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Finite Element Analysis of Thermally-Induced Bistable Plate Using Four Plate Elements

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Abstract : The present study deals with the finite element (FE) analysis of thermally-induced bistable plate using various plate elements. The quadrilateral plate elements include the 4-node conforming plate element based on the classical laminate plate theory (CLPT), the 4-node and 9-node Mindlin plate element based on the first-order shear deformation laminated plate theory (FSDT), and a displacement-based 4-node quadrilateral element (RDKQ-NL20). Using the von-Karman’s large deflection theory and the total Lagrangian (TL) approach, the nonlinear FE governing equations for plate under thermal load are derived. Convergence analysis for four elements is first conducted. These elements are then used to predict the stable shapes of thermally-induced bistable plate. Numerical test shows that the plate element based on FSDT, namely the 4-node and 9-node Mindlin, and the RDKQ-NL20 plate element can predict two stable cylindrical shapes while the 4-node conforming plate predicts a saddles shape. Comparing the simulation results with ABAQUS, the RDKQ-NL20 element shows the best accuracy among all the elements.

Keywords : Bistable, finite element method, geometrical nonlinearity, quadrilateral plate elements
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