Standard Test Methods for Interlaminar Shear

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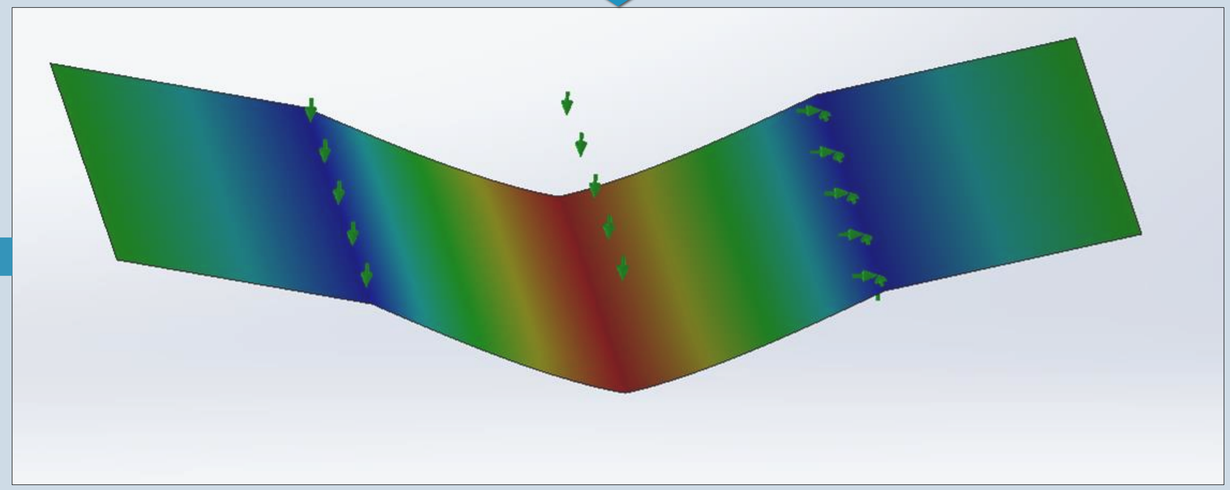
Introduction

Delamination in composites is a key failure mode, reducing structural integrity and life-span. Standard testing is needed to understand delamination and design composites resistant to failure. Due to the COVID-19 pandemic, planned physical testing moved towards attempting numerical modelling as a means of determining the shear properties of a unidirectional carbon fibre/ epoxy laminate. Investigating changes in interlaminar shear strength (ILSS) as laminate thickness increases.

Solidworks Finite Element Analysis (FEA)

- **2D shell model (orthotropic-homogenous laminate properties) with ply numbers (8-12)**
- **Tested in 3-point flexure (maximising shear stress)**
- **Loaded until beam deflection = 0.05, 0.1, 0.15, 0.2, 0.25 mm**
- **Extracted values for ILSS (MPa) and Load (N) at each deflection**



Solidworks FEA: 8 ply model deflection plot (0.25mm)

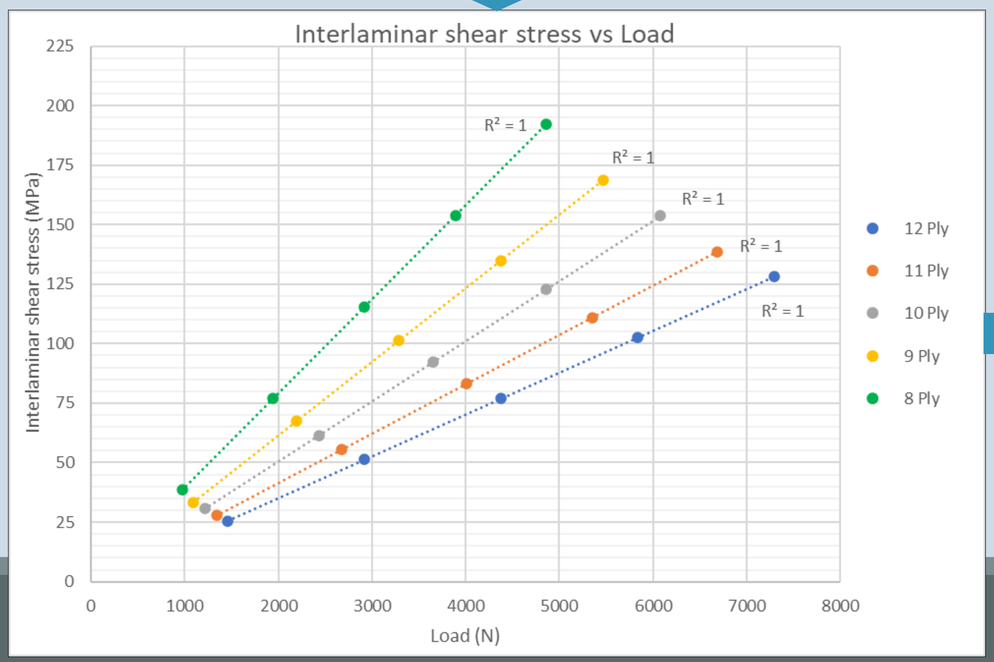
Results

- **Linear relationship between load, displacement and ILSS**
- **Laminate acts completely linearly elastic at all deflections**

No failure mechanisms displayed within data:

1. **No load drops from delamination/ matrix cracking/ fibre-matrix debonding.**
2. **No changes in stress distribution at high deflection where the model would be dominated by compression between the supports, rather than shear.**

- **Overall: Modelling highlights Solidworks FEA shell modelling is ineffective at determining ILSS and its corresponding failure mechanisms.**



Advanced composite modelling methods

- **Advanced modelling is required to model the distinct failure modes occurring at the interface between plies, where matrix cracking, fibre-matrix debonding and ultimately delamination occurs. By accurately modelling how the initiation and propagation of these failure mechanisms occur, ILSS can be calculated. Advanced methods researched:**

1. **Advanced interface elements**
2. **Micro scale modelling**
3. **3D FEA modelling**

- **Conclusion: A mix of interface modelling, 3D FEA, micro scale modelling and classical laminate theory may be used to model interlaminar shear failure and calculate ILSS at an accuracy comparable to that of physical testing.**