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## PROBLEM STATEMENT

Design an I-beam with Toray 3900-2 resin / T800 unidirectional carbon fiber capable of withstanding up to 7200 lbf 3-point bend test.

## DESIGN

- **Top Flange** - Composed of mostly 0° direction fibers with a stepwise ply stack design from the middle to support the center point loading. 4 plies spanned the length of 26 inches and the rest were used as tapering for the stepwise design. Some 45° plies were added to mitigate torsion.
- **Bottom Flange** - Composed of mostly 0° fibers and tabs to support the loading on the ends. A stepwise ply stack was used to avoid stress concentration. Similarly, to the top 45° plies were added.
- **Web** - Consisted of -45°/45°/90° oriented fibers to limit shear forces during loading



Figure 1: CNC Fabric Cutting

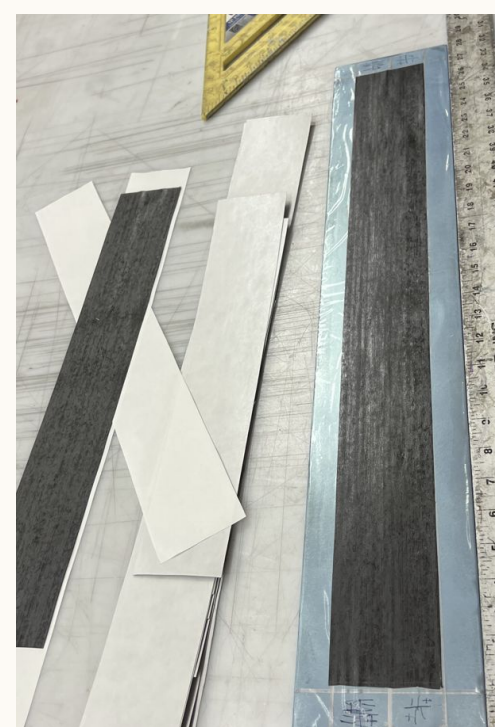


Figure 2: Students organizing and marking up tooling for the beam layout

## Acknowledgements

- Alex Gray (Research Engineer – UW MSE)
- Navid Zobeiry (Advisor)

## TESTING AND ANALYSIS

A 3-point-bend test was set up under the same specifications as the competition, with earlier iterations of the beams breaking at approximately 7600 lbs. Plies were removed according to beams' mode of failure in order to aim for a flexural strength closer to 7200 lbs and to reduce weight.

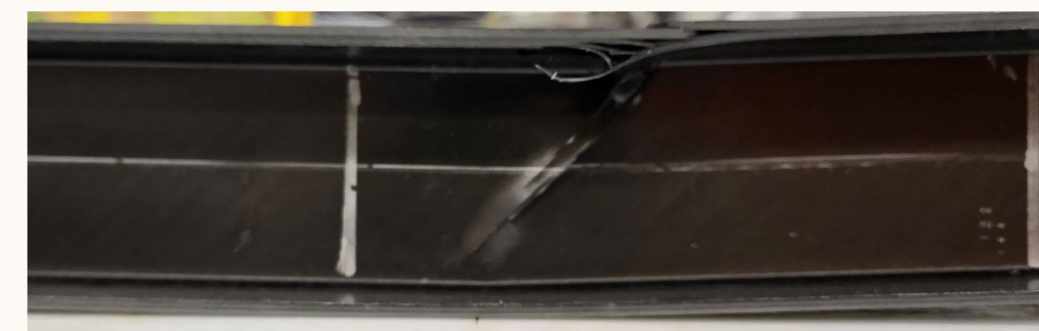


Figure 3: Failure on the first iteration beam



Figure 4: Final Carbon I beam

## MANUFACTURING AND PROCESSING

- Ply/Layup designed to have optimal weight-to-strength ratio
- Plies sketched in 2D CAD software for CNC fabric cut
- Plies are organized and tooling is sanded and wrapped in release film
- The plies are stacked into components on the tooling debulked every 3 layers
- Components are assembled to form I-beam shape
- I-beam is wrapped in breather and vacuum bagged
- Curing of the beam in the autoclave for 350°C for 2 hours at 89 psi
- Beam is extracted and cut to meet competition requirements



Figure 5: Web lay up using tools



Figure 6: Webs assembled into I shape

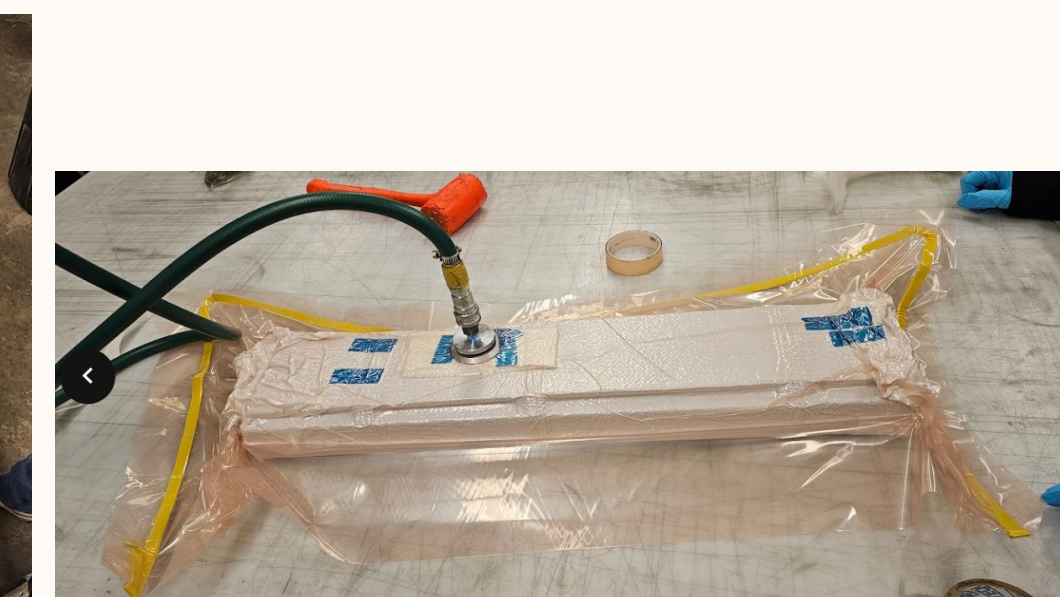


Figure 7: Vacuum bagging