Accepted Manuscript

Bending models for superelastic shape memory alloy laminated composite cantilever beams with elastic core layer

N.V. Viet, W. Zaki, R. Umer

PII: S1359-8368(17)34174-4

DOI: 10.1016/j.compositesb.2018.04.035

Reference: JCOMB 5643

To appear in: *Composites Part B*

Received Date: 1 December 2017

Revised Date: 19 March 2018

Accepted Date: 9 April 2018

Please cite this article as: Viet NV, Zaki W, Umer R, Bending models for superelastic shape memory alloy laminated composite cantilever beams with elastic core layer, *Composites Part B* (2018), doi: 10.1016/j.compositesb.2018.04.035.

Bending models for superelastic shape memory alloy laminated composite cantilever beams with elastic core layer

N.V. Viet[1], W. Zaki[*1], and R. Umer[1,2]

[1]Mechanical Department, Khalifa University of Science and Technology, Abu Dhabi, UAE.

[2]Centre for Future Materials, University of Southern Queensland, Toowoomba, QLD, Australia.

[*]Corresponding author email: wael.zaki@kustar.ac.ae

Abstract

This paper develops a novel and simple analytical model to investigate the bending response of superelastic shape memory alloy (SMA) laminated composite cantilever beam during a complete loading/unloading cycle based on ZM's three-dimensional (3D) thermomechanical model for SMAs and Timoshenko beam theory. The laminated composite beam configuration is formed by two SMA layers bonded to one elastic core layer. The results show a superelastic behavior of the composite. The moment-curvature response, martensite distribution along vertical direction, stress distribution along vertical and axial direction, tip deflection of the composite are revealed. The effects of temperature, thickness ratio and stiffness ratio on the moment-curvature response are also investigated. 3D finite element analysis (FEA) is carried out in parallel to validate against results obtained from analytical and exact numerical models. A good agreement is obtained. Whereby the maximum observed difference in terms of curvature is 7 % between analytical and 3D FEA data, and 0.5 % between analytical and accurate numerical solutions at moment $M_e = 0.181\,N.m$ during the loading cases. This novel work sheds a light on the fundamental and deep knowledge of SMA composite's static bending behavior. That will be very helpful and significant for other researchers to furtherly investigate on dynamical behavior of this and other SMA laminated composite configurations.

Keywords: A. Laminates; C. Analytical modelling; C. Numerical analysis; C. Finite element analysis (FEA); Shape memory alloy.

1. Introduction

It has been reported that SMAs possess unique material properties [1, 2], which are still not observed in other materials. Such properties involve the superelasticity and shape memory effect. The superelasticity is well