Digital image correlation of mixed-mode delaminations

[Abstract]

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Digital image correlation of mixed-mode delaminations

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A methodology is developed to observe the 2D near-crack tip strain fields of delaminations in laminated fibre-reinforced polymer double cantilever beam (DCB) specimens. ‘Uneven bending moment’ (UBM) apparatus is designed, built and developed to apply pure bending moments to DCB tips to allow stable fracture tests to be carried out over the full range of fracture mode partitions. Very fine speckle patterns are applied to the near crack-tip regions and are observed with a high-power lens to measure the near-crack tip strain fields with digital image correlation (DIC). A programme of testing is then carried out with unidirectional glass/epoxy DCB specimens with various through-thickness delamination locations. Analysis of the measured strain fields reveals that: (1) The high near-crack tip opening and shearing strains are localised ahead of the crack tip in the resin-rich region between plies. (2) There exist two bending moment ratios at which the opening strain field becomes very small in comparison to the shearing strain field. (3) There exist two bending moment ratios at which the shearing strain field becomes very small in comparison to the opening strain field. These four ratios correspond to pure fracture modes, that is, the two pure-mode-II fracture modes and the two pure-mode-I fracture modes. This behaviour and the values of these ratios correspond closely to the Euler beam mixed-mode partition theory developed at Loughborough University by Wang and Harvey (2012).