Size effects in transverse tensile strength

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Size effect in transverse tension

- Where failure is brittle and depends on defects, size effects are expected.
- AS4/3501-6 specimens, 178mm long.
- 12.7, 25.4, 50.8 mm wide, 4-64 plies.
- Clear trend for reducing strength with increased stressed volume.
- Weibull modulus of 12.2.
- Matrix microcracks and fibre-matrix debonds proposed as likely inherent flaws.

O’Brien & Salpekar, 1995
Size effect in interlaminar tension

- Curved beams in bending
- HTA Carbon / 913
- Fully scaled specimens: 240x20x8, 120x10x4, 60x5x2 mm, 16, 32, 64 plies
- Weibull modulus of 18.6

Wisnom, Jones & Hill, 2001
Comparison of tension and bending

- IM7/8552
- 3PB, 4PB, tension, with different stressed volumes
- At least 36 repeats of each type gives good statistical dataset

Arndt, de Carvalho & Czabaj, 2020
Experimental results

- Significant decrease in strength with stressed volume
- All three sets of data fit Weibull distributions
- Weibull moduli 11.9-14.7
- 36% increase in strength when edges polished
Predictions using 2-parameter Weibull model

• Calculate stresses for equal probability of failure by integrating over volume:

\[ P(\sigma) = 1 - e^{-\int_V \left( \frac{\sigma}{\sigma_0} \right)^m dV} \]

• Flexural strengths well predicted from distribution of tensile strengths
Conclusions

• Transverse strength is defect controlled and so shows large scatter and a strong size effect
• Similar size effect for interlaminar tensile strength
• 2-parameter Weibull modulus fits data and can be used to predict strength
• Cannot use single deterministic values of transverse strength

