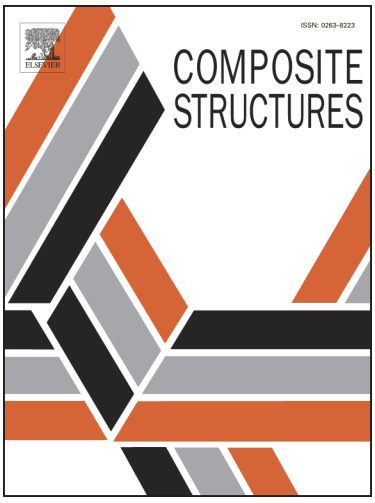

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Validation of the multi-objective structural optimisation of a composite wind turbine blade

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Abstract

Structural optimisation of a wind turbine blade is presented in this work. The optimisation was performed using a multi-objective genetic algorithm and finite element modelling to determine the optimal structural design for a glass fibre-reinforced polypropylene composite blade. A candidate blade design from the Pareto efficient set was manufactured and tested for a range of structural characteristics, including: mass, centre of gravity, deflections, strains and natural frequencies. Static testing was carried out using a Whiffle tree test rig and a laser scanner was used to determine the deflection of the blade to a high degree of accuracy. The finite element model results for the custom-made design are compared to the measured blade response. The FE model predictions for strains, mass and natural frequencies are in relatively good agreement with the test results; however, notable deviations in the deflections predictions are attributed to modifications to the blade for manufacture and the shell-based modelling approach. The differences are discussed in detail and recommendations for future design work are outlined. The test results of the bespoke blade are also compared to two additional designs to determine the level of improvement afforded by the genetic algorithm approach. The bespoke glass fibre blade demonstrated an improvement in tip deflection of 16% relative to the original blade design, with a slight decrease in mass.