University of BRISTOL

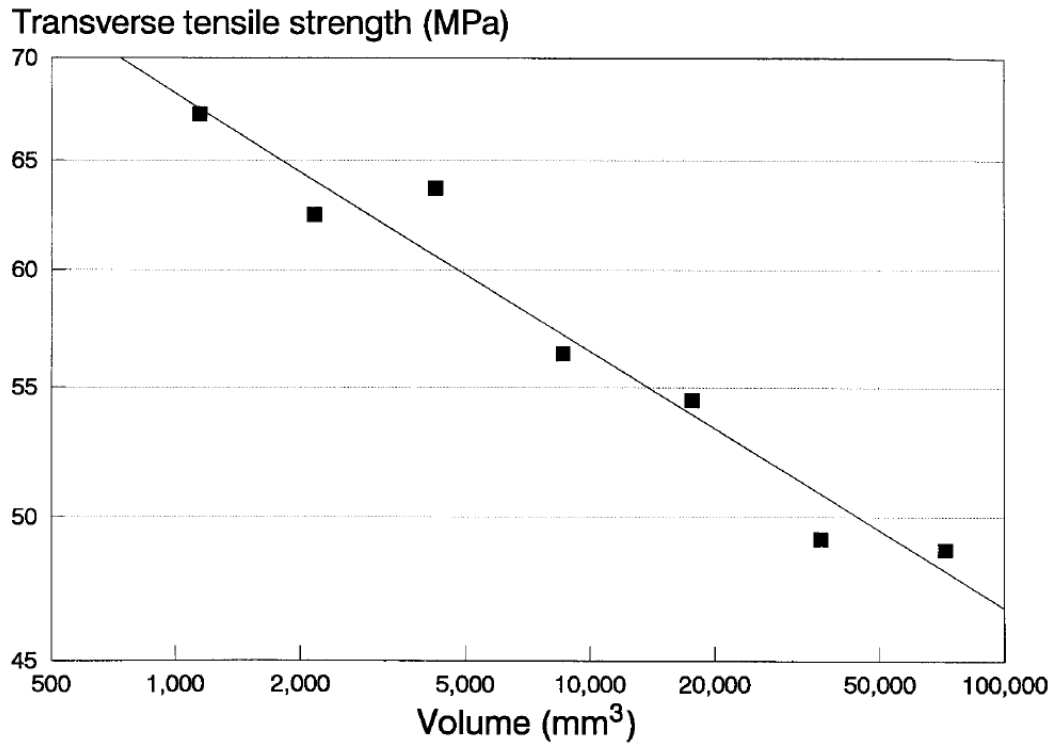
Bristol Composites Institute

Size effects in transverse tensile strength

Michael R. Wisnom

Size effect in transverse tension

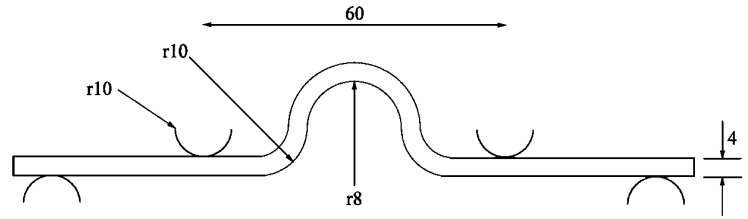
- Where failure is brittle and depends on defects, size effects are expected
- AS4/3501-6 specimens, 178mm long
- 12.7, 25.4, 50.8 mm wide, 4-64 plies
- Clear trend for reducing strength with increased stressed volume
- Weibull modulus of 12.2
- Matrix microcracks and fibre-matrix debonds proposed as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

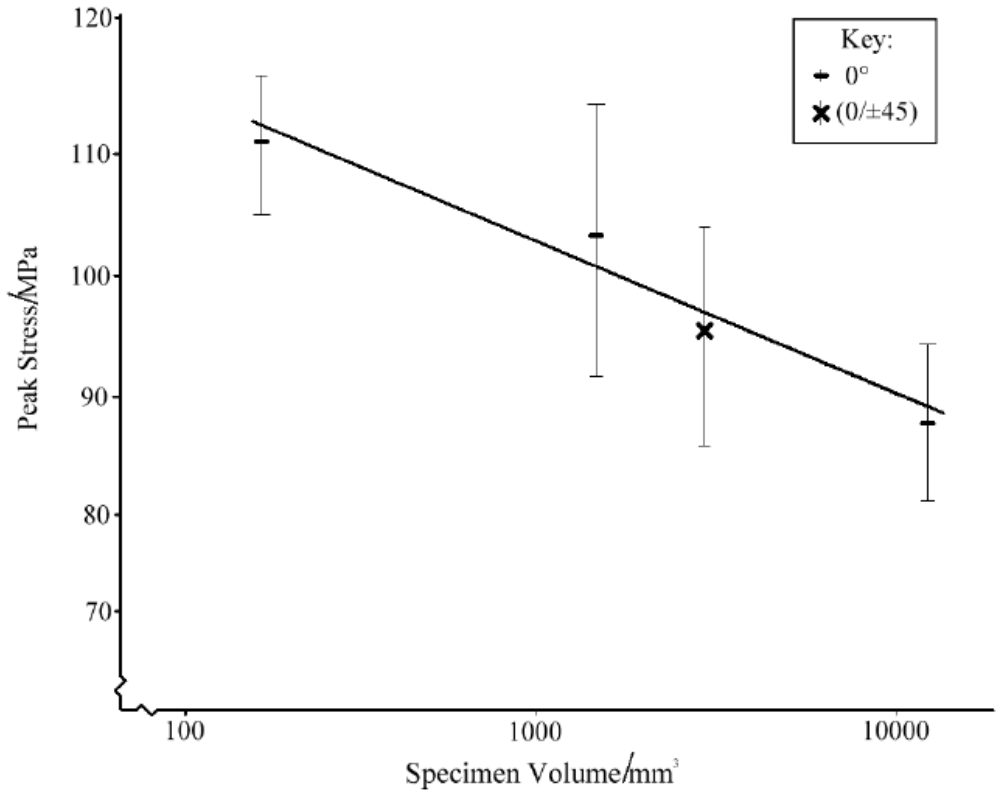


O'Brien & Salpekar, 1995

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

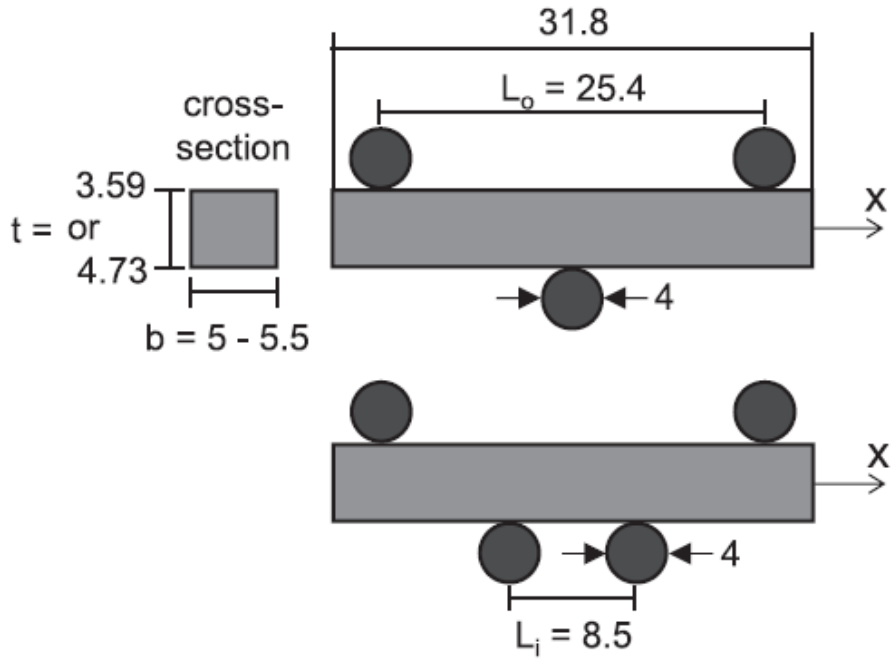


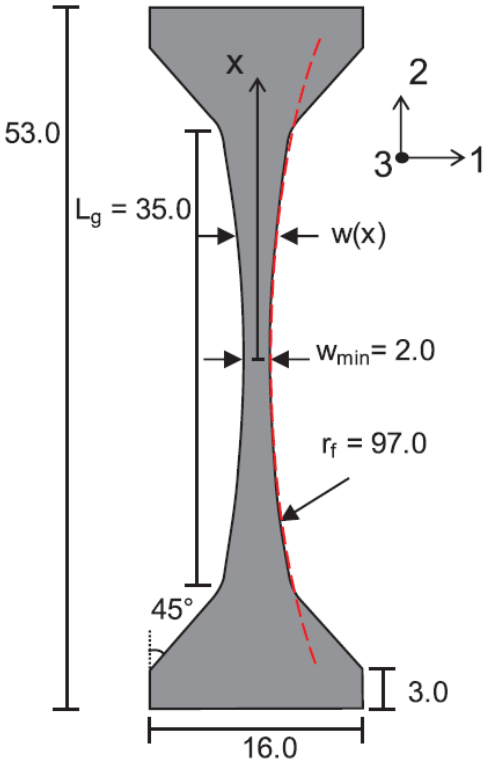


Wisnom, Jones & Hill, 2001

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

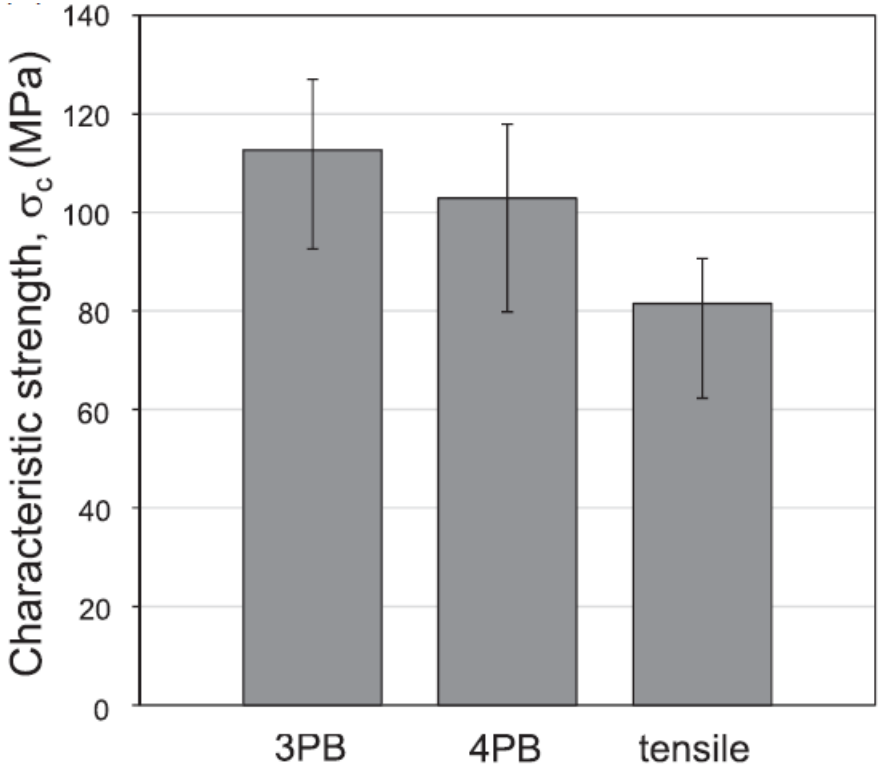


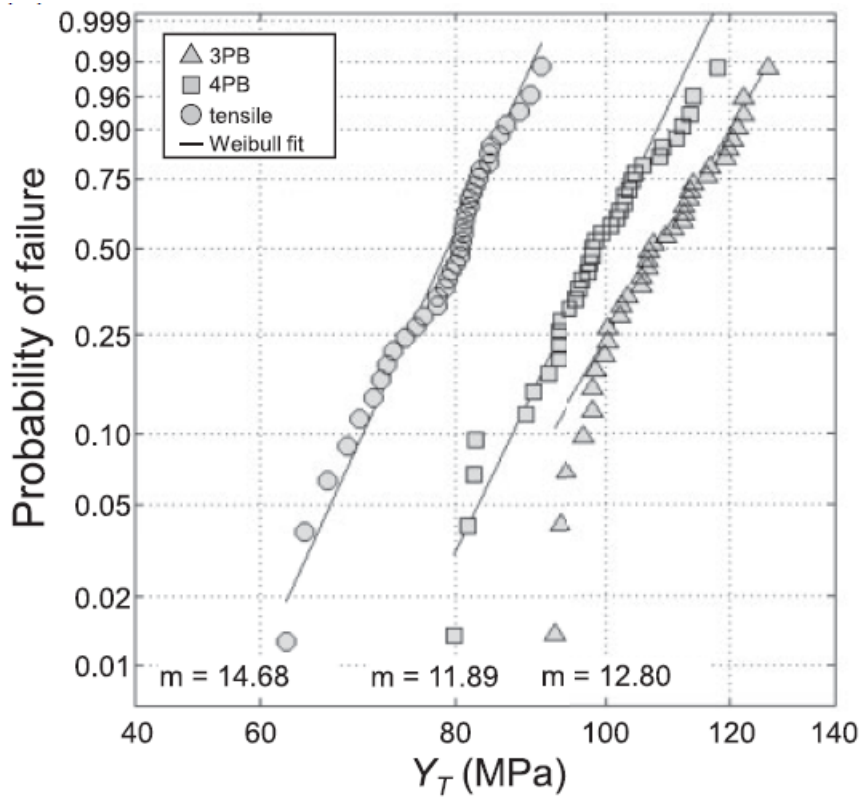


Arndt, de Carvalho & Czabaj, 2020

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



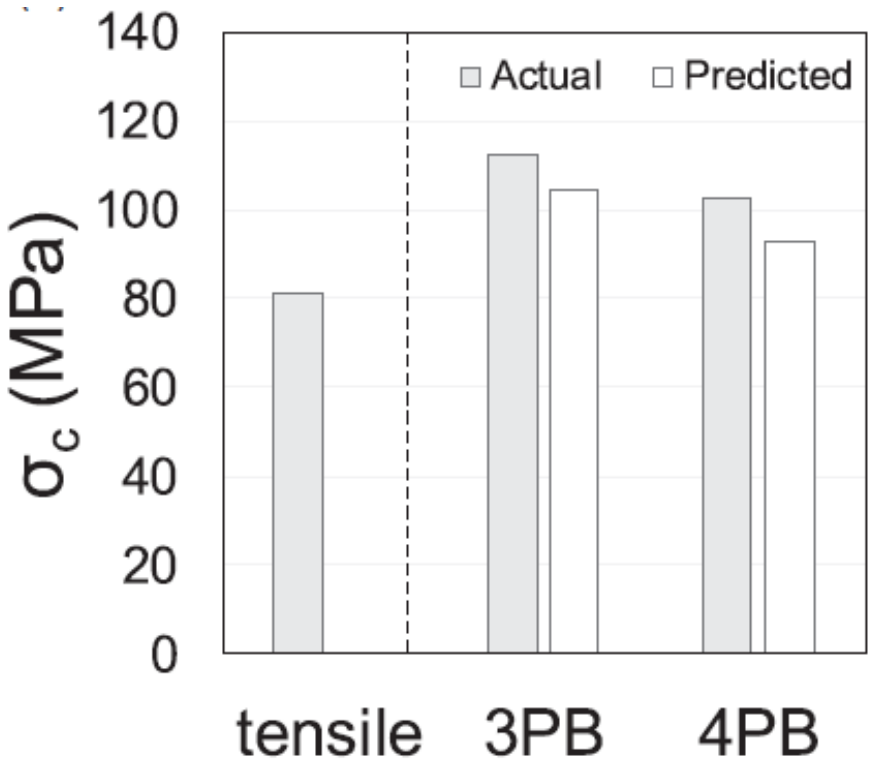


Predictions using 2-parameter Weibull model

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

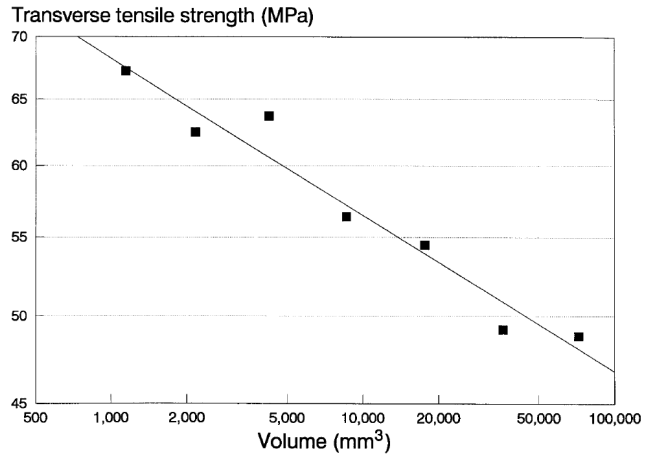
$$P(\sigma) = 1 - e^{\left[-\int_V \left(\frac{\sigma}{\sigma_0}\right)^m \mathrm{d}V\right]}$$

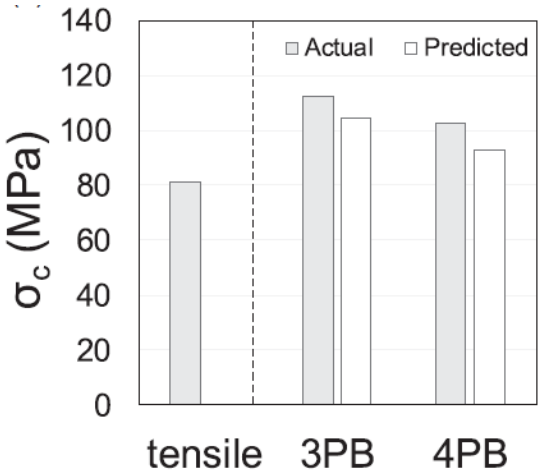
- Flexural strengths well predicted from distribution of tensile strengths



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





References

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