STUDY OF AN ACTUATED BISTABLE COMPOSITE LAMINATES FOR SHAPE CHANGE APPLICATIONS

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Abstract

Asymmetric laminates are known to exhibit two stable cylindrical states and one unstable saddle state. Such bistability has attracted attention in aerospace applications because of its minimum energy input requirement to achieve and maintain a large deflection and shape change. This paper presents an experimental observations of an arbitrary laminate of $[-30/60]_T$ with and without a piezoelectric actuation and compares against both energy-based analytical and finite element models. It is observed that the analytical model is able to offer a qualitative understanding of the bistable behaviour and curvature shapes but is unable to model the distinctive curvature changes near the boundaries which can be captured by the finite element model. The investigation also presents an addition of a piezoelectric actuation for snap-through in both analytical and numerical models which is compared with the experimental results.

Keywords Bistable composites; smart structures; morphing; piezoelectric actuation

1. Introduction

Asymmetric laminates have an anisotropic response to the elevated temperatures experienced during manufacture, and the residual thermal stress leads to a curved deformation (Hyer 1980). Such a curved laminate can have two stable states at room-temperature, Cylindrical 'State I' with a major curvature in x and Cylindrical 'State II' with a opposite curvature in the orthogonal y-axis. These characteristics are of particular interest in