Exact Solutions for Buckling and Post-buckling of Functionally Graded Graphene-Reinforced Composite Beams (Postprint)

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Abstract

The nonlinear buckling and postbuckling mechanical behaviors of graphene platelet (GPL) reinforced functionally graded beams are investigated using an exact analytical solution method. In this study, GPLs are assumed to be uniformly distributed within each layer of the beam, while their weight fraction varies gradiently or uniformly along the thickness direction, leading to continuously graded material properties through the thickness. The effective material properties are determined based on the Halpin-Tsai micromechanical model and the rule of mixtures. Additionally, the nonlinear governing equations for GPL-reinforced functionally graded beams are derived via the energy variational method based on Euler-Bernoulli beam theory and the Von-Kármán nonlinear strain-displacement relationship. Exact analytical solutions to these equations are obtained, yielding analytical expressions for critical loads, buckling modes, and postbuckling deformations. A parametric study is also performed to analyze the influence of GPL weight fraction, geometry, dimensions, and distribution pattern on the nonlinear buckling and postbuckling behavior of the composite beam.

Full Text

Preamble

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Note: Figure translations are in progress. See original paper for figures.