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Effect of Micro-Scale Uncertainties on the Elastic Properties of Fibre-Matrix Composites

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Abstract. This study evaluates the effect and sensitivity of micro-scale geometric and material property uncertainties on the numerically determined effective elastic properties of unidirectional fibre reinforced matrix composite materials. Due to the multi-scale build-up nature of composites many uncertainties occur, mainly material properties and geometric uncertainties. These uncertainties present a challenge in estimating composite material properties. Research has been conducted to understand their effect. However, there are limited studies investigating the effect of geometric random fibre stacking uncertainty. Hence, this study examines the effect of geometric along with seven material property uncertainties on a composite's effective elastic properties using a developed periodic RVE homogenisation tool. A factorial design method is used to investigate the sensitivity of all possible uncertainty combinations. It is concluded that fibre stacking uncertainty is an influential uncertainty that needs to be represented along with constituent material properties uncertainties in a multi-scale analysis approach. Additionally, concept of a polynomial-based surrogate model is developed to approximate homogenised effective elastic properties under the effect of uncertainties without the need to run numerical homogenisation.