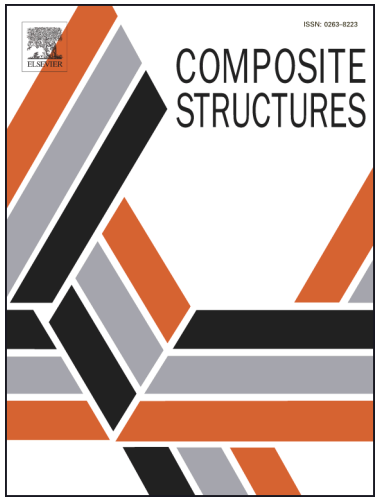


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# Uncertainty analysis of mechanical properties of plain woven carbon fiber reinforced composite via stochastic constitutive modeling

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## Abstract

Carbon fiber reinforced polymer (CFRP) composites possess inevitable geometric variabilities across scales, which directly relates to the fluctuations of mechanical properties. Meanwhile, complex damage and failure are involved in material behaviors. In this study, a phenomenological damage constitutive law of plain woven CFRP was first established based on experimental data. In order to further characterize the uncertainty of mechanical properties, a stochastic constitutive model was developed. A series of statistical volume element (SVE) finite element models were constructed according to the geometrical parameters extracted from micro-computed tomography (micro-CT) image. A set of mechanical response data including damage and failure stages were obtained from SVE simulation results. Uncertainty was introduced into several constitutive parameters and was then quantified by statistical Vine Copula method, margin characteristics, as well as correlations among these parameters, were analyzed. The proposed stochastic constitutive model was verified through comparison with experimental results, which showed the ability of the model to express the randomness of mechanical properties.

**Keywords:** Plain woven carbon fiber reinforced polymer; Damage constitutive laws; Uncertainty analysis; Stochastic constitutive model; Vine Copula

## 1. Introduction

Carbon fiber reinforced polymer (CFRP) composites, manufactured by compressing and curing polymer matrix and carbon fibers under certain volume fraction and textile pattern, have gained more and more applications in industrial fields such as aerospace [1-3] and automotive [4-6] for their excellent characteristics of low density, high specific stiffness and strength [7, 8]. As a typical class of composite materials used in reality, plain woven CFRP usually presents anisotropic and tension/compression asymmetric characteristics [9], thus, it's essential to fully understand the mechanical properties under