

DO FIBRE BREAKS AFFECT DELAMINATION PROPAGATION IN UNIDIRECTIONAL INTERLAYER HYBRID COMPOSITES?

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Fibre-hybrid composites are widely used in transport, wind energy and sports applications due to their design versatility and lower cost compared to all-carbon fibre composites. Interlayer hybrids, where the fibre types are dispersed in layers, are the easiest to manufacture and therefore the most commonly used. The larger design freedom of hybrids is a result of the richer taxonomy in their failure mechanisms.

The failure mechanism of unidirectional (UD) hybrid composites is determined at the moment of the fracture of the low elongation (LE) fibre layer [1]. If the energy released in by the LE layer cannot be absorbed by the high elongation fibre layers, delamination is triggered. The propagation of the delamination depends not only on the constituent properties but also on the damage state of the composite. This damage includes LE fibre breaks, which in interlayer hybrids control the LE layer fracture and the final failure of the composite.

The work presented here takes the fibre breaks as the fundamental damage [2] and scales it up to predict layer fractures and the initiation and propagation of delamination between layers of different fibre type. Upon the first LE layer fracture, the model determines the energy release rate due to an increment Δd of the delamination length (see Figure 1). If the energy release rate is higher than the mode II interlaminar fracture toughness, the delamination propagates by Δd . The fibre break damage influences the energy release rate and therefore the delamination propagation. The stress field in the delaminated state is predicted using finite element models (FEM) with pre-defined delamination lengths. By combining the FEM predictions with the fibre break damage development we are able to predict different failure modes in UD interlayer hybrid composites under tension.

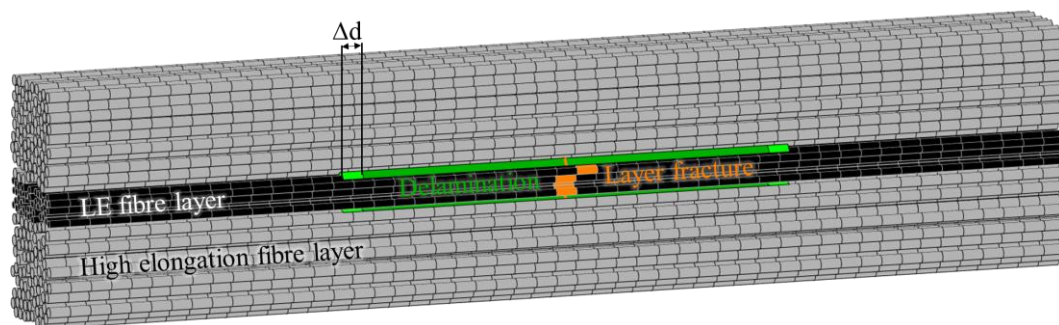


Figure 1. Interlayer fibre-hybrid packing with a layer fracture and partial delaminated interface.

References

- [1] Jalavand et al., *Compos. Part A*, 74 (2015) 123-131
- [2] Swolfs et al., *Material Design*, 93 (2016) 39-45