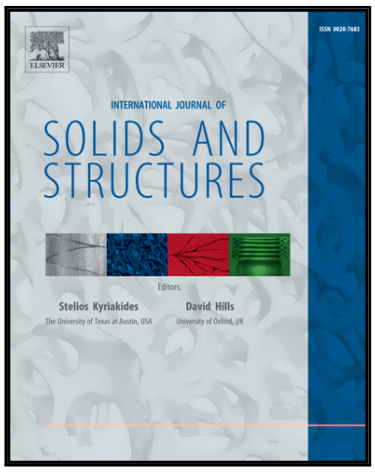

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Safvan Palathingal, G.K. Ananthasuresh

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A bilateral relationship between stable profiles of pinned-pinned bistable shallow arches

Safvan Palathingal[a], G. K. Ananthasuresh[a,*]

[a] *Department of Mechanical Engineering, Indian Institute of Science, Bengaluru, India*

Abstract

Arch-profiles in the two force-free stable equilibrium states of shallow bistable arches are related to each other. We derive a two-way, i.e., bilateral, relationship between stress-free initial profile and stressed toggled profile so that pinned-pinned bistable arches of arbitrary profiles can be efficiently analyzed and designed. The derivation relies on representing the initial and toggled profiles with two sets of mode weights corresponding to the buckling mode shapes of a pinned-pinned column. Furthermore, we prove that the fundamental mode weights should be non-zero for an arch to be bistable. The following corollaries arise from the aforementioned relation: (1) symmetry in initial and toggled profiles remains unchanged; (2) all the mode weights other than the fundamental mode weight have the same sign in both stable states; (3) magnitudes of corrugations in stable force-free arch-profiles are approximately equal. Derivations and proofs of the principal relationship and its corollaries as well as examples of analysis and design of bistable arches of arbitrary arch-profiles are presented in the paper.

Keywords: Bistable mechanisms, snap-through, buckling in arches, checking for bistability

*Corresponding author.
Email addresses: safvanp@iisc.ac.in (Safvan Palathingal), suresh@iisc.ac.in (G. K. Ananthasuresh)