught poly-fiber fabric would bow inwards between ribs, therefore creating an inconsistent airfoil profile across the wing.

For our initial leading edge test, we simply epoxied the leading edge sheet metal directly to some sample aileron ribs which had been capped with 1” e-glass.

Initial Test

We used wrongly dimensioned ailerons with fiberglass on its perimeter as our “ribs” for this prototype. To attach, we scruffed the 2024 T6 0.016” Aluminum with sandpaper and Scotch-Brite to both clean it and help the epoxy adhere better. To attach the LE to fiberglass, we used the West Systems epoxy kit, which we’ve been using uniformly throughout the plane (with

micro glass bubbles when attaching with foam). We then used Polypropylene Webbing to tie down the LE, which was skeptical to say the least.

As you can see, our aluminum refused to stick to the fiberglass, causing it to spring back as soon as we removed the tie downs.

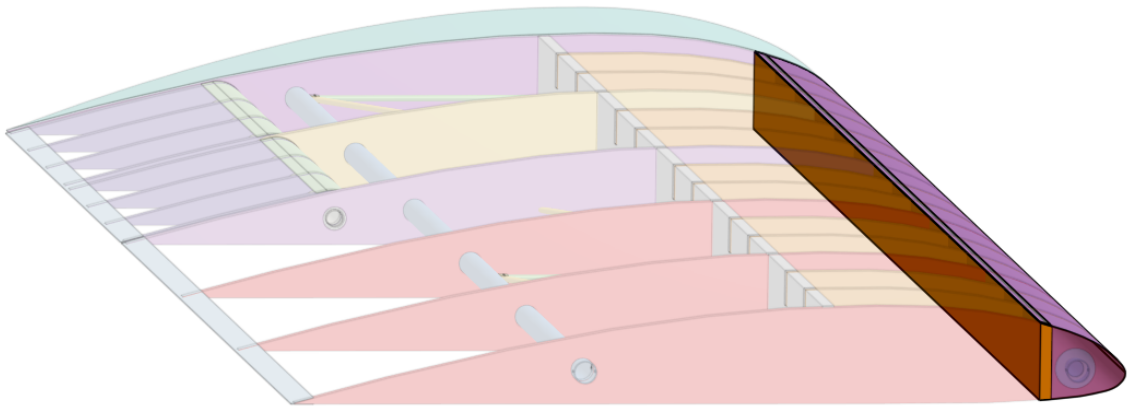
Other planes, such as the Legal Eagle, use staples or nails to pin down the LE sheet metal, but our ribs are made of foam so we're not sure about the validity of that method since, well, it's foam.

Because of our restrictions in following industry standards, we were debating our ability to use a LE for this version of the plane. Additionally, the combined weight of the main leading edge and aileron leading edge would add around three pounds per wing so an alternative method would be to use a greater number of false ribs. It's difficult to calculate the exact weight of each false rib since the weight of the epoxy necessary to attach it can vary widely. Even though the estimated weight in the CAD might be lighter than using the aluminum sheet metal, it might end up weighing substantially more.

With all these problems, we reached our to the HomeBuiltAirplanes.com forum for advice. They had a multitude of other solutions so we decided to experiment a bit before making a final decision.

Support Blocks

They first recommended we create a "support block" for our LE sheet metal where it would have more surface area to attach to- something that looks like this:



Advantages:

- Greater surface area → improves adhesion to sheet metal
- Continuous area to attach to → prevents the aluminum from pulling bending upwards between ribs

Concerns:

- The additional aluminum, epoxy, and foam would add 3 pounds per wing (a simulated estimate). Our wing is already overweight so this significantly decreases our fondness of this design.
- The leading spar and all attached U bracket joints are inaccessible.
- Adds parts -> increased complexity, more difficult construction, more potential points of failure
- As the wing bows upwards under load, the leading edge sheet metal will resist without any relief points and quickly fail at the glue joint.

Masking Paper

One of the simpler ideas to fix our problem was to simply use masking paper between the aluminum and fiberglass to improve adhesion.

We decided to try the masking paper idea first because of its simplicity, where we used 3M High Strength 90 Contact Spray Adhesive to attach our masking paper. We also bought proper cargo straps for the test and to use on the final wing construction. We used just random rope we found on the last test, which we thought may have been part of the attachment problem.

We were originally unsure about which adhesive to use, so below is our comments and research

Adhesive	Specialty Surfaces	Strength (psi)	Time to cure/bond	Price/oz	Notes
3M High Strength 90 Contact Spray Adhesive	Wood, laminates, metal, plastics, concrete	230	10 minutes	$0.80	Highest Strength 3M Spray-on.
3M Super 77 Multipurpose Adhesive	Paper, plastics, cardboard	160	10 minutes	$0.65	General Purpose.
Loctite Premium MAX 9 Construction Adhesive	Brick, ceramic, drywall, to a lesser extent: metal	n/a for metal	24 hours	$1.05	Outdoor repair.
JB Weld MarineWeld™ Twin Tube	Aluminum, Fiberglass, Plastics, Metal	5020	24 hours	$4	Aluminum centered
KwikWeld™ Syringe	Metal, Wood, Plastic, Automotive, Ceramic, Aluminum	2424	1 hour	$9.40	Metals

The full 3M adhesive chart can be found here, and it details spray (aerosol), cylinder, and bulk products.

As seen from the chart above, the 3M High Strength 90 would be the best for our purpose. Although it has a considerably lower psi than the LB weld brands' products, it is 4x cheaper. Because the aluminum will not have a considerable amount of pull against the paper, it's high strength of 230 psi should be more than enough for our purpose.

3M spray on the prototype aluminum LE.

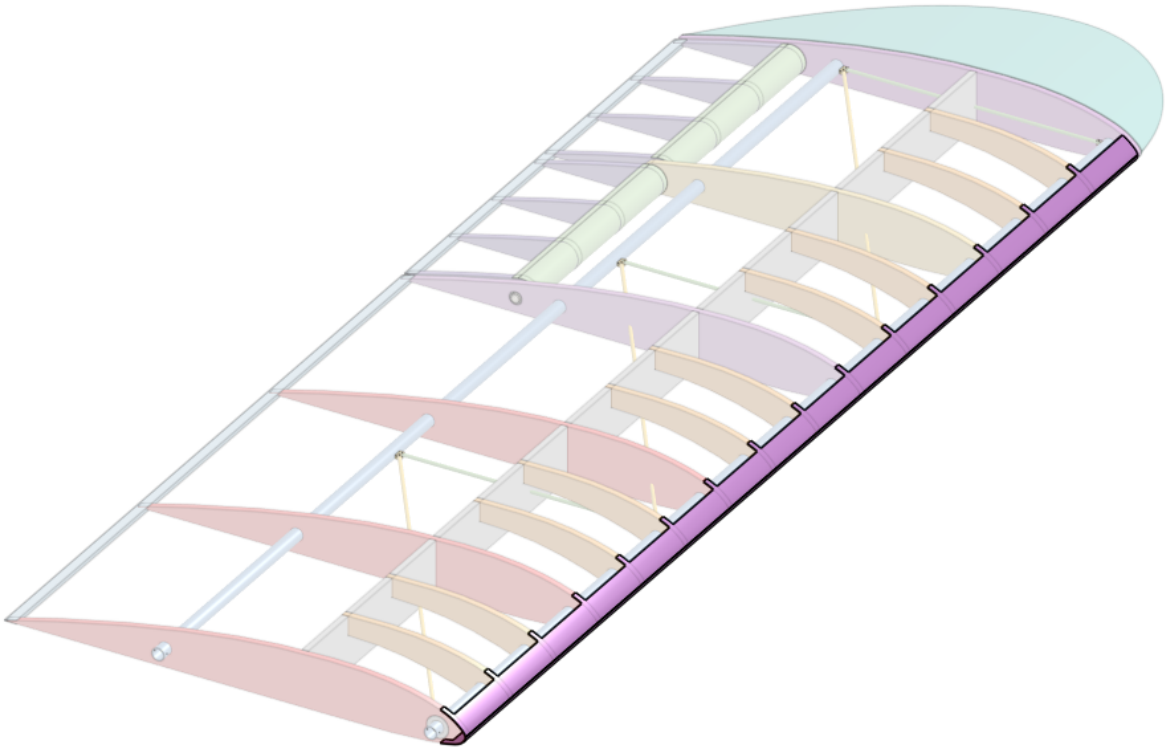
Surprisingly, the masking paper idea worked all on its own!

These were done in a rush on extra foam that we lost the dimensions to so it's obviously not perfect.

Good things:
It stuck!! The 3M Super 90 Contact Spray Adhesive was an experiment in itself, so we can use it on future tests now that we know it adheres very well to the slick aluminum.

Problems:
We used wood scraps to better distribute the force of the clamps, but unfortunately, we got too much epoxy on them so they wouldn't remove unless physically ripped off (which is where the crack in the foam comes from). In the future to solve this problem, we're going to put parchment paper between the wood and epoxy.

Improvements:
To make the leading edge sheet metal lighter, we're going to implement a "finger" style design.



We hope this blog post was informative and we'll keep you all updated on our progress through this!