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Structural Deformation Performance of Glass Fiber Reinforced Polymer Composite Beam Actuated by Embedded Indented SMA Wires

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Abstract:

Intelligent morphing wings have become a research hotspot due to their potential value. This paper is also an innovative basic research work to study it. The deformation performances of the GFRP(glass fiber reinforced polymer) composite beams embedded different pre-strained indented SMA wires were experimentally and numerically studied. The indentation SMA wire made by mechanical indentation method has better interface bonding strength than normal SMA wire. In this paper, the indented SMA wires acting as actuators, were embedded in a symmetrically GFRP laminated composite beam and located at the eccentric position of the laminate. The layering scheme of the laminated plate is as follows: [90°(4:1 fabric)/SMA/0°/ 0°/90°(4:1)]. The 0 ° direction is consistent with the direction of the axis of the SMA wire. The Finite element method is adopted to simulate the deformation of the beam with indented SMA wire in which the linear constitutive model of fully constrained SMA wires, together with considering their thermally-induced strain response, is used to describe the recoverable properties of SMA. The prediction from the numerical simulation agrees well with experimental measurements.

Keyword: indented SMA wire; GFRP composite beam; deformation; finite element method; experimental research

1. Introduction

Embedding shape memory alloy (SMA) materials into polymer-based composite structures has attracted considerable attention in the recent decades [1-17]. Rogers et al. [1] employed SMA wires into a composite plate to control its natural frequencies. Lau KT et al. [2] discussed vibration characteristics of SMA composite beams with different boundary conditions. S. M. R. Khalili et al.[3] conducted the dynamic analysis of a continuous SMA hybrid composite beam subjected to impulse load. Yuvaraja M. et al.[4] carried out experimental work to evaluate the vibration control of flexible beam. H. Asadi et al.[5] investigated the free vibration of shape memory alloy hybrid composite (SMAHC) beams in