

## Accepted Manuscript

Stability Considerations and Actuation Requirements in Bistable Laminated Composites

V.S.C. Chillara, M.J. Dapino

PII: S0263-8223(17)31773-7  
DOI: <https://doi.org/10.1016/j.compstruct.2017.09.097>  
Reference: COST 8960

To appear in: *Composite Structures*



Please cite this article as: Chillara, V.S.C., Dapino, M.J., Stability Considerations and Actuation Requirements in Bistable Laminated Composites, *Composite Structures* (2017), doi: <https://doi.org/10.1016/j.compstruct.2017.09.097>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

# Stability Considerations and Actuation Requirements in Bistable Laminated Composites

V.S.C. Chillara, M.J. Dapino\*

*Department of Mechanical and Aerospace Engineering, The Ohio State University,  
Columbus, OH 43210, USA*

---

## Abstract

Laminated composites with a core layer sandwiched between orthogonal mechanically-prestrained laminae exhibit two weakly-coupled cylindrical shapes where each shape is influenced only by one prestrained lamina. This study investigates the domain of bistability and actuation requirements of bistable laminated composites. An analytical model is constructed as follows: point-wise displacements and areal dimensions are scaled; strain energy and actuation work are computed using high-order displacement polynomials; and net energy is minimized using the Rayleigh-Ritz method to calculate stable shapes as a function of actuation force. Shape transition is shown to be a multi-stage phenomenon through an experimental procedure involving friction-free tensile tests and 3D motion capture. The simulated actuation energies agree with measurements within 12%. Square laminates are shown to be bistable only when the ratios of laminae prestrains are greater than 0.2. The aspect ratio limit for bistability can be improved by maximizing both prestrains while maintaining a prestrain ratio of one. It is shown that in-plane forcing requires 100 times more energy than an equivalent pure-moment. A parametric study reveals that the composite's performance parameters are more sensitive to the core's thickness than its modulus; the sensitivity of actuation energy is minimal relative to that of deformation and stiffness.

*Keywords:* Bistable, morphing, high-order model, actuation, fiber-reinforced elastomer

---

\* *Corresponding author*

*Email addresses:* chillara.1@osu.edu (V.S.C. Chillara), dapino.1@osu.edu (M.J. Dapino)

Download English Version:

<https://daneshyari.com/en/article/6705039>

Download Persian Version:

<https://daneshyari.com/article/6705039>

[Daneshyari.com](https://daneshyari.com)