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Abstract

Multi-objective robust optimization of multi-directional carbon/glass fibre-reinforced epoxy hybrid composites has been presented in this study. Two conflicting objectives, namely minimizing the density and minimizing the cost under the constraint of a specified minimum flexural strength, were considered with the design variables being the fibre type, fibre orientation angle and fibre volume fraction of each lamina. A modified version of the non-dominated sorting genetic algorithm (NSGA-II) was used in order to find the Pareto optimal solutions. Furthermore, robust optimization problems were defined by including manufacturing related uncertainties in the thickness and orientation of each lamina. These uncertain variables were considered as uncertain-but-bounded with the worst case for the minimum flexural strength being determined through an internal anti-optimization solver. The optimization and anti-optimization problems were solved with Pareto optimal and robust solutions being presented for carbon/glass fibre hybrid composites with different levels of minimum flexural strength. The results showed that, in general, consideration of uncertainties in thickness and fibre orientation angle increased the material cost and/or density with this effect being more important for high strength composites.

Keywords: Polymer matrix composite; Hybrid; Flexural; Multi-objective optimisation; Robustness