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Size Effect in Interlaminar Shear Strength and Comparison with In-plane Shear

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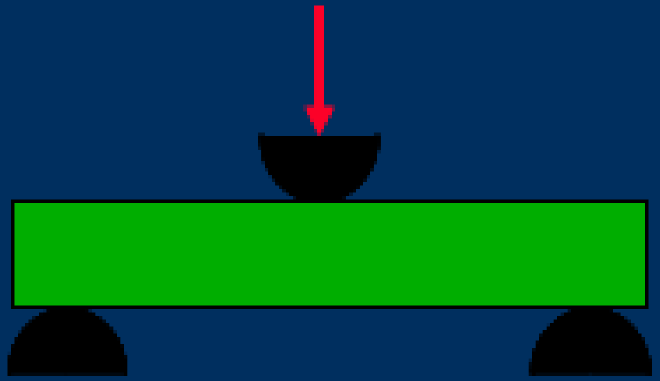
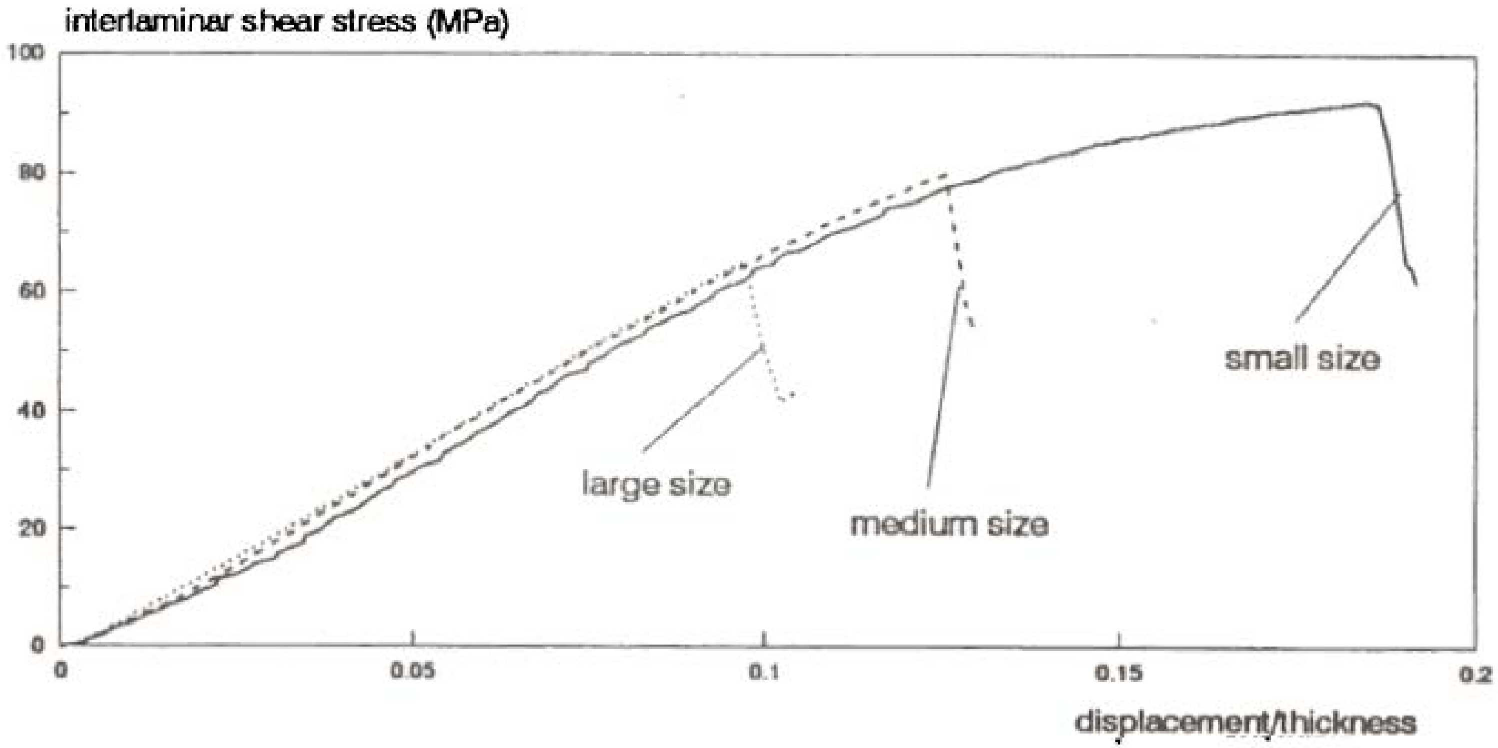
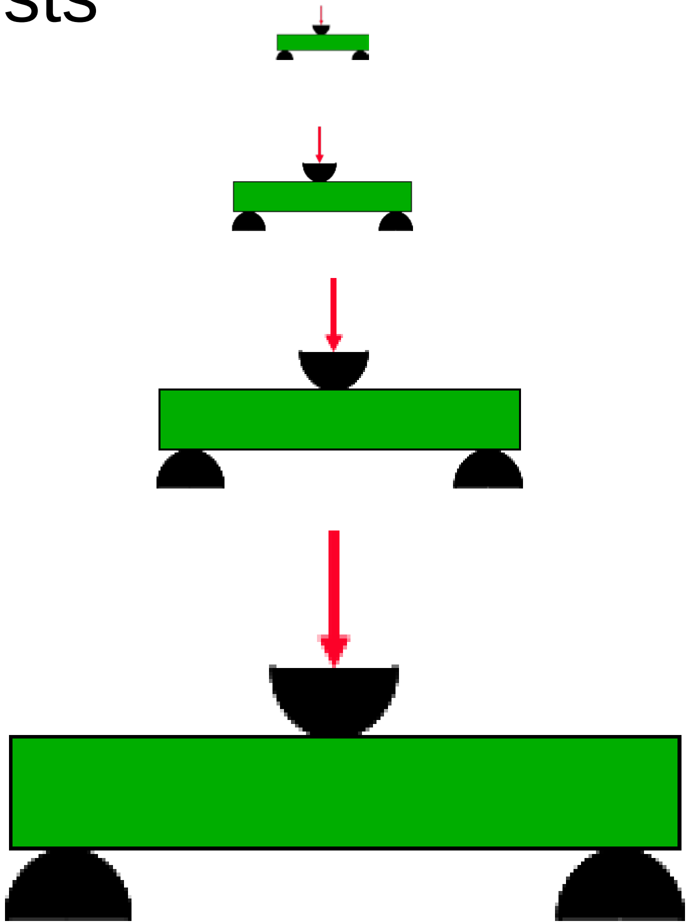


Size effect on interlaminar shear strength

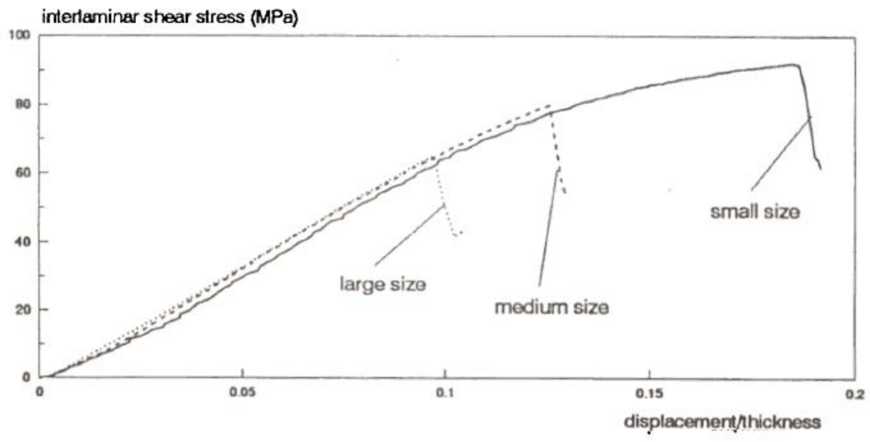
- Scaled XAS/913 carbon/epoxy short beam shear tests
- All dimensions doubled, t from 1.6 to 12.8 mm



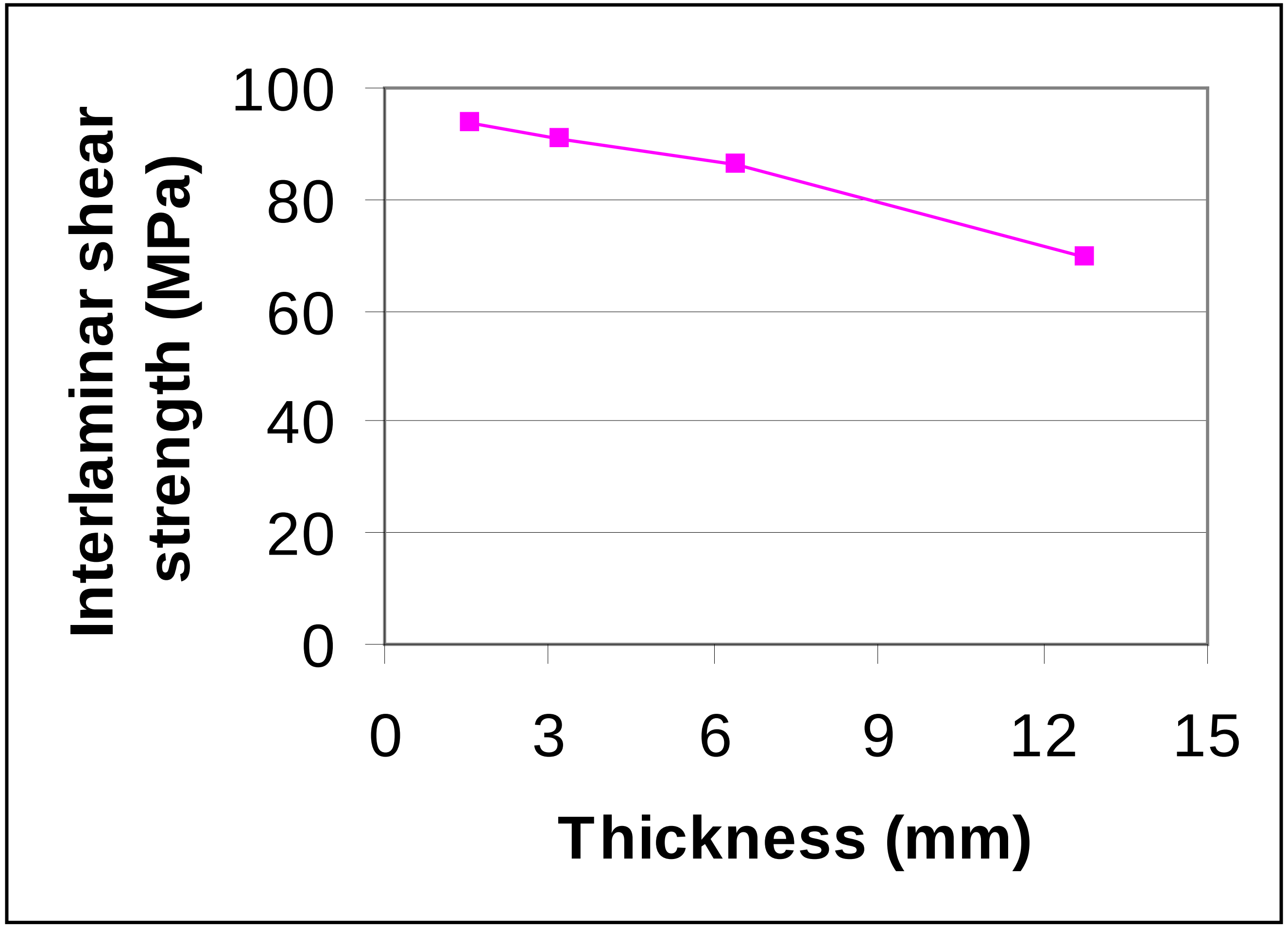


Size effect results

- Substantial reduction in strength with size
- Failure is defect controlled

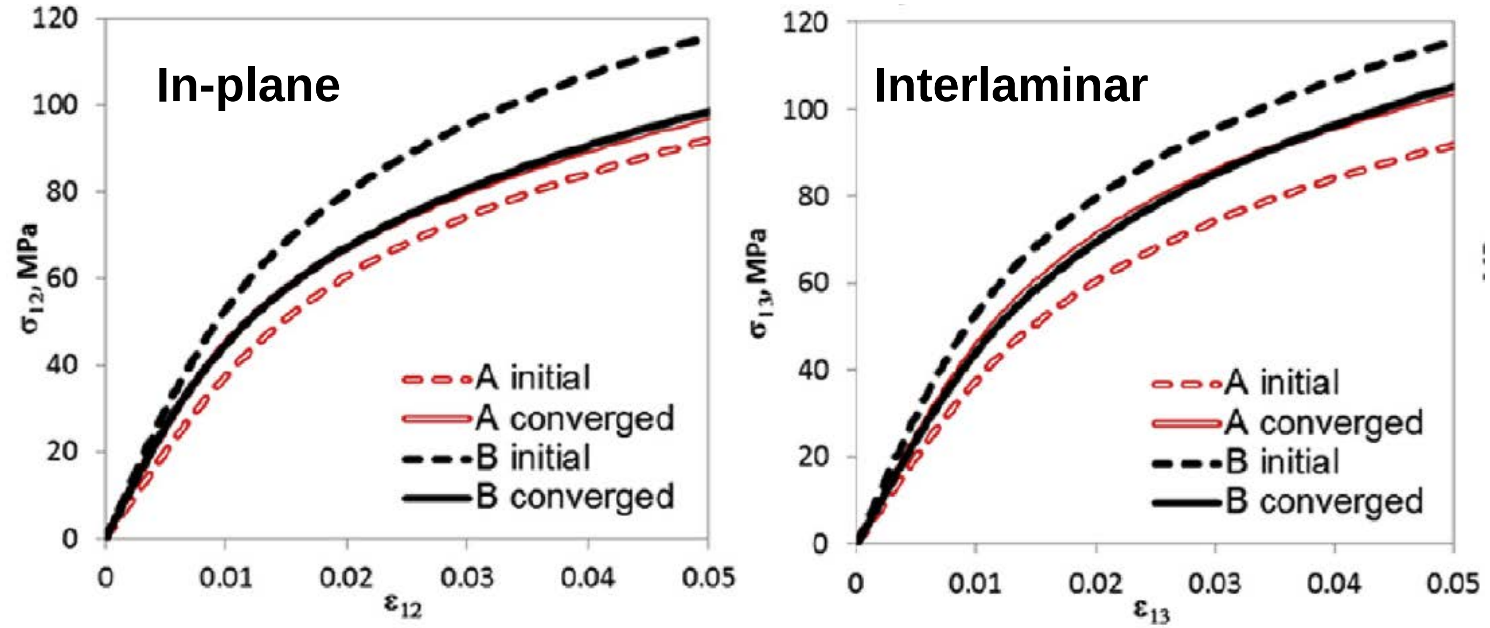


[1] Cui, Wisnom & Jones, 1994



Interlaminar versus in-plane shear

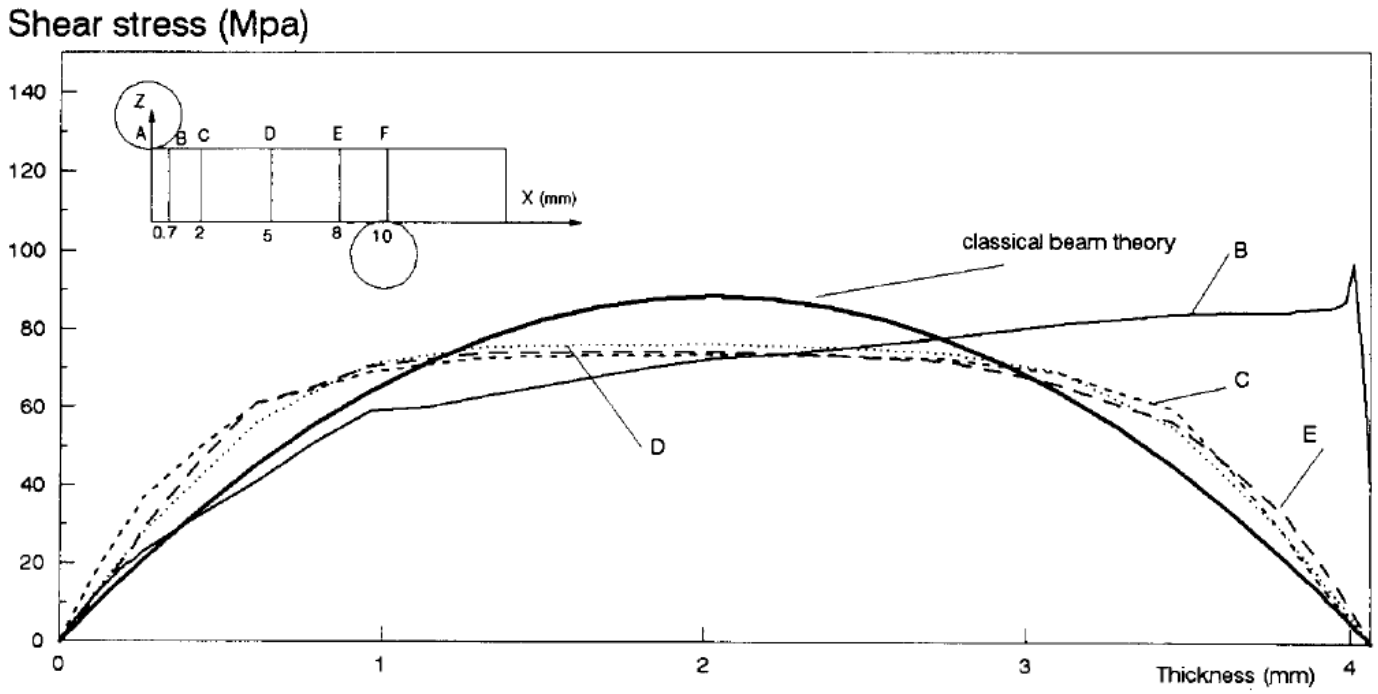
- IM7/8552 carbon/epoxy stress-strain responses very similar
- Curves from DIC on plate twist test and non-linear FE updating
- Interlayer toughened materials may behave differently



[2] Seon, Makeev, Cline, Shonkwiler, 2015

Are interlaminar & in-plane strengths different?

- Shear strength values depend on correct stress distribution
- E.g. linear short beam shear equation assumes parabolic distribution
- $\tau = 0.75\ P / wt$ (1)
- Material non-linearity changes maximum stress
- FE shows ILSS is typically ~15% lower than from (1)



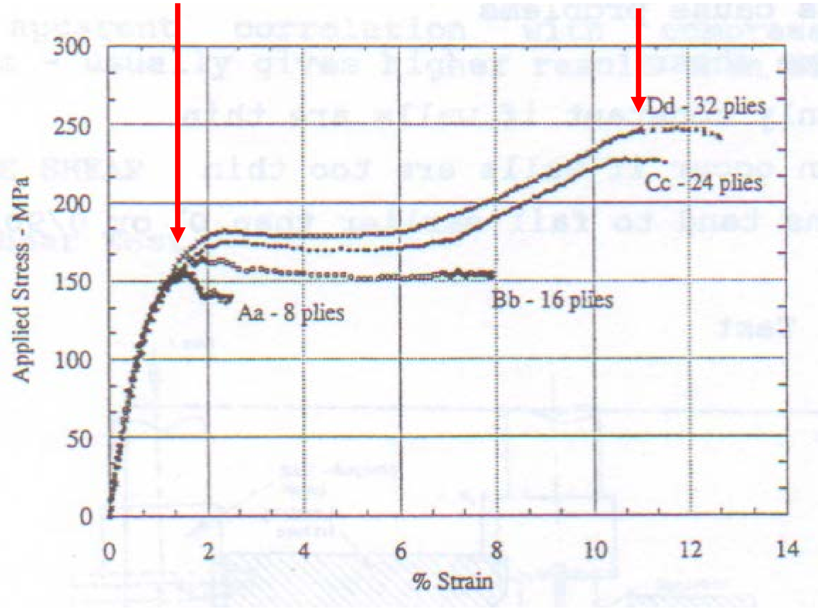
[3] Cui & Wisnom, 1992

Rationalising in-plane & interlaminar strength

- In-plane tests with bridging fibres may over-estimate strength
- E.g. shear strength from angle ply tests
- As plies rotate, fibres carry more load
- Simple equation $\tau_{12} = \sigma_1/2$ no longer valid [4]
- First failure not catastrophic due to bridging
- Consistent values of in-plane and interlaminar shear strength can be obtained when both are measured properly
- Need to consider size effect

Shear strength reached

Shear strength over-estimated



[5] Kellas, Morton & Jackson, 1991

References

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[2] Seon G, Makeev A, Cline J, Shonkwiler B, 2015. Assessing 3D shear stress-strain properties of composites using Digital Image Correlation and finite element analysis-based optimization. Composites Science and Technology 117:371-378. http://dx.doi.org/10.1016/j.compscitech.2015.07.011

[3] Cui W, Wisnom MR, 1992. Contact finite element analysis of three and four point short beam bending of unidirectional composites. Composites Science and Technology 45:323-334. https://doi.org/10.1016/0266-3538(92)90047-7

[4] Wisnom MR, 1995. The effect of fibre rotation in ±45 tension tests on measured shear properties. Composites 26(1):25-32. https://doi.org/10.1016/0010-4361(94)P3626-C

[5] Kellas, S, Morton J, Jackson, KE, 1991. An evaluation of the ±45 tension test for the determination of the in-plane shear strength of composite materials, Proc. ICCM 8, Honolulu, July 1991. http://iccm-central.org/Proceedings/ICCM8proceedings/papers/ICCM8_V4_69.pdf