FABRICATION AND TESTING OF LARGE-SCALE JOINING ELEMENTS

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OBJECTIVE

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- Investigate the performance of large-scale composite T-joints using 3D woven materials
- Evaluate mechanical performance of joint concepts in tension and shear loading

APPROACH

- Fabricate carbon sandwich bulkheads
- Join bulkheads using integrated triangular balsa core
- 3Tex materials/2D fabric materials used
- Test fixture produced in house
- The full-scale joint tested in tensile loading and the failure modes investigated

FABRICATION OF THE JOINTS

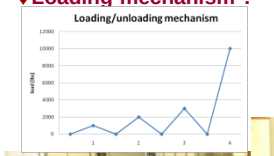
- Fabrication of Face sheets
  - 48" by 24" bulkheads fabricated using quasi-isotropic layup of 1/8" thick T700 carbon fabric infused with Ashland Derakane 510A.
- Fabrication of the Joints
  - All Joints used two 7" triangular cores bonded at the vertical and horizontal bulkhead intersection
  - Joint A - A 3/16" thick face sheet using 2-D fabric
  - Joint B - a 3/16" thick 3TEX preform placed on the core and infused under vacuum with the Ashland Derakane 510-A Vinyl-Ester resin
  - Joint C - Two 3TEX flap fabrics wrapped around the triangular core with the flaps overlapping on the long side of the core and the other flaps ending at the bulkhead corner. Finally, the thick section flap extended onto the either bulkhead
  - Joint D - Identical to Joint C while wrapping the thin horizontal bulkhead flap around the 90º bulkhead corner.

TEST FIXTURE AND TESTING

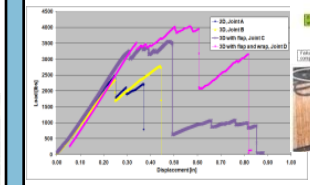
- Instron 4484 testing machine with a load cell of 30,000lbf.
- The two ends of the horizontal part was supported by 3/4" diameter bolts and the load applied perpendicular to the hull with a crosshead speed of 0.05in/min
- Two dial gages were placed on the bolts to check deflection of the bolts
- 5 strain gages were set up on critical points on this part to observe the strain during loading and one LVDT was used to observe the displacement at the center of the base panel.

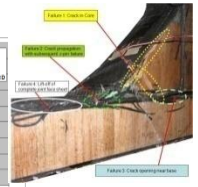
TEST FIXTURE AND TESTING

- Loading mechanism :



RESULTS





	Load at first failure [lbs]	Load compared to Joint A [%]	Ultimate Load [lbs]	Load compared to Max Load Joint A [%]
Joint A	2510	100	2162	86
Joint B	2402	96	2756	127
Joint C	3251	130	3569	165
Joint D	3525	140	4032	186

FAILURE MODES

- First failure (preforms without flap) occurs at 2500lbs and 2400lbs for Joint A and B respectively (Failure 1).
- Initial failure for Joint C and D (3D preform with flaps) occurs at higher load levels (3200lbs for Joint C and 3500lbs for Joint D).
- The maximum load capacity of the joint is increased to 3500lbs for Joint C and 4000lbs for Joint D.
- The higher load capacity of Joint C and D is due to the presence of the z-fibers that results in stable crack growth and increased energy absorption

CONCLUSION

- The mechanical tests of the flange concept using 3TEX material showed promise as the first failure load capacity was increased by 40%.
- The 3D concept with flap increased in the ultimate load capacity by more than 80%

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