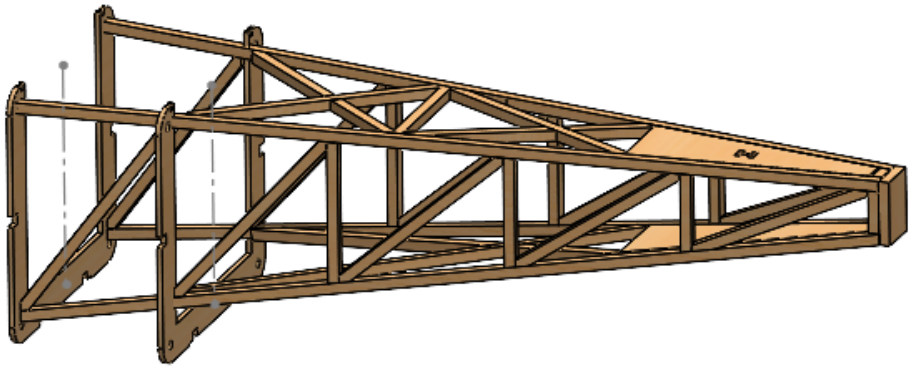
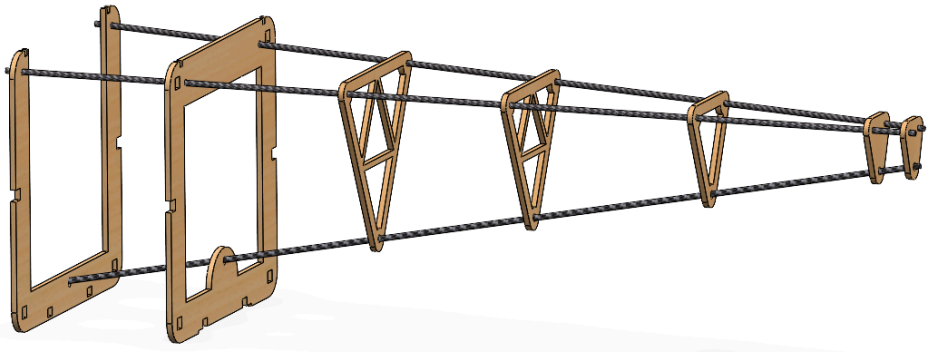
MCR FUSE 24/25 Tail Sizing
Bending/Torsion Tests

This document is to serve as a summary of the bending and torsion tests done on the prototypes of Design 1: Balsa Strut Design, and Design 2: Carbon Fiber longerons, to determine which design is preferred for the 2024/25 MCR plane.

Design 1: Balsa Strut Design
Weight: 42g (solidworks)



Design 2: Carbon Fiber longerons
Actual Weight.: 0.13lbs with bulkheads and kevlar string
Actual Weight 0.077lbs with plywood bulkheads and kevlar string but without the main fuse bulkheads



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7, 8, and 9 are a lie. They dont exist.

Summary

Results:

Design 1: Balsa Strut Design

Downward force: 15.062 lbs

Sideways force: 9.8 lbs

Upward force: 10.6 lbs

Design 2: Carbon Fiber longerons

Downward force: 19.0 lbs

Sideways force: untested

Upward force: untested

Recommendation

I highly suggest we go with the design with carbon fibre longerons and kevlar string with plywood bulkheads.

Overall, it weights about the same (maybe slightly less depending on the manufacturing technique). It has a higher max bending strength (19 lbs compared to 15 lbs) and though not proven, i feel like it can handle bending better from multiple directions whereas the balsa design could only handle the max strength from the top down.

Where the balsa barely showed deformations before having a quick snap break, this design started seriously bending at around 15 lbs and snapped at 19 lbs, where i think there is a good benefit to have an indicator as to when a part is going to fail rather than a sudden collapse (looking at you OceanGate (o_0)).

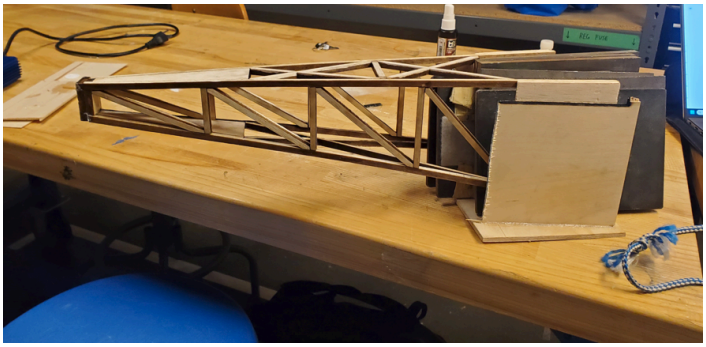
Torsion wise, it felt a lot sturdier compared to the balsa design where the balsa would split down the grain during torsion, this design handles much better at torsion because of the kevlar strings strings (without the kevlar strings, it bends just by someone looking at it.)

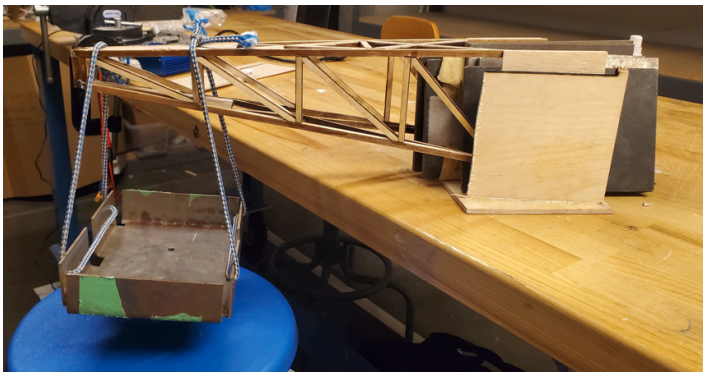
Balsa Strut Bending Test #1: Bending test downwards force.

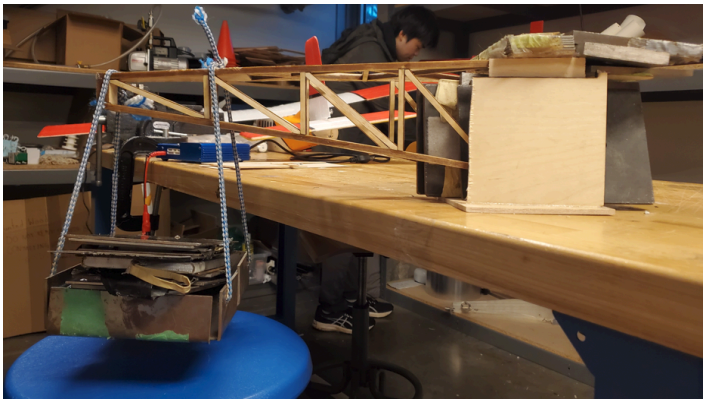
Test setup:
Glued plywood to parts supported by fuselage bulkheads as an anchor.

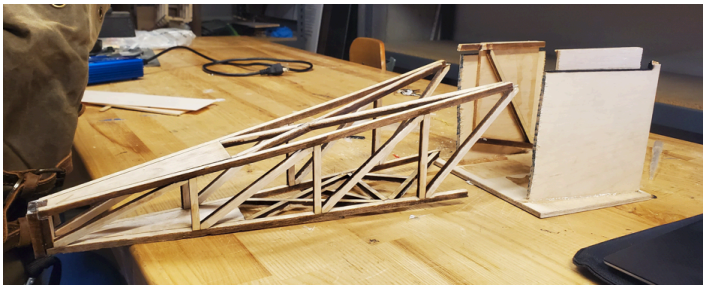
3.018 lbs, held up, no visible bend
+1.235 lbs, held up, no visible bend
+0.780 lbs, held up, no visible bend
+1.065 lbs, held up, no visible bend
+0.970 lbs, held up, no visible bend
+0.882 lbs held up, no visible bend
+1.049 lbs, held up, no visible bend
+1.190 lbs held up, slight bend, heard cracks
+0.930 lbs, held up, slight bend.
+0.536 lbs,held up,
+0.525 lbs, held up
+0.968 lbs, held up
+0.774 lbs, held up, heard cracking
+1.140 lbs, held up
+0.772 lbs, , broke

Held up 15.062 lbs before failure point. Failure point located on longerons where the tail is connected to the fuselage. Failure point was located right at the gap between the diagonal struts and the plywood anchor point simulating the fuse bulkhead. For final design, I will modify this design so diagonal struts connect/are supported by the bulkhead surface and are reinforced.



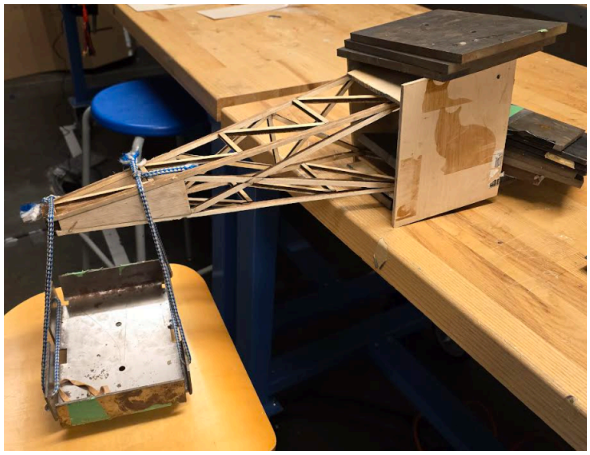
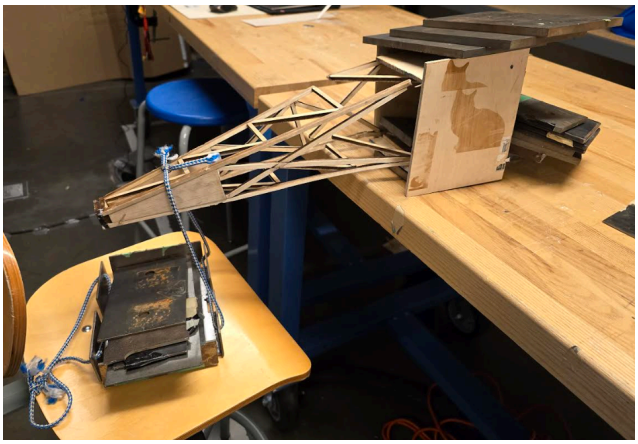






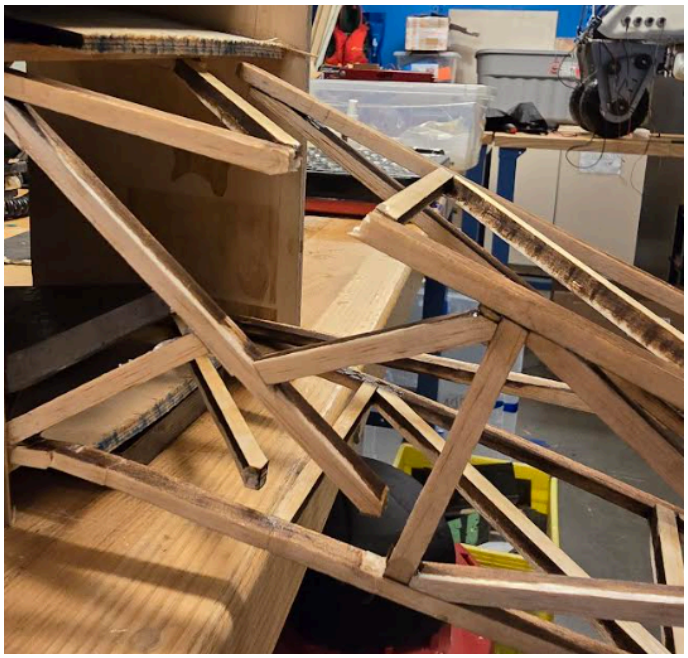
Balsa strut bending test #2: bending test sideways force

Test setup:
Glued plywood to parts supported by fuselage bulkheads as an anchor.
For budget/material/time limitations, previous broken joints were fixed with blue glue.

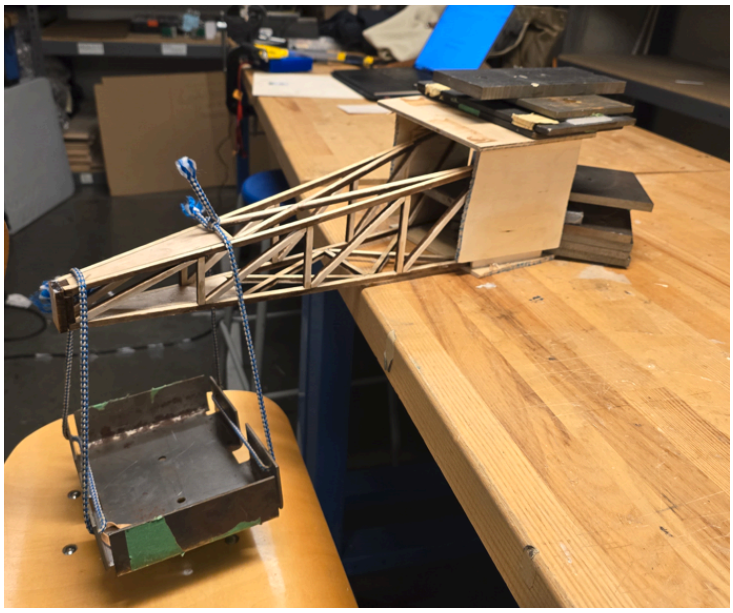
Withstood 9.8 lbs without before breaking (measured on a notsoaccurate scale)

Broke at 7 places simultaneously, none of which were previously fixed.



Balsa strut bending test #3: bending test upwards force

Test setup:
Glued plywood to parts supported by fuselage bulkheads as an anchor.
For budget/material/time limitations, previous broken joints were fixed with blue glue.

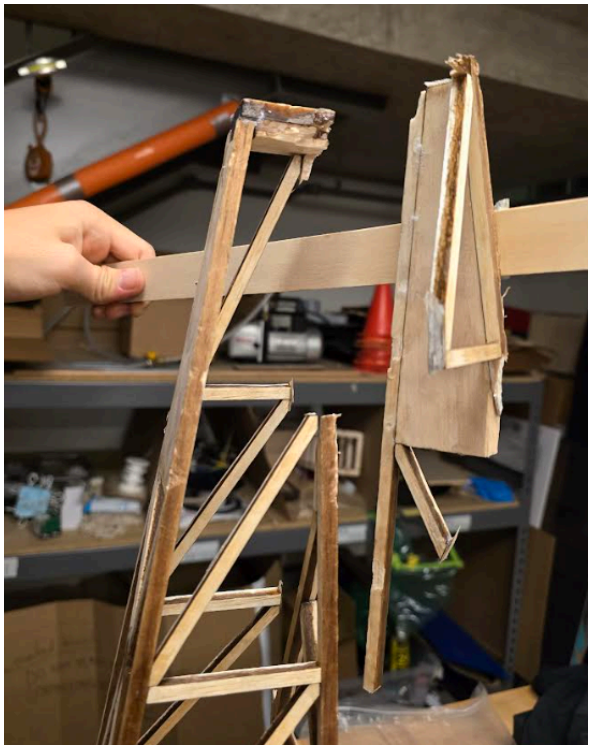


Held up 10.6 lbs before breaking (measured with a notsoaccurate scale)

Broke at base where the top left longeron broke along its grain. Surprisingly not where i reglued the longerons.

Balsa strut torsion test #1

At this point, this thing was held up with hopes and prayers and a shit ton of glue so i didnt expect any value.
On the left is the setup, on the right is the failure points, which were located on the connection points between the balsa stringers at the end.

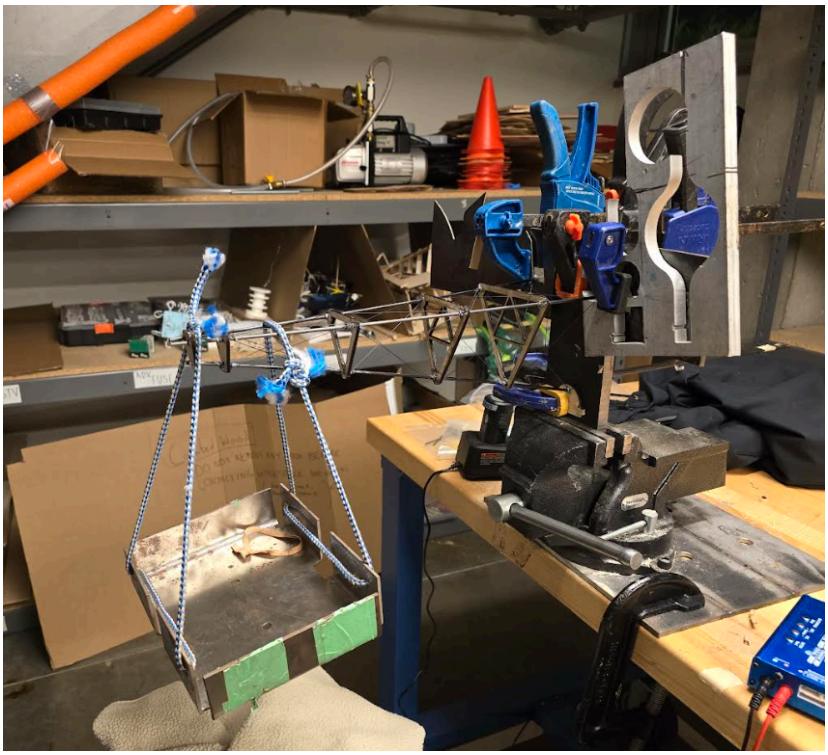
Notably, not a lot of force was used when bending so that might be a downside.

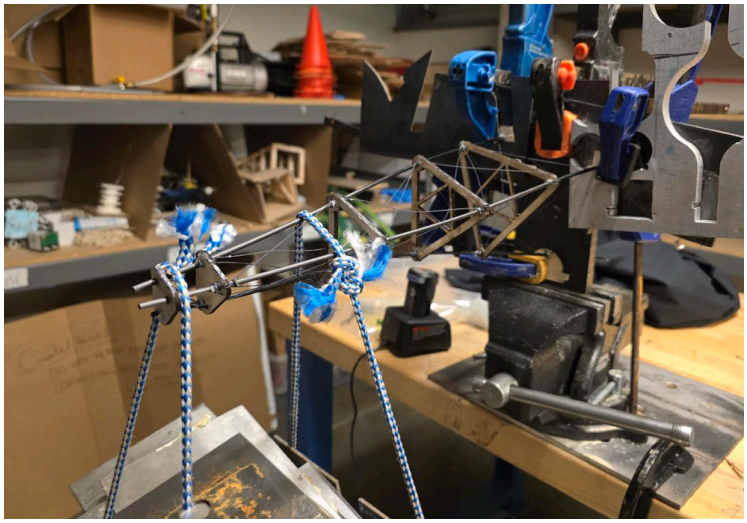
Carbon fiber longerons bending test #1: bending test

downwards force

Setup:
Originally i had designed bulkheads to support this but the bulkheads were too weak and so i clamped it onto a metal vice to simulate a “fixed” point.

Due to the complexity, material, and price, only 1 of these tests could be done per tail but each side is designed nearly the same so it should withstand similar amounts of force.

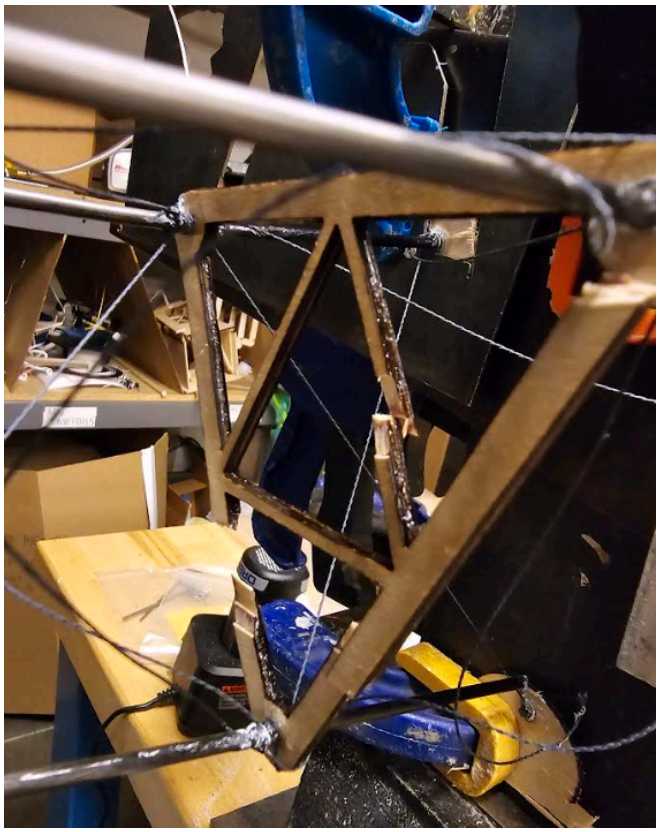


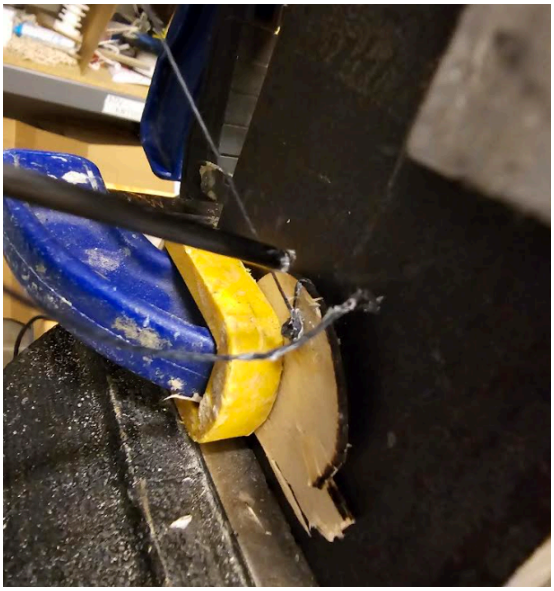


Serious bending at around 15 lbs of metal

Limit: 19.0 lbs of metal

Broke at 19 lbs of metal.





A little blurry but the 2 main points of failure was the first bulkhead and the 2 left carbon fibre longerons at the base. No kevlar string snapped during this whole process.