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3D X-ray CT of fatigue damage in fibre composites

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A uni-directional (UD) glass fibre composite made from a non-crimp fabric (NCF) was investigated by 3D X-ray computed tomography (CT) to study the fatigue damage at different stages of the fatigue life. The damage was found to appear as local UD fibre fracture regions close to the so-called supporting backing layer, which seemed to have an important role in the location of the damage initiation. Furthermore, the damage appeared as 3D regions containing both clusters and chains of fibre fractures, and it was concluded that considering this problem in 3D seemed to be important in order to obtain realistic results.

Fatigue damage in wind turbine blade materials

With a lifespan of around 20 years, a wind turbine blade experiences repeated loading in the order of $10^8$ cycles, which is much higher than for most other structures. Therefore fatigue is one of the main limiting factors when designing long blades. However, the main load carrying parts of the blades are made from UD NCF composite and their fatigue damage mechanism is complex and not well understood. To improve the materials and decrease safety factors, it is important to gain understanding on the fatigue progression behaviour.

Experimental method

Fatigue tests (R=0.1) were carried out on four 410mm long butterfly shaped specimens and stopped at different number of cycles. X-ray CT experiments were performed on a Zeiss X-radia Versa 520. As the image resolution in X-ray CT scans is decreasing for increasingly large cross-sections, cut-outs were performed on a Zeiss X-radia Versa 520. As the image resolution in X-ray CT experiments are considered to obtain high resolution (1.2 $\mu$m voxel resolution). This results in m voxel resolution. This results in a small field of view (2.4mm), however high resolution is necessary to see individual UD fibre fractures.

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References