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Uncovering the fatigue damage initiation and progression in uni-directional non-crimp fabric reinforced polyester composite

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Abstract

The current work studies the fatigue damage initiation and progression in a quasi-unidirectional non-crimp fabric based fibre composite used for wind turbine blades. This is done by combining in-situ transilluminated white light imagining (TWLI) with ex-situ X-ray computed tomography (CT) experiments along with tension clamp X-ray CT experiments. TWLI is used to monitor the off-axis cracks in the thin supporting backing fibre bundles present in quasi-UD composites, and a crack counting algorithm is applied to automatically count the cracks in images obtained in-situ during fatigue testing. It is found that off-axis cracks not only initiate at the specimen edges but also at isolated locations inside the specimen, which could be related to the microstructural features. In addition, a clear effect of strain level on the measured off-axis crack density is observed. From the X-ray CT experiments, it is found that the UD fibre fractures initiate and progress from regions where the off-axis backing fibre bundles are 'in contact' with a UD fibre bundle. Damage is seen to first initiate at a cross-over region of the backing fibre bundles, and later at a region with only one backing fibre bundle. In addition, applying tension to the specimen during X-ray CT scanning is found to reveal additional UD

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