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Nonlinear vibration of functionally graded graphene-reinforced composite laminated cylindrical shells in thermal environments

Hui-Shen Shen [1,2,]*, Y. Xiang [3,4], Yin Fan[1,3]

[1] School of Aeronautics and Astronautics, [2] School of Ocean and Civil Engineering, Shanghai Jiao Tong University, Shanghai 200240, People's Republic of China
[3] School of Computing, Engineering and Mathematics, [4]Centre for Infrastructure Engineering, Western Sydney University, Locked Bag 1797, Penrith, NSW 2751, Australia

Abstract

This paper presents an investigation on the nonlinear vibration behavior of graphene-reinforced composite (GRC) laminated cylindrical shells in thermal environments. The material properties of the GRCs are temperature-dependent and the functionally graded (FG) materials concept is adopted which allows a piece-wise variation of the volume fraction of graphene reinforcement in the thickness direction of the shell. An extended Halpin-Tsaia micromechanical model is employed to estimate the GRC material properties. The motion equations for the nonlinear vibration of FG-GRC laminated cylindrical shells are based on the Reddy's third order shear deformation theory and the von Kármán-type kinematic nonlinearity, and the effects of thermal conditions are included. The nonlinear vibration solutions for the FG-GRC laminated cylindrical shells can be obtained by applying a two-step perturbation technique. The results reveal that the nonlinear vibration characteristics of the shells are significant influenced by the GRC material property gradient, the stacking sequence of the plies, the temperature variation, the shell geometric parameter and the shell end conditions.

Keywords: Functionally graded materials; Nanocomposites; Nonlinear vibration; Cylindrical shell; Temperature-dependent properties

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Corresponding author. E-mail address: hsshen@sjtu.edu.cn (H.-S. Shen)

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