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MODELLING OF FIBRE BREAK DEVELOPMENT IN UNIDIRECTIONAL COMPOSITES UNDER LONGITUDINAL BENDING

Arsen Melnikov, Yentl Swolfs, Francisco Mesquita, Stepan V. Lomov, Larissa Gorbatikh

Department of Materials Engineering, KU Leuven
Kasteelpark Arenberg 44 bus 2450, 3001 Leuven,
Belgium
E-mail: arsen.melnikov@kuleuven.be, web page: www.composites-kuleuven.be

ABSTRACT

Understanding of failure development in unidirectional (UD) composites is fundamental in composites research. Failure of UD composites is controlled by two phenomena: stochastic failure of individual fibres and stress redistribution around broken fibres. Every fibre has its own strength according to a Weibull distribution due to random distribution of flaws [1]. These fibres hence start failing at random locations. The fibre breaks cause a redistribution of stresses in neighboring fibres, thereby increasing their probability to fail [2]. This transfer of load leads to clustering of fibre breaks [3]. Unstable growth of a cluster at a certain strain leads to the final failure of the composite, therefore this cluster is called "critical cluster".

The existing strength model for UD composites developed by Swolfs et al. [4], allows to account for statistical distribution of strength of fibres and stress redistributions around fibre breaks.

In the current study the model is further developed to account for the presence of non-uniform stress fields and applied to the case of three-point bending of a UD composite. The most important difference from the original model for uniform tension here is non-uniformity of the stress and strain fields throughout the composite. In bending, the composite has compressive and tensile zones; this study focuses on the tensile region.

Using Monte-Carlo simulations, the distribution and accumulation of fibre breaks in function of the applied load were obtained. Statistics of the critical cluster position and its development has been analysed.

An experimental investigation using synchrotron computed tomography is ongoing and it should help with validation of the model. Further, the model can be used to investigate effects of additional disturbances in the stress fields of a UD fibre bundle, which are induced by different reasons.

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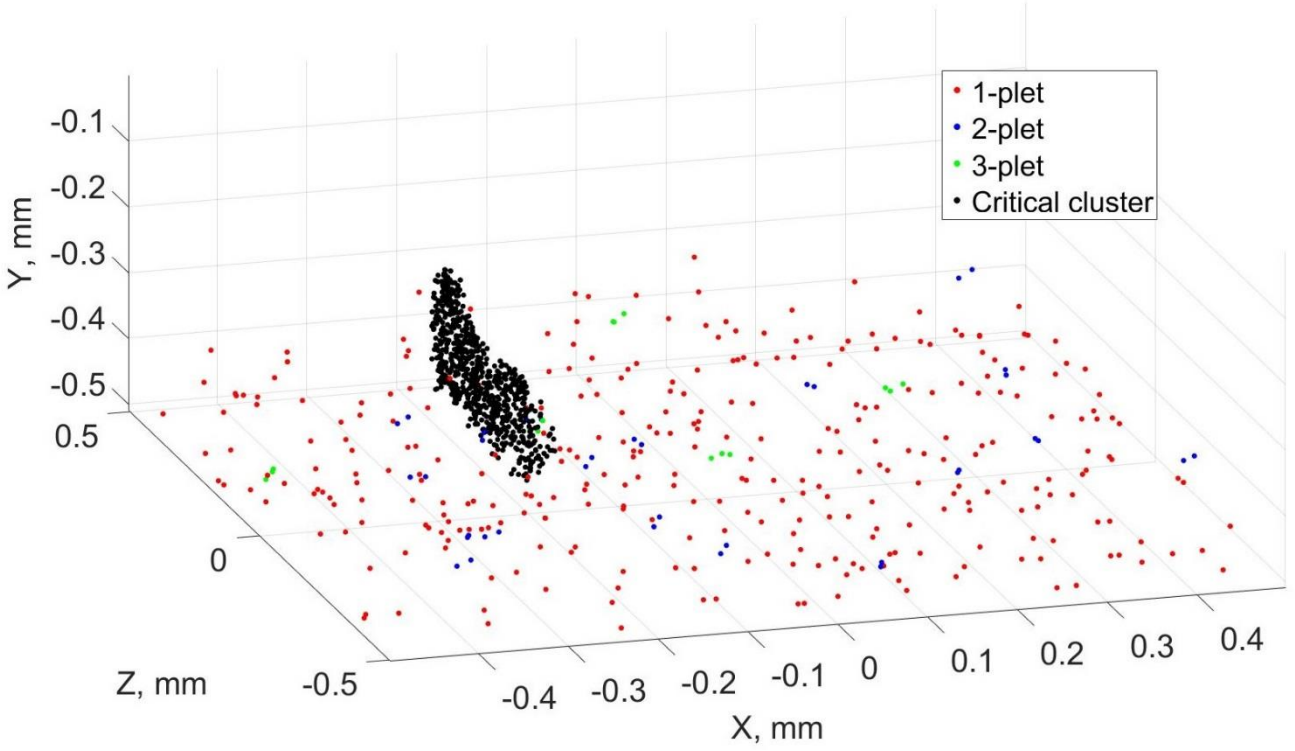

Figure 1: Fibre breaks positions when a stopping criterion of the model is satisfied

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