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Predicting Trans-laminar Fracture Using VCCT and In-situ CT Scans

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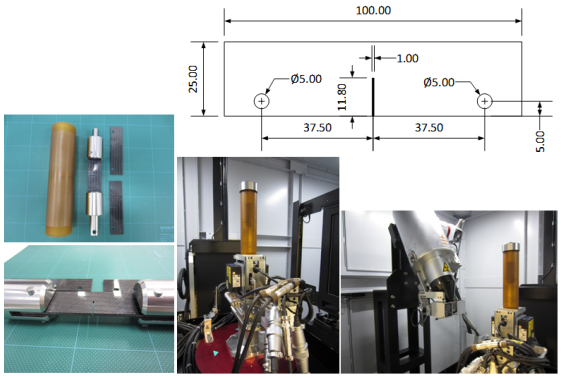
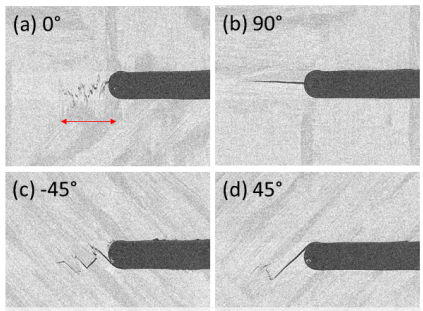
In Situ-CT scans were carried out to predict the failure propagation load of a large stiffened panel. The test focused on translaminar fracture toughness characterisation and **a partial resistance curve (R-Curve) was constructed**. With the aid of Virtual Crack Closure Technique (VCCT), the **predicted failure propagation load was 7% higher than the measured load [1]**.

Objectives
- To measure the effective crack length of small coupons using in-situ CT scan
- To predict the fracture propagation and max load of the stiffened panel using small coupons and VCCT

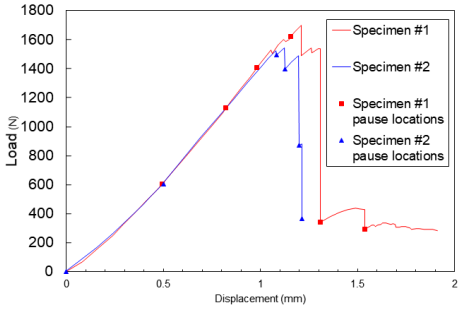
Specimen configuration & test set-up



Test results

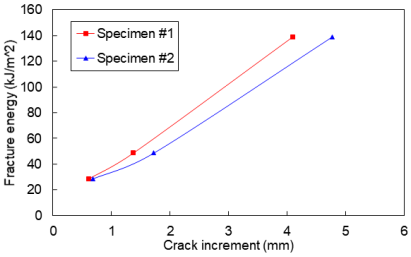


- Crack length is measured from the average of the four 0 degree plies.



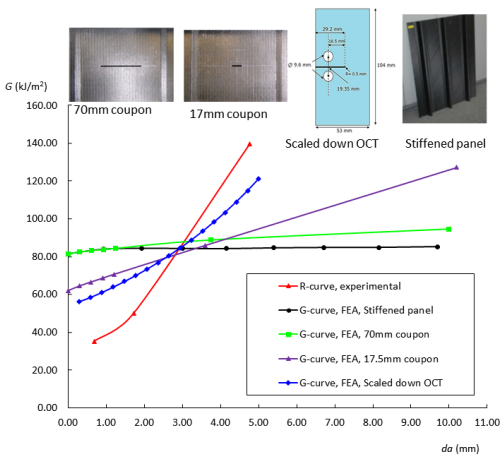
Fracture energy calculation

- Calculation based on ASTM E1922
- G_c increases with Δa
- No plateau yet due to small specimen size
- Max value at approx. 140 kJ/m²
- How can these results be implemented for prediction?



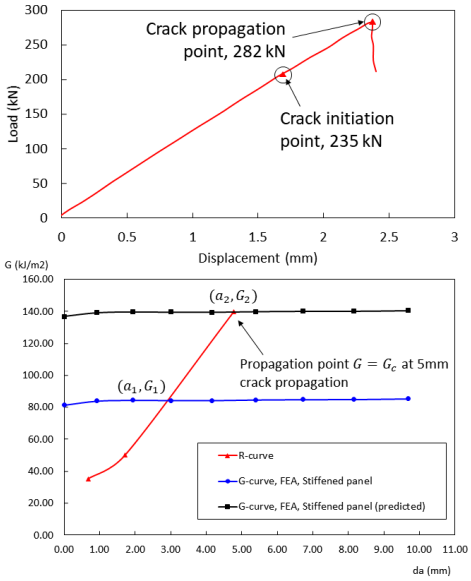
- G curves – Strain energy release rate curves from FEA of other specimens with same material
- All curves intersect at approx. 3mm notch length, which is independent of geometry
- 3 mm corresponds to the damage-zone size
- Consistent G at initiation of fracture

R-curve compared against G-curves



- R-curve from In-situ CT scan
- New measure R-curve consistent with previous G calculations for initiation
- Increasing G_c explains stable fracture after initiation

Failure propagation prediction



- VCCT analyses of stiffened panel for fracture initiation and propagation
- At G_1= 84 kJ/m2, the load is 235 kN, thus F_2 can be worked out from G_c=140 kJ/m2.
- Predicted F_2 = 303 kN only 7% from max load of 282 kN.

Conclusions

- Successful In-situ CT scan for trans-laminar fracture toughness characterisation
- Partial R-curve obtained from a single specimen
- R-curve validated against previous FEA results
- Satisfactory prediction of fracture propagation load of the large panel based on the small specimen results

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[1] Sun, X., Takeda, S. I., Wisnom, M. R., & Xu, X. (2020). In situ characterization of trans-laminar fracture toughness using X-ray Computed Tomography. *Composites Communications*, *21*, 100408.