Corrotational Formulation of Geometrically Nonlinear Element for Koiter's Stability Analysis

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ABSTRACT

Modeling laminated composites requires accurate stresses for prediction of damage and failure, which in this work is achieved by using a mixed variational formulation. Also, it is convenient to have a displacement-only element for implementation into commercial codes such as Abaqus, ANSYS, etc., which in this work is achieved by static condensation. The element must be computationally inexpensive, for which we develop a 4-node linear element, which still shows similar or faster convergence than displacement-based quadratic elements. Ideally, the generalization from geometrically linear to nonlinear should be simple and robust, for which we employ a corrotational formulation. Finally, it is sought to have an inexpensive computation of stability and mode interaction using Koiter's analysis, but this requires accuracy up to fourth-order energy terms. This requirement reinforces our choice of mixed variational principle and corrotational formulation, which combined are able to provide h2 convergence rate in the displacements, stress, and all energy terms, up to fourth order.