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Numerical study on the buckling and vibration of functionally graded carbon nanotube-reinforced composite conical shells under axial loading

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Abstract

An efficient numerical method within the framework of variational formulation is employed to study the buckling and vibration of axially-compressed functionally graded carbon nanotube-reinforced composite (FG-CNTRC) conical shells. The effective material properties of functionally graded composite conical shell are estimated based on the extended rule of mixture. To derive the governing equations, the matrix form of Hamilton's principle is first presented on the basis of the first order shear deformation theory. Then, employing the generalized differential quadrature (GDQ) method in axial direction and periodic differential operators in circumferential direction, the numerical differential and integral operators are introduced to perform the discretization process. The comparison study is carried out to verify the accuracy and efficiency of the proposed method. Numerical results indicate that the volume fraction and types of distribution of CNTs have considerable effects on the buckling and vibration characteristics of FG-CNTRC conical shells subjected to axial loadings.

Keywords: FG-CNTRC conical shells; Vibration; buckling; Variational formulation; Differential quadrature method

1. Introduction

The excellent and multipurpose characteristics of carbon nanotubes (CNTs) have made them outstanding candidate for new generation of materials. Their superlative mechanical, thermal and electrical properties [1–3] have attracted a great deal of interest among scholars for reinforcing polymer as a replacement candidate of conventional fibers [4, 5]. On the other hand, functionally graded materials (FGMs) are inhomogeneous composites characterized by smooth and continuous variations in material properties and have found a wide range of applications in many

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