

Bridge #:
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Glass Half Full Beam

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Category E

PROBLEM STATEMENT

Design a box beam using dry fiberglass materials that will hold a distributive load of 5,600 lbf applied at the center.

BEAM DESIGN

There are four components to this beam:

- 6" diameter $\pm 45^\circ$ biaxial S-glass tube sleeves
- Satin 0° S-glass tabs at the 3 contact points
- Stitched $\pm 45^\circ$ biaxial E-glass for webs and tab reinforcements
- E-glass roving used as noodles to fill in gaps where web and top/bottom meet

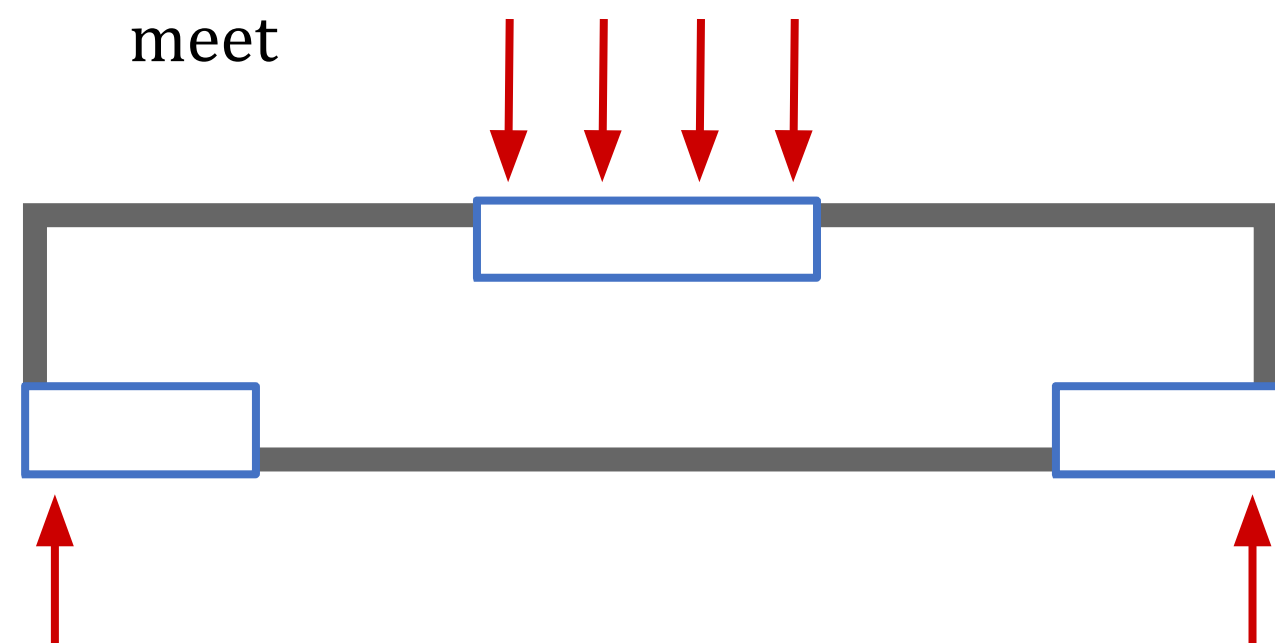


Figure 1: Reinforced sections (in blue) along the length of the beam with arrows showing force (in red).

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MANUFACTURING

A 2" x 3" x 30" steel tool was sanded (up to P400), cleaned with acetone and isopropyl alcohol, then coated with three layers of 710-NC Aero Mould Release. Four other tools (two steel caul plates, two 2" x 3" aluminum tools) for the top and bottom flanges, and webs were sanded and wrapped in release film.



Figure 2: Spreading resin through plies.

Plies were cut on a CNC fabric cutting table. Then, they were layed up on release film by spreading resin (Pro-Set INF-114 and INF-213) through each ply before stacking another ply (Figure 2).

Each stack was then debulked to remove excess resin (Figure 3). This is a new process implemented for better resin distribution and based on high resin content of previous beams.



Figure 3: Debulking stacked plies.



Figure 4: Beginning of assembly process.



Figure 5: Final cured and trimmed beam.

The top, bottom, and webs are then assembled with noodles packed in the joinings (Figure 4), bagged, vacuumed, and finally placed in an autoclave under slight pressure to cure. After curing, the beam is removed, extracted with a mechanical extraction set-up, and trimmed with a wet-tile saw.

TESTING

Previous beams failed under load at the bottom corners of the web and in crush at the top contact point (Figure 6). Plies were added to mitigate these issues.

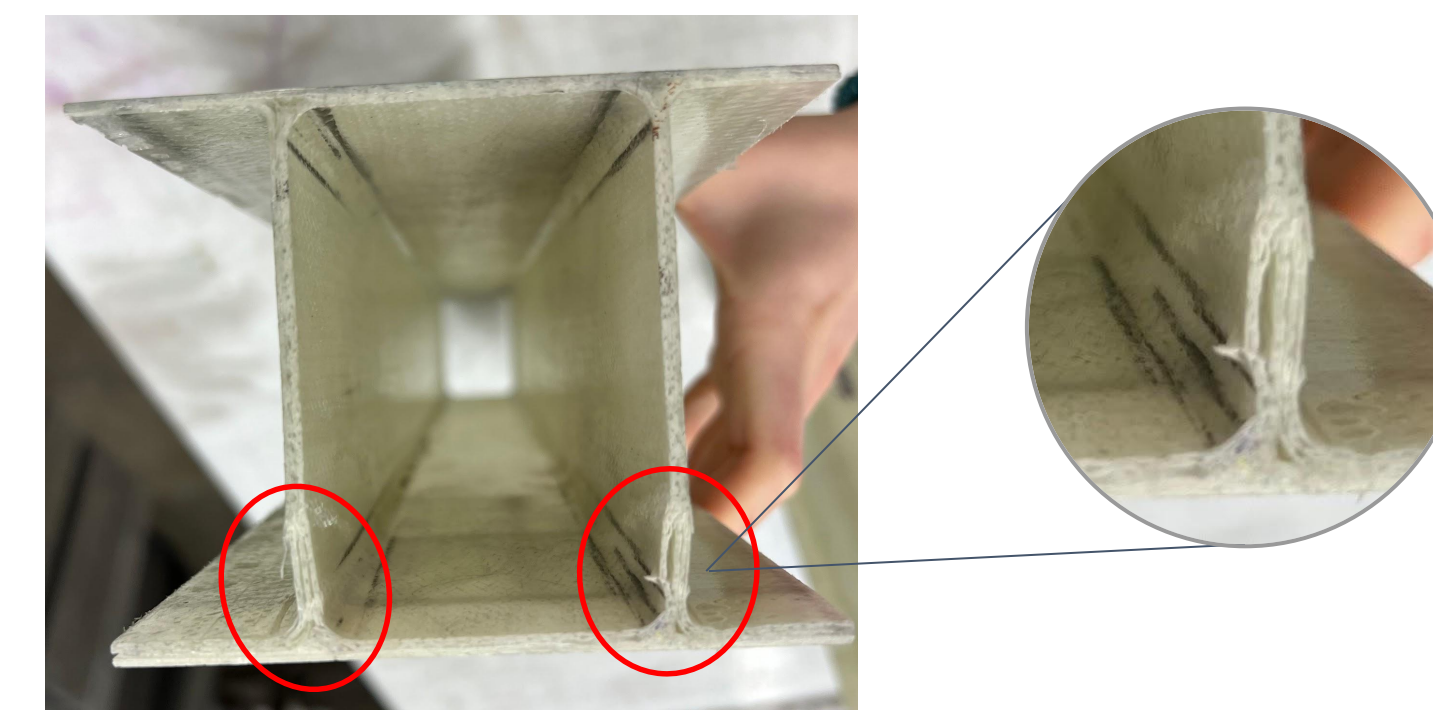


Figure 6: Beam failure points from cross-section view. Close-up view of delamination.

IMPROVEMENTS

By adding tabs around the ends of the center part and webs (Figure 7), the mode of failure was no longer along the corners joining the bottom and the web.



Figure 7: Tabs added to the center web part at the ends, encircling the tool.

Adding additional tabbing to the top also helped prevent crush at the top contact load point.