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Kristine M. Jespersen, Lars P. Mikkelsen

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Three dimensional fatigue damage evolution in non-crimp glass fibre fabric based composites used for wind turbine blades

Kristine M. Jespersen[a,*], Lars P. Mikkelsen[a]

[a]*Department of Wind Energy, Section of Composites and Materials Mechanics, Technical University of Denmark, Risø Campus, 4000 Roskilde, Denmark*

Abstract

This work studies the tension fatigue damage progression of a uni-directional glass fibre composite made from a non-crimp fabric similar to those used for the main load carrying parts of a wind turbine blade. The spatial damage progression in a chosen region of a test specimen is monitored on a micro-structural scale by ex-situ X-ray computed tomography. The centimetre sized specimen remains uncut during the ex-situ experiment. The experimental results indicate that uni-directional fibre fractures initiate from matrix cracks related to the structure of the fabric: first in the thin off-axis backing bundles at triple cross-over regions where the $\pm 45°$ and $90°$ backing bundles intersect each other and lie close to a uni-directional bundle, and later followed by damage initiation in the other cross-over regions. Uni-directional fibre fractures were seen to increase in number with increasing number of cycles, and mainly progress in the thickness direction of uni-directional bundles (away from the backing bundles). Furthermore, the crack face separation of individual broken uni-directional fibres was observed to gradually increase with an increasing number of cycles. The progression path of the uni-directional fibre fractures was seen to be very dependent on the local backing bundle arrangement.

Keywords: A. Polymer Matrix Composites (PMCs), A. Glass fibres, B. Fracture, D. Non-destructive testing, Micro-tomography

*Corresponding author.
E-mail address: kmun@dtu.dk (K.M. Jespersen).