

Bending Model for Laminated Composite Cantilever Beams with Multiple Embedded Shape Memory Alloy Layers

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ABSTRACT

A new model is proposed for composite laminate beams comprising multiple alternating shape memory alloy (SMA) and elastic layers. The model fully considers asymmetry in SMA behavior, which is found to significantly influence the behavior of the laminates. Moreover, the equations governing the response of the SMA-reinforced beams are derived for a complete loading-unloading cycle considering a Timoshenko beam model combined with well-established constitutive relations for SMAs. The derivation procedure involves first identifying the solid phase structure of the beam for a given applied load, followed by integration of the stress and strain in a cross section to obtain moment and shear force equations. The influence of temperature, as well as of layer thickness and material properties on the bending response of the beam is investigated. The analytical formulation is found to fit 3D model simulations using finite element analysis (FEA).