Accepted Manuscript

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PII: S1359-8368(16)31100-3

DOI: 10.1016/j.compositesb.2016.09.005

Reference: JCOMB 4497

To appear in: *Composites Part B*

Received Date: 21 June 2016

Revised Date: 2 September 2016

Accepted Date: 3 September 2016

The effects of matrix cracks on the nonlinear bending and thermal postbuckling of shear deformable laminated beams containing carbon nanotube reinforced composite layers and piezoelectric fiber reinforced composite layers

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Abstract:

This paper investigates the effect of matrix cracks on the nonlinear bending and thermal postbuckling of a piezoelectric shear deformable laminated beam which contains both carbon nanotube reinforced composite (CNTRC) layers and piezoelectric fiber reinforced composite (PFRC) layers. Two matrix-cracked models, namely self-consistent model (SCM) and elasticity theory model (ETM), are selected to describe the degraded stiffness of carbon fiber reinforced composite (CFRC) layers. 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 governing equations are established and solved by means of a two-step perturbation approach. The beam-foundation interaction and thermal effects are also included. The material properties of all layers used are assumed to be temperature-dependent. The effects of the density of matrix crack, CNT volume fraction, temperature variation, the foundation stiffness as well as applied voltage on the nonlinear bending and thermal postbuckling behavior of hybrid laminated beams with multiple matrix cracks are discussed in detail.

Keywords: hybrid laminated beams; matrix cracks; nonlinear bending; thermal postbuckling; temperature-dependent properties; piezoelectric layers

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