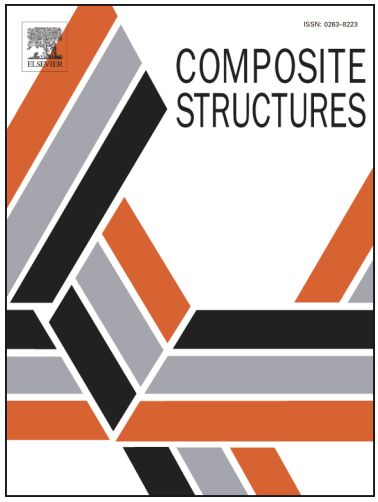

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PII: S0263-8223(17)32497-2
DOI: https://doi.org/10.1016/j.compstruct.2018.01.098
Reference: COST 9338

To appear in: *Composite Structures*

Received Date: 4 August 2017
Revised Date: 27 December 2017
Accepted Date: 30 January 2018

Please cite this article as: Cater, C.R., Xiao, X., Goldberg, R.K., Gong, X., Multiscale Investigation of Micro-scale Stresses at Composite Laminate Free Edge, *Composite Structures* (2018), doi: https://doi.org/10.1016/j.compstruct.2018.01.098

Multiscale Investigation of Micro-scale Stresses at Composite Laminate Free Edge

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ABSTRACT

The free edge effect is well understood at the laminate and lamina scale. The influence of the microstructure on micro-scale stresses and free edge cracking, however, is less known. This work aims at a better understanding of the effect of microscopic features on micro-scale stresses and the tendency of initial micro-cracking at the laminate free edge. To this end, a two-scale finite element (FE) modelling approach is developed. It consists of a meso-scale model to capture the laminate stacking sequence and the global stress field under a given loading condition, and a micro-scale model to predict the local constituent level stresses at the free edge. The two models were coupled one-way through a strain localization rule. A procedure to determine the boundary conditions for micro-scale FE models containing a free edge was proposed. The model was used to examine the 90/90 interface in $[25_N/-25_N/90N]_S$ IM7/8552 carbon/epoxy composite laminates. The effects of thermal and tensile loading were investigated independently to understand the influence of the interlaminar microstructure on micro-scale stresses at free edges during manufacture and under mechanical loading. The results agreed with the trend of free edge pre-cracks and progressive damage observed in experiments.

Keywords: Laminate; Free edge; Multiscale modelling; Interlaminar microstructures.