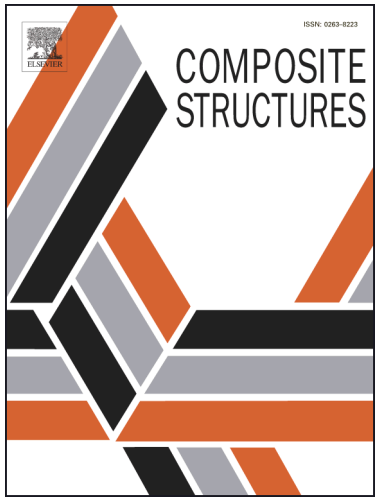

A unified nonlinear analytical solution of bending, buckling and vibration for the temperature-dependent FG rectangular plates subjected to thermal load

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A unified nonlinear analytical solution of bending, buckling and vibration for the temperature-dependent FG rectangular plates subjected to thermal load

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Abstract

This paper presents a unified nonlinear analytical solution of bending, buckling and vibration for the temperature-dependent functionally graded (FG) rectangular plates subjected to thermal load. Geometric nonlinearity resulted from mid-plane stretching is considered. Material properties of FG plates are assumed to vary with temperatures and the volume fractions of the constituents. Newly proposed higher order shear deformation theories in present available literature are sorted out and given a unified application. Three types of mathematical models, P-FG, S-FG and E-FG models, describing effective material properties of functionally graded materials (FGMs) are discussed. Finally, based on the unified nonlinear analytical solution, influences of material heterogeneity, thermal load, and plate geometry on bending, buckling and vibration of FG plates are studied. Outcomes reveal that the nonlinear solution exhibits better accuracy in calculation of shear stress in bending responses. The thermal load plays an important role in determining the bending, buckling and vibration of the FG plate. In addition, the characteristics of these three types of mathematical models to simulate effective material properties of FGMs are numerically compared and discussed.

Keywords: Unified nonlinear analytical solution, FG rectangular plates, Thermal load, Geometric nonlinearity

1. Introduction

The concept of FGMs is proposed by Japanese scientists [1] in the early 1980s. FGMs are mixed materials, and the volume fractions of the constituents vary continuously in the gradient direction. They have become increasingly popular in recent decades due to their favorable mechanical properties. As a type of heat-shielding advanced structural materials, FGMs find their applications in aerospace, nuclear fusions and biomaterial electronics, etc. For example, thermal barrier plate structures for high temperature applications are

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