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The effects of matrix cracks on the nonlinear vibration characteristics of shear deformable laminated beams containing carbon nanotube reinforced composite layers

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Abstract:

This paper deals with the effect of matrix cracks on the free and forced vibration characteristics of a shear deformable laminated beam which contains carbon nanotube reinforced composite (CNTRC) layers. Two matrix-cracked models, namely self-consistent model (SCM) and elasticity theory model (ETM), are selected to describe the degraded stiffness of the beam. The beam rests on a two-parameter elastic foundation in thermal environments. Based on a higher order shear deformation theory and von Kármán nonlinear strain-displacement relationships, the motion equations are established and solved by means of a two-step perturbation approach. The material properties of both fiber reinforced composite (FRC) layers and CNTRC layers are assumed to be temperature-dependent. The effects of the crack density, CNT volume fraction, temperature variation, as well as the foundation stiffness on the dynamic responses of hybrid laminated beams with multiple matrix cracks are discussed in detail.

Keywords:

hybrid laminated beam; matrix crack; nonlinear vibration; temperature-dependent properties; elastic foundation

1. Introduction

Recently, fiber reinforced composite (FRC) materials have been extensively used in the aircraft structures and aerospace vehicles due to their high strength-to-weight and stiffness-to-weight ratios. The structure member, such as beam, used in these applications is commonly exposed to a variety of dynamic excitations which may produce excessive