PREDICTING TRANS-LAMINAR FRACTURE USING VCCT AND IN-SITU CT SCANS

X. Sun[1*], S. Takeda[2], M. R. Wisnom[1], and X. Xu[1]

[1] Bristol Composites Institute (ACCIS), University of Bristol, University Walk, Bristol BS8 1TR, UK
[2] Structures and Advanced Composite Research Unit, Japan Aerospace Exploration Agency (JAXA)
* xs14134@bristol.ac.uk

With the upsurge in use of advanced composites in the aerospace, marine and automotive industries, a comprehensive understanding of their failure mechanisms, especially trans-laminar fracture is important. Previous work on this topic was reviewed in Ref. [1]. More recently, a High-fidelity Finite Element Method (Hi-FEM) has been developed to deduce the R-curve for Mode I trans-laminar fracture based on the previous work [2-5]. The measurement of crack increments Δa in trans-laminar fracture tests has proven challenging. There are numerous methods such as optical measurement, Digital Image Correlation (DIC) and deplying, with X-ray Computed Tomography (CT) being an especially powerful tool to examine internal damage states and measure crack growth [4]. However, multiple interrupted tests are required for crack length measurements and dye penetrant is often needed to enhance the CT scan images which may induce a negative effect on test results.

The current research aims to develop an in-situ CT scanning method to characterise Mode I trans-laminar fracture properties such as R-curves in a single continuous test. The R-curve measured using in-situ CT scans is applied with the Virtual Crack Closure Technique (VCCT) for the failure prediction of another notch configuration. A test panel was manufactured at JAXA through Vacuum assisted Resin Transfer Moulding (VaRTM). The material used was biaxial carbon Non-Crimp Fabric (NCF) with a stacking sequence of $[(45/\text{-}45)/(0/90)]_{2s}$. The geometry is in accordance with the ASTM E1922 standard. The in-situ CT scans are conducted in JAXA. A customized in-situ test rig has been developed as shown in Figure 1.

Figure 1. In-situ CT scanner in JAXA.

References

[1] M.J. Laffan, S.T. Pinho, P. Robinson, A.J. McMillan (2012), Translaminar fracture toughness testing of composites: A review, *Polymer Testing*, **31**, 481-489.

[2] X. Xu, M.R. Wisnom, Y. Mahadik, S.R. Hallett (2014), An experimental investigation into size effects in quasi-isotropic carbon/epoxy laminates with sharp and blunt notches, *Composites Science and Technology,* **100**, 220-227.

[3] X. Xu, M.R. Wisnom, X. Li, S.R. Hallett (2015), A numerical investigation into size effects in centre-notched quasi-isotropic carbon/epoxy laminates, *Composites Science and Technology,* **111**, 32-39.

[4] X. Xu, M.R. Wisnom, Y. Mahadik, S.R. Hallett (2015), Scaling of fracture response in over-height compact tension tests, *Composites Part A: Applied Science and Manufacturing,* **69**, 40-48.

[5] X. Xu, M.R. Wisnom, S.R. Hallett (2019), Deducing the R-curve for trans-laminar fracture from a virtual Over-height Compact Tension (OCT) test, *Composites Part A: Applied Science and Manufacturing*, **118**, 162-170.