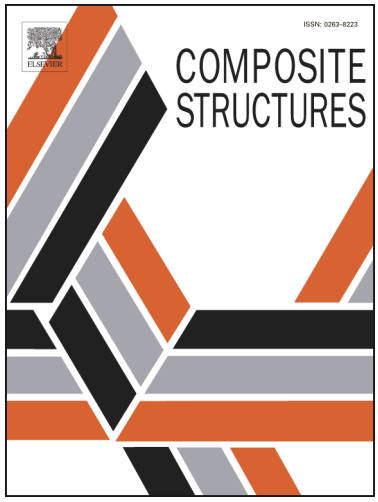

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Helical Bistable Composite Slit Tubes

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Abstract

Bistability in doubly curved and twisted (helical) composite slit tubes is investigated for the first time. This work establishes a natural extension in this area which has been focused on straight and until more recently, doubly curved (toroidal) tubes with positive Gaussian curvature. The model developed introduces longitudinal and transverse curvature, and twist into strips of laminated composite material. The composite is engineered to be bistable and the second stable state determined via strain energy minimisation using the Rayleigh-Ritz method. The strain energy is formulated as a function of curvature strains, longitudinal stretching and a variable middle ply fibre angle of the laminate. The second stable state forms a compact and untwisted cylindrical coil with the latter engineered by tailoring the middle ply fibre angle. A new manufacturing process capable of producing helically curved tubes using glass-fibre/polypropylene-matrix composite is presented to verify the hypothesis of this work. An untwisted coil enables the efficient stowage and deployment of new forms of bistable composite tube which adhere to similar form factors as straight and toroidal ones. By embedding electrical conductors, helical bistable composites enable new lightweight, compact and multifunctional structures for communication and sensing applications.

Keywords: helical, doubly curved and twisted, curvature, bistable composites

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