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Buckling of Pressurized Functionally Graded Carbon Nanotube Reinforced Conical Shells

Jam J.E.¹, Kiani Y.²

Abstract

A linear buckling analysis is presented for nanocomposite conical shells reinforced with single walled carbon nanotubes (SWCNTs) subjected to lateral pressure. Material properties of functionally graded carbon nanotube reinforced composite (FG-CNTRC) conical shell are assumed to be graded across the thickness and are obtained based on the modified rule of mixture. Governing equilibrium equations of the shell are obtained based on the Donnell shell theory assumptions consistent with the first order shear deformation shell theory. General form of the equilibrium equations and the complete set of boundary conditions are obtained based on the concept of virtual displacement principle. Shell is assumed to be under lateral pressure. Prebuckling load of the shell is estimated based on the linear membrane analysis. Stability equations of the shell are extracted via the adjacent equilibrium criterion. Resulting stability equations are discretized by suitable trigonometric functions in circumferential direction and generalised differential quadrature method in axial direction. An eigenvalue problem is established to obtain the buckling pressure and circumferential buckling mode of the conical shell. It is shown that, CNTs volume fraction and CNTs distribution law are important factors on the buckling mode and buckling loads of the FG-CNTRC conical shells.

Keywords: Linear Buckling, Functionally Graded Carbon Nanotube, Reinforced Composite, Generalized Differential Quadrature, Conical Shell

1 Introduction

A novel class of materials, known as carbon nanotubes (CNTs) have attracted increasing attention in recent years. It is widely known that, addition of CNTs in a matrix enhances the thermal and mechanical properties of composites [1].

Functionally Graded Materials (FGMs) are also known as a new generation of composites [2]. To improve the thermo-mechanical properties of solid structures, two kinds of FGMs, namely, FG unidirectional fibers reinforced composites and FG particles reinforced composites are born. The concept of FGM and CNTs may be combined together by nonuniform distribution of CNTs across, for example, the thickness of a solid structure. CNT-based FGMs were first proposed by Shen [3]. Numerical results of Shen reveal

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