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Modelling process induced deformations in 0/90 non-crimp fabrics at the meso-scale

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Abstract

The manufacture of non-crimp fabric composites typically requires the forming and consolidation of the reinforcement material. During this process the material is subjected to complex loading where the coupling of tensile, bending, shear and compressive forces result in deformations to the internal architecture of the textile. To determine the extent of these deformations a numerical modelling method has been developed to capture the kinematic behaviour of non-crimp fabric textiles. This method focuses on capturing the interactions between the fibrous tows and the stitch yarns which bind the tows together. Through modelling at a level of detail in which the meso-scale interactions are explicitly present, the macro-scale behaviour of the material proceeds naturally within the model, negating any requirement for detailed characterisation of the physical material. This also enables a detailed description of the internal architecture of the deformed fabric to be extracted for analysis or further modelling. The present study explores the method's ability to capture both local and global deformations which occur in non-crimp fabrics, specifically to capture the onset of deformations that appear due to tow-stitch interactions and the forming and compaction of multiple layers. Comparison with experimental results show good agreement for both meso-scale deformations, resulting from multi-layer compaction, and global in-plane shear deformations induced through forming over complex tooling.

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