Prediction of the bending behavior of natural fiber composites based on multi-scale FEA analysis

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As environmentally sustainable substitutes to E-glass, natural fibers are being increasingly employed as reinforcements in polymer matrix composites. The mechanical properties of natural fiber composites were explored experimentally and numerically in this investigation. Prepregs of flax fiber reinforced polypropylene were fabricated through a pultrusion process. Unidirectional tensile coupons with different fiber volume fraction as well as different dimensions were fabricated and subjected to tensile test to investigate the effect of fiber volume fraction and sample dimension on the tensile properties of the natural fiber composites. A multi-scale finite element analysis model based on progressive damage analyses which were carried out at two levels was developed to predict the mechanical properties of natural fiber composites using a commercial FEA solver, ABAQUS. A micro-scale representative unit cell was built to predict the mechanical properties of unidirectional natural fiber composites, the results of which were treated as inputs for the macro-scale analysis which simulated the bending response of natural fiber composites. Failure criteria and material property degradation scheme suitable for natural fiber composites were selected and coded in USDFLD user subroutine. The results obtained from experimental and numerical work were presented and compared.

Keywords: natural fiber composites, progressive damage analysis, finite element analysis, flax, bending