AN INVESTIGATION INTO THE FIBRE BRIDGING FRACTURE TOUGHENING MECHANISM OF COMPOSITE MATERIALS

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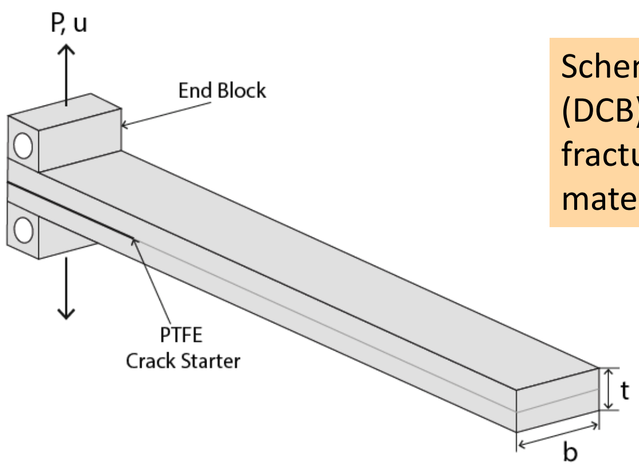
INTRODUCTION

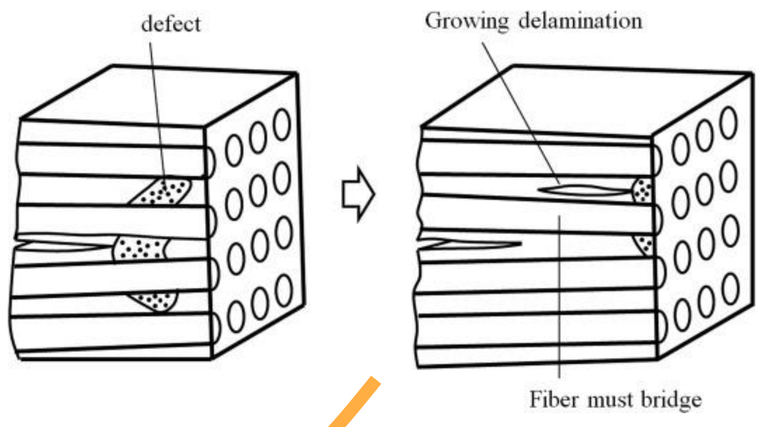
- The study investigated **large scale fibre bridging (LSFB)** in unidirectional CFRP specimens.
- **Double cantilever beam** tests were conducted to measure the interlaminar fracture toughness under Mode I loading.
- The research examined the contribution of **fibre bridging to fracture toughness** using R-curves.
- The results showed that all specimens exhibited **rising R-curves**, indicating **significant fibre bridging effects**.
- **Fibre cutting** was performed to gain insights into the contribution of fibre bridging in a double cantilever beam (DCB) specimen.

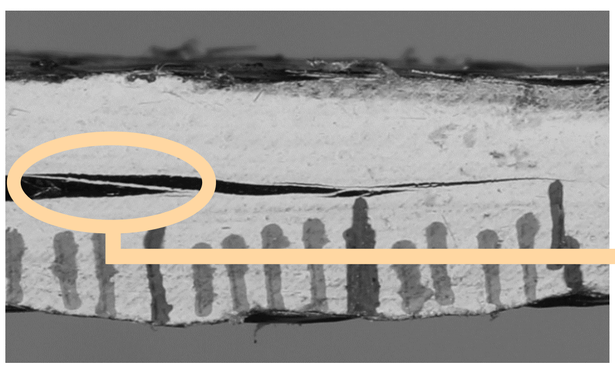
TEST METHOD



Schematic of a Double Cantilever Beam (DCB) - used to measure the interlaminar fracture toughness of a composite material under Mode I loading.

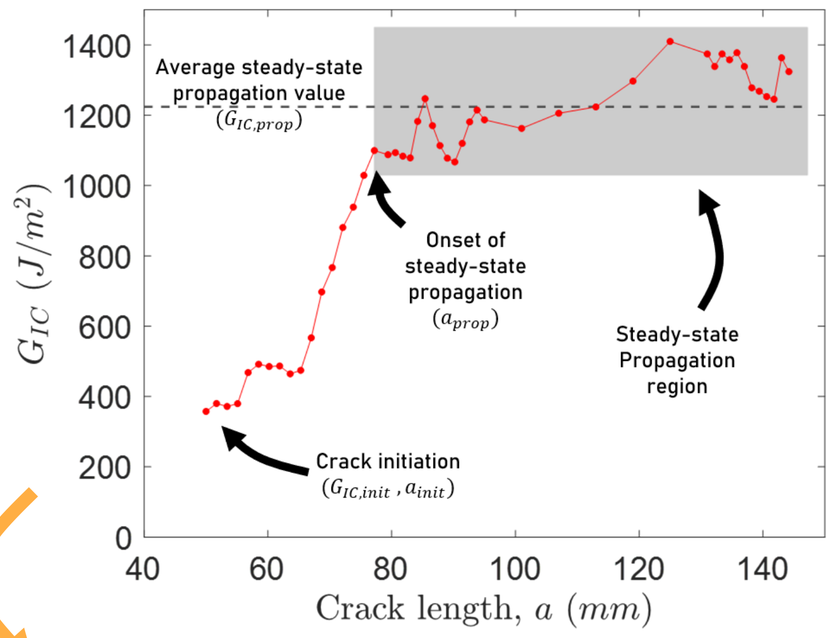
Schematic showing how a defect in the processing zone ahead the crack tip can grow into the primary crack and cause fibres to bridge the crack.





Photograph taken of a DCB specimen during testing, in which this phenomena is shown.

Typical R-curve plot ($G_{IC} - a$) of a DCB experiencing Large Scale Fibre Bridging (LSFB) with key values identified.

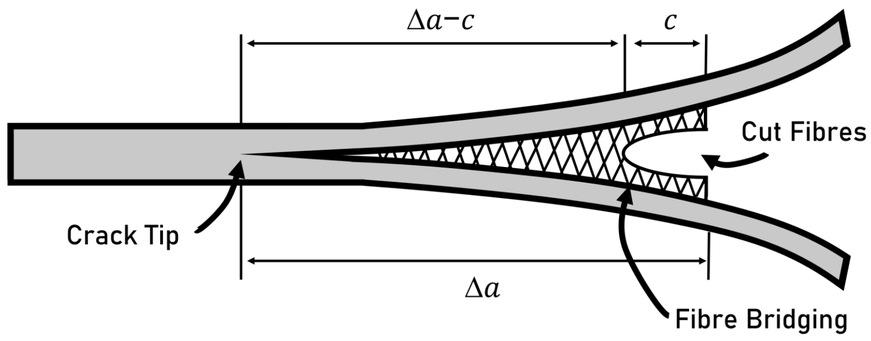


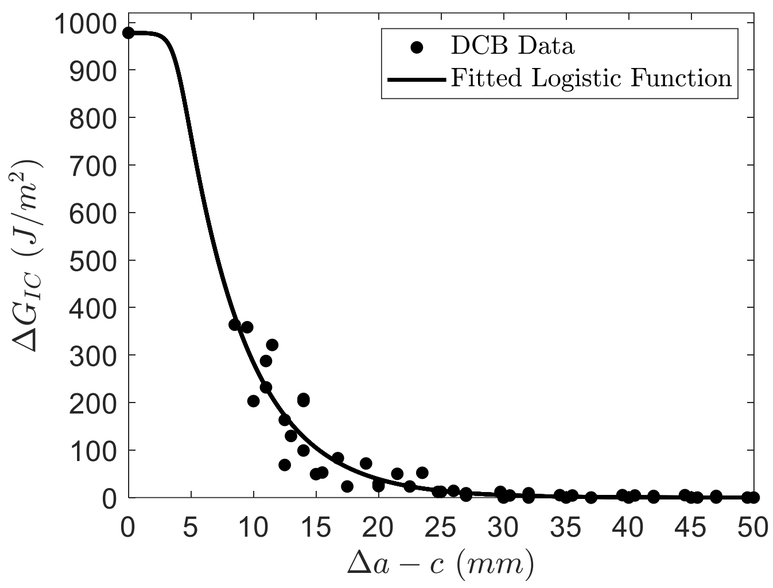
$G_{I,\,init}$ (J/m^2)	$G_{I,\,prop}$ (J/m^2)	$G_{I,\,prop-init}$ (J/m^2)	R-curve length (mm)
337.39 ± 53.57	1315.50 ± 93.90	978.11 ± 108.10	30.50 ± 0.55

Averaged results of all DCB specimens tested.

FIBRE BRIDGING EXPERIMENT

Illustration defining the fibre cut length, c, the crack growth length, Δa, and the length of fibre bridging zone still intact, $\Delta a - c$.

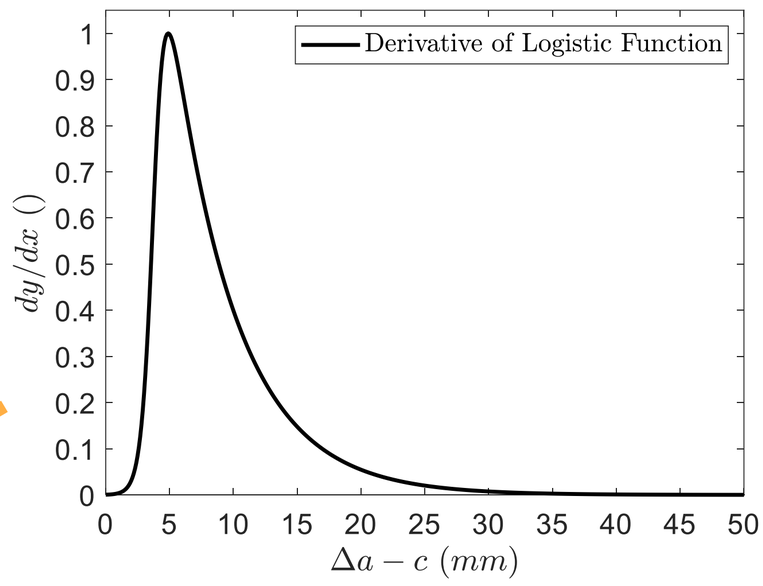


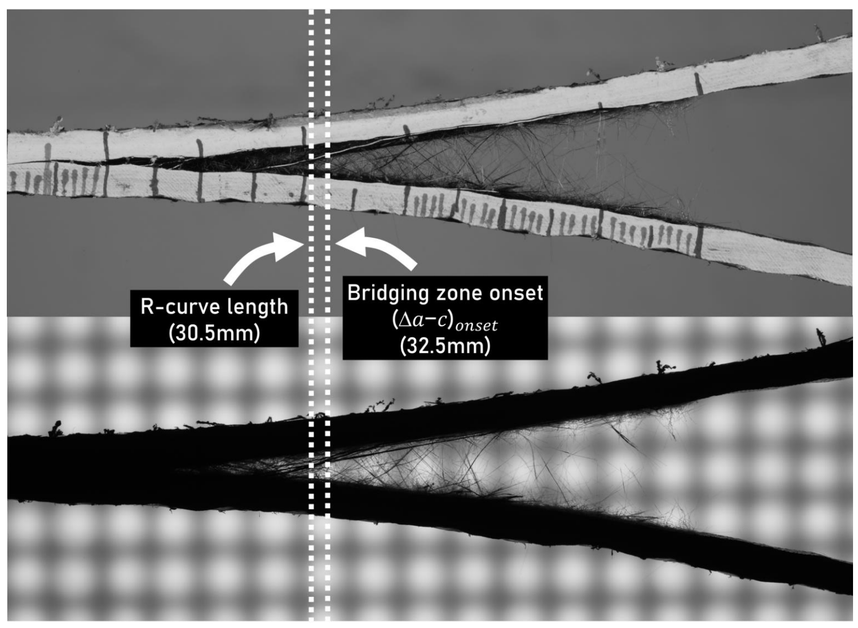


Plot of the recovered fractured energy ΔG_{IC} as the fibre bridging zone is cut.

Derivative of the fitted logistic function above.

The resistance distribution of the fibres bridging.





Visual demonstration of the measured R-curve length and the onset of the bridging zone, $(\Delta a - c)_{onset}$, overlaid on a DCB specimen.

CONCLUSIONS

- The 'effective' bridging zone length obtained via the fibre cutting experiment showed good correlation to the R-curve length.
- The fibre cutting experiment quantitatively evaluated fibre contribution to fracture energy based on distance from the crack.
- The resistance distribution of the fibre bridging shows good correlation to typically assumed bridging laws.