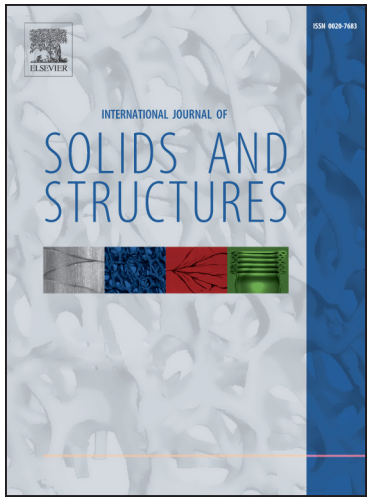

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Geometrically Exact Planar Beams with Initial Pre-stress and Large Curvature: Static Configurations, Natural Frequencies, and Mode Shapes

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Abstract

Within this paper, an analytical formulation is provided and used to determine the natural frequencies and mode shapes of a planar beam with initial pre-stress and large variable curvature. The static configuration, mode shapes, and natural frequencies of the pre-stressed beam are obtained by using geometrically exact, Euler-Bernoulli beam theory. The beam is assumed to be not shear deformable and inextensible because of its slenderness and uniform, closed cross-section, as well as the boundary conditions under consideration. The static configuration and the modal information are validated with experimental data and compared to results obtained from nonlinear finite-element analysis software. In addition to the modal analysis about general static configurations, special consideration is given to an initially straight beam that is deformed into semi-circular and circular static configurations. For these special circular cases, the partial differential equation of

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