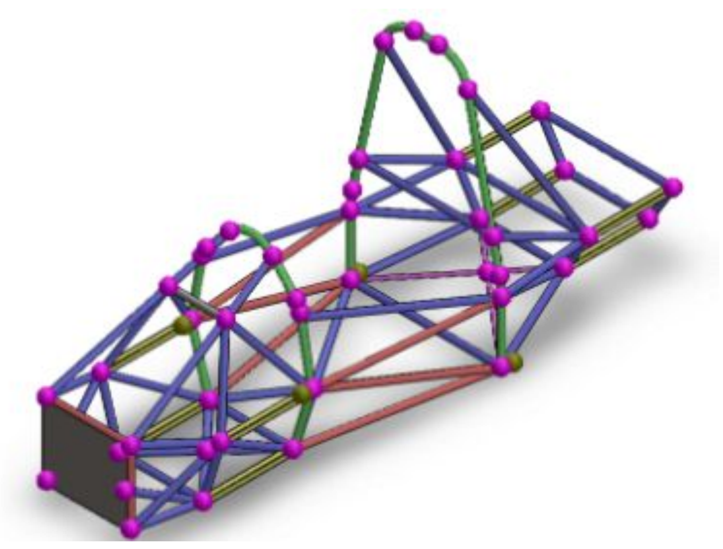
FSAE Carbon Fiber Space Frame

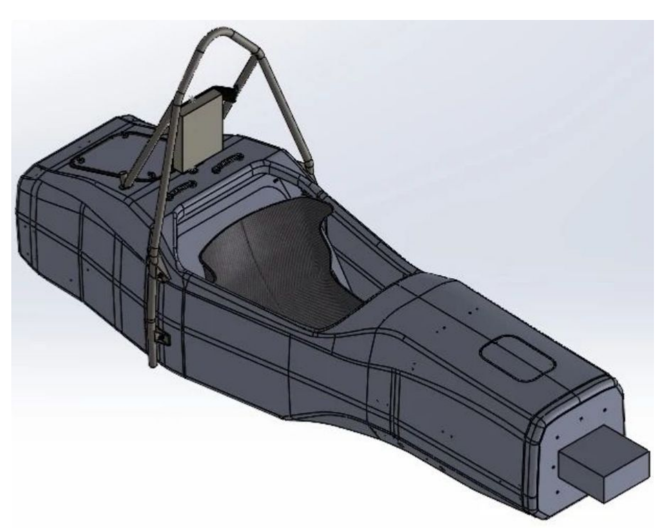
Anusha Jain[2], Gabe Hallett[1] ,Calvin Nguyen[1], Malachi Morris[2], Shahrul Song[1]
Boeing/FSAE
[1]Mechanical Engineering, [2]Aeronautics & Astronautics Engineering

INTRODUCTION

The Formula SAE competition allows for carbon monocoque or steel tube space frame for vehicle chassis

- *Carbon monocoque – Stiff and lightweight, expensive and difficult to manufacture.*
- *Steel tube space frame – Heavy and reduced stiffness, easy to manufacture*





PROBLEM STATEMENT:

Simplify manufacturing & design processes by using a carbon tube space frame combining the benefits of each current chassis type. While carbon tubes are trivial to manufacture, they cannot be joined by welding. This trade study is designed to find the best alternative joint method.

CORE FUNCTIONS

- Withstand highest theoretical load case ~ 3g bump, 3g cornering, and 3g braking
- Manufacturable, affordable, and durable

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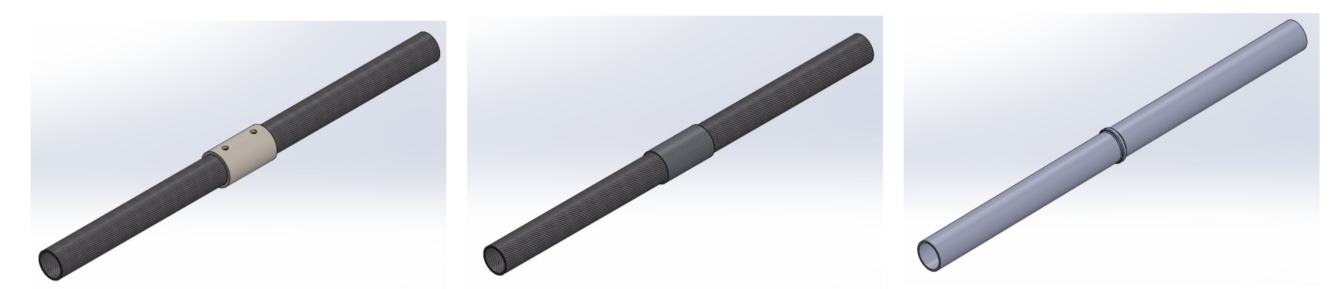
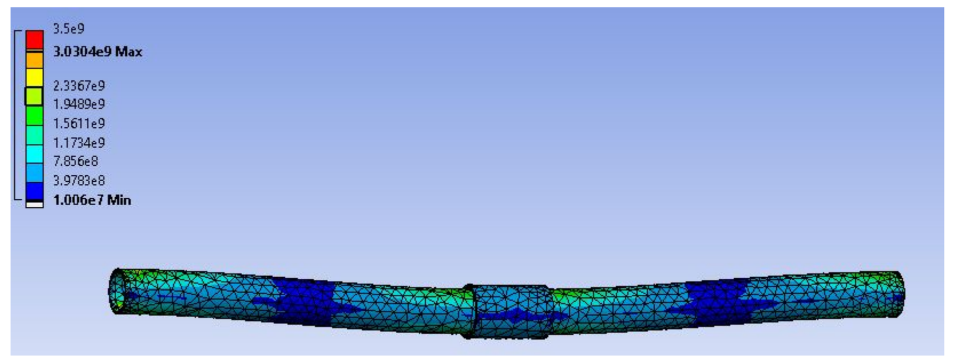
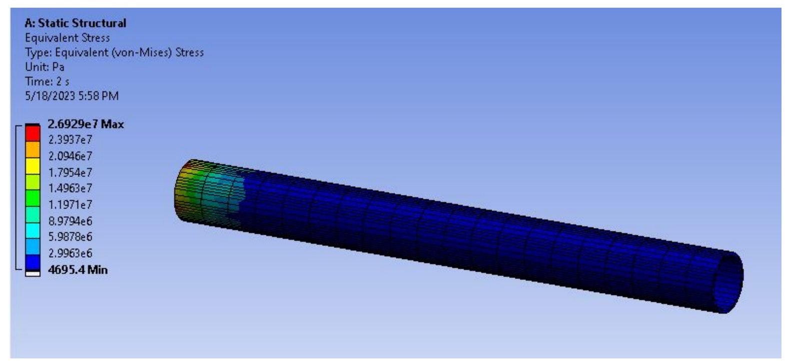
DESIGN AND DEVELOPMENT



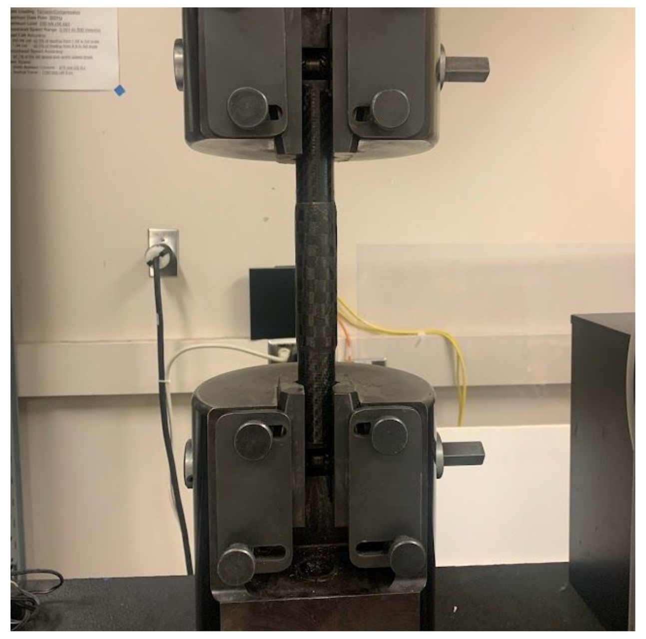
	Aluminum-Carbon	Carbon-Carbon	Steel Reference
Description	Carbon, 7075 aluminum, DB420 epoxy, 0.25" aluminum rivets	Prepreg (PW, 90, 90, 0, 0, 0, 0 PW) standard modulus over OTS carbon tube	4130 Steel TIG welded
Manufacturing time	32 mins	1 hour	40 mins
Weight	225g	195g	316g
Cost	Medium $$ ~, carbon tubes, aluminum stock, shims, rivnut	Expensive $$$ ~ carbon tubes and prepreg carbon fiber	Cheapest $ ~ steel & welding gas and rod
Design	Medium ~ Tolerance consideration, rivet drill hole	Hardest ~ Fiber orientation, epoxy type	Easiest ~ Welding joint shape
Expected Bending: Expected Tensile:	9 kN 29.9 kN	75 kN 2.6-5.2 kN	5 kN 116 kN

Simulation

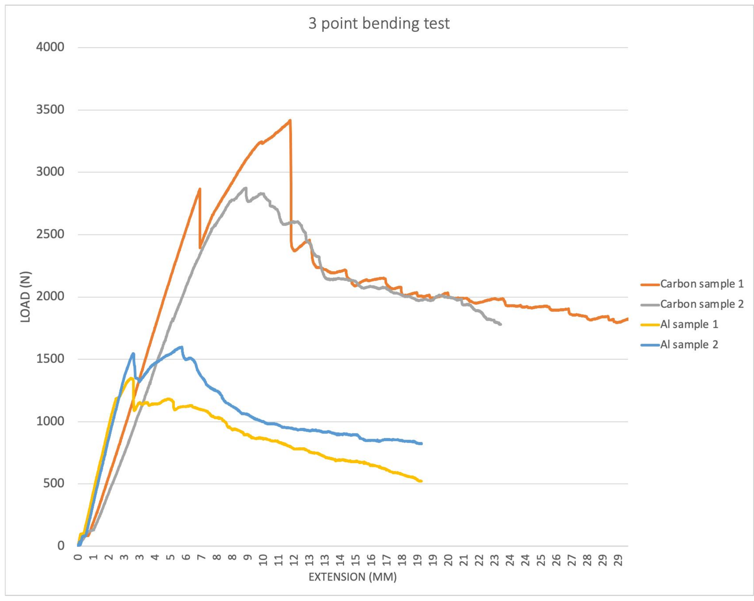


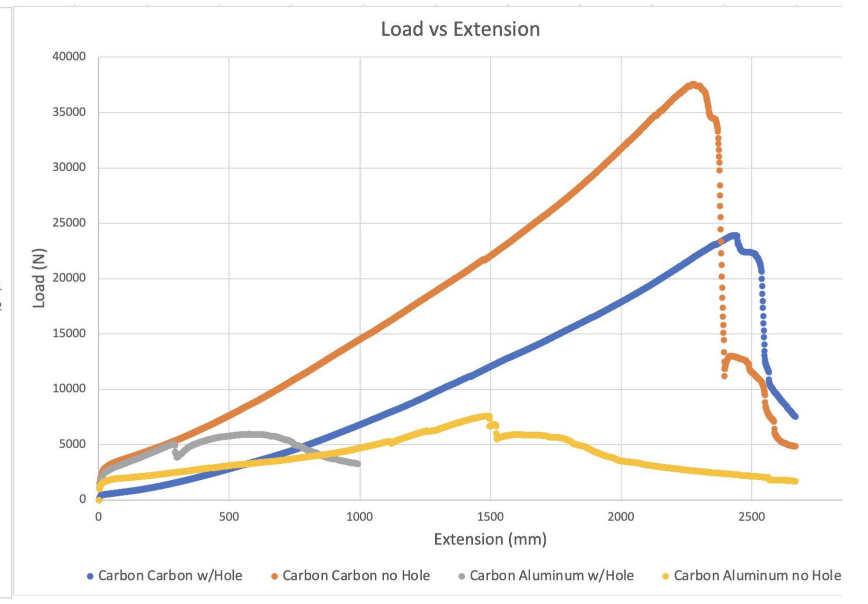


Testing



RESULTS





- *Initial testing shows the carbon joint outperforms aluminum*
- *The bending test on the left shows that the aluminum joint was slightly stiffer but yielded on average at a lower load*
- *The tensile graph on the right shows that the carbon joint was able to withstand significantly more load without failing while the aluminum one failed at significantly lower load (the carbon joint did not fail but the tube did)*

CONCLUSION & FUTURE WORK

We designed, manufactured, and tested coupons for three different joint types to compare. Our steel control demonstrated the highest strength, but also the highest weight. Our carbon joint was the lightest but the hardest to manufacture. Aluminum was the most manufacturable but lowest strength. Our recommendation is to test joints with higher number of members, up to five, before making a choice for competition chassis.

Acknowledgements

Ashley Emery, Eli Patten, Marcin Rabiega, Eric Moyer, Alex Davies, Brendon Rippe, and The Boeing Company

Mechanical Engineering Capstone Exposition

June 2nd 2023, Husky Union Building, University of Washington, Seattle