Ex-situ time-lapse x-ray CT study of 3D micro-structural fatigue damage evolution in uni-directional composites

In this study, the progress of damage under tension-tension fatigue of a uni-directional (UD) glass fibre composite made from a non-crimp fabric is studied using transilluminated white light imaging (TWLI) and X-ray computed tomography (CT). TWLI images are automatically captured throughout the fatigue test, and at two damage levels the test is stopped and the sample is examined by X-ray computed tomography. From the TWLI observations it is apparent that part of the measured initial stiffness drop might be caused by edge effects rather than off-axis cracking. Some of the off-axis cracks are seen to initiate already after the first cycle, whereas some grow gradually and others appear suddenly during cycling. The off-axis cracks are observed to saturate after a few thousand cycles. The UD fibre fracture damage in the region observed by X-ray CT is probably already saturated at the first interruption point, as no significant change is seen between the two X-ray images. However, the study indicates how TWLI can be used as an initial indicator to locate damage regions at an early stage for the future ex-situ X-ray CT experiments.

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