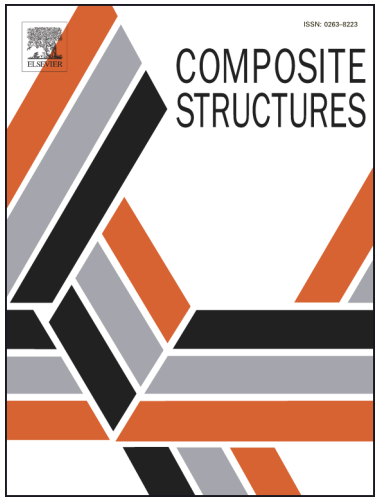

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From SEM images to elastic responses: a stochastic multiscale analysis of UD fiber reinforced composites

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Abstract

In this work, the elastic response of unidirectional fiber (UD) reinforced composites is studied in a stochastic multiscale way. First, the micro-structure of UD carbon fiber reinforced composites is statistically studied based on SEM images of its cross-section and an algorithm to generate numerical micro-structures with an equivalent random distribution of fibers is developed. In particular, based on the images spatial analysis, the empirical statistical descriptors are considered as dependent variables and represented using the copula framework, allowing generating micro-structure realizations used as Stochastic Volume Elements (SVEs). Second, a stochastic scale transition is conducted through the homogenization of SVEs. With a view to the use of the resulting meso-scale random field in structural stochastic analyzes, the homogenization is performed in two steps in order to respect the statistical content from the micro-meter-long SVEs to the millimeter-long structural finite elements. To this end, the computational homogenization is applied in a hierarchy model: i) Micro-structure generator produces Small SVEs (SSVEs) which are homogenized; ii) Big SVEs (BSVEs) are constructed from the SSVEs. Finally, it is shown on simple illustrative examples that the scatter of the (homogenized) stress distribution in a composite ply can be simulated by means of the developed methodology.

Keywords: Multiscale, Stochastic, Unidirectional Composites, Stochastic Volume Elements, Micro-structures generator

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