IN-PLANE MECHANICAL PROPERTY AND DAMAGE CHARACTERIZATION OF GLASS EPOXY COMPOSITES FOR MATERIAL MODELLING

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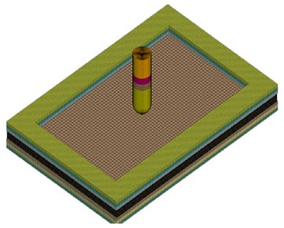
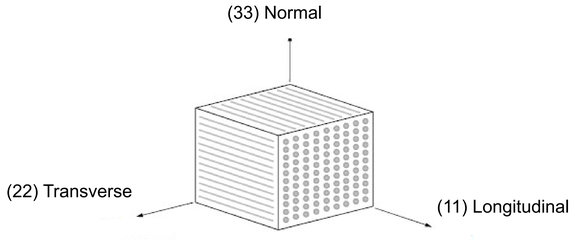
Introduction

- Researchers use computational models to predict performance data of composites in various situations – for example, low velocity impact
- Experiments done in differing material models using LS-DYNA, like MAT_213, with databases of information about composites



Material and Model Data

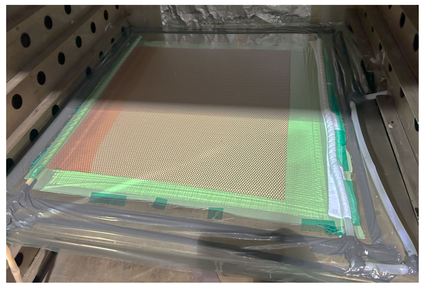
- Material: S2-glass plain weave 24 oz/yd^2 fabric and RDL-RDC high toughness epoxy resin

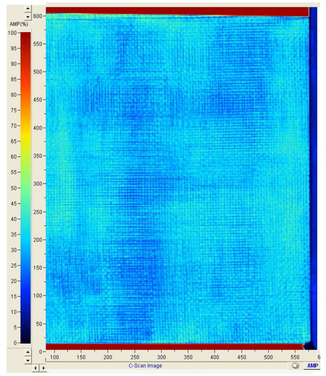


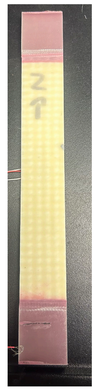
- Model requires data such as stress-strain, poison's ratio, damage profile, damage type, maximum stress, etc.
- Objective: Manufacture and test a glass-epoxy composite in plane tension longitudinal (11) and transverse (22) tension

Manufacturing Panel and Samples

- Manufactured composite panel using VARTM with curing and post-curing in oven
- Cut samples for both compression and tension



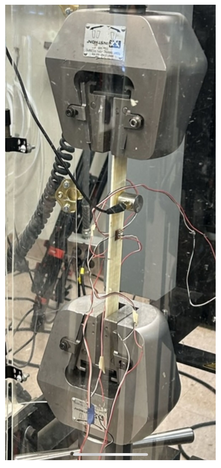




- Preformed C-scan to check for impurities
- Cut differing sections of the panel for each test
- Cut 14 (11) samples and 6 (22) samples
- Fiber volume fraction: 46.5%

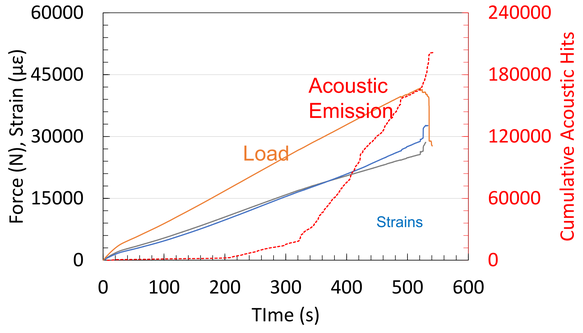
Testing Process

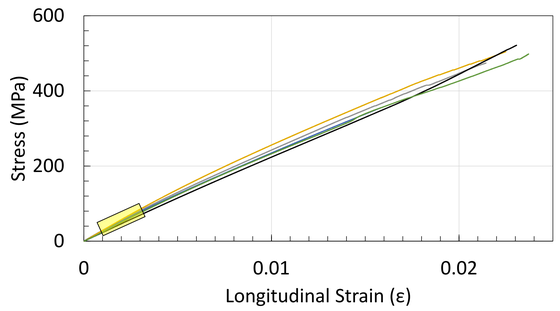
- Tests followed ASTM D3909 standards using Instron 4484
- 0.05 in/min
- Monotonic and cyclic testing
- Monotonic used to determine appropriate scaling of cycles
- Biaxial strain gages to measure ε_{11} and ε_{22}
- Acoustic emission sensors for damage initiation and quantification



Data Analysis and Results

- 5 samples of each (11) and (22) were tested monotonically
- 3 samples of (11) were tested cyclically
- Strain vs time, stress vs time, acoustic cumulative counts vs time, and stress vs strain plotted

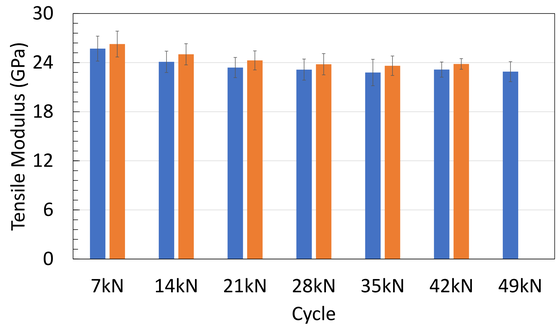


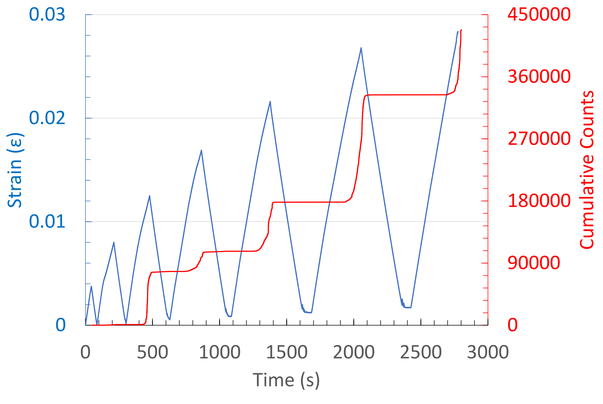


- Modulus and failure stress calculated
- Modulus → slope in 0.1 – 0.3% strain

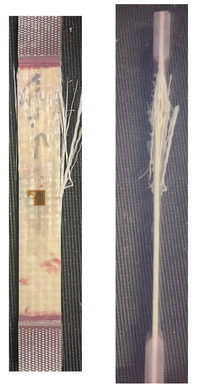
	Failure Stress (MPa)	Tensile Modulus (GPa)
Longitudinal Direction (11)	618 ± 13	26.6 ± 1.3
Transverse Direction (22)	556 ± 8	26.5 ± 1.9

- Loading and unloading modulus calculated
- Modulus → slope from min – max strain
- Compared strain with acoustic cumulative counts





- Minimal decrease in moduli due to high linearity of the stress strain curves
- Minimal change to slope prevent stiffness reduction
- Similar likely result for (22)
- Decreasing likely in other moduli like (12) shear modulus



Conclusions

- The maximum stress and tensile modulus in both directions determined
- Failure stress and strain are generally unaffected by cyclic loading in (11)
- Composite starts to have permeant damage past ~1% strain
- No more cyclic tension testing for (11) needed

Future Work

- Analyze frequency data of the acoustic sensor to figure out the type of failure and fracture
- Test in-plane compression samples and analyze the data
- Test in-plane shear using +- 45 samples and/or 2 rail shear

Acknowledgements

Research was sponsored by the **Army Research Laboratory** and was accomplished under **Cooperative Agreement Numbers W911NF-24-2-0127 and W911NF-18-2-0299.** The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the Army Research Laboratory or the U.S. Government. The U.S. Government is authorized to reproduce and distribute reprints for Government p*urposes not withstanding any copyright notation herein*