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A MIXED MODE COHESIVE LAW FOR DELAMINATION IN GRP LAMINATES WITH LARGE SCALE BRIDGING

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Cohesive zone modelling with cohesive elements is a convenient and commonly used tool for investigating delamination in glass fibre reinforced polymer (GRP) laminates. The behaviour of the cohesive elements is governed by a cohesive law relating tractions to opening displacements. Characterisation of such cohesive laws is the topic of this paper.

GRP laminates can show extensive fibre bridging during delamination, often referred to as large scale bridging (LSB). For delaminations with LSB, the shape of the cohesive law will influence the delamination behaviour (whereas delaminations without LSB are generally governed by the critical energy release rate alone). The shape of the cohesive law can be obtained from the fracture resistance measured on double cantilever beam (DCB) samples by partial differentiation of the fracture resistance with respect to the crack-end opening displacements. However, two aspects make the determination of cohesive laws challenging: 1) Variation in crack-tip deformations across the width of the specimen due to anticlastic bending and 2) The development of fibre bridging makes the mode-mixity at the crack-tip divert from the opening evolution observed at the crack end.

Due to the above stated aspects, a straightforward determination process seems infeasible. Iterative optimisation schemes are necessary for determination of cohesive laws for use in full 3D FE models of LSB specimens to overcome the effects of anticlastic bending and shifting crack-tip mode mixity from onset to steady state fracture propagation. The iterative optimisation procedure proposed by Joki et al [1] to overcome the challenges caused by anticlastic bending can be extended to solve the challenge caused by the shift in crack-tip mode mixity. The methodology described by Sørensen et al. [2] can be used to find a starting point (initial guess) for the optimisation.

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