

PROCEEDINGS

A FE-Based Reduced-Order Modeling Technique with Mixed Kinematics for Geometrically Nonlinear Buckling Analysis of Structures

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ABSTRACT

In this work, a finite element based reduced-order technique in the framework of mixed nonlinear kinematics is proposed for the geometrically nonlinear analysis of thin-walled structures [1]. The mixed nonlinear kinematics are established by combining the co-rotational formulation with the updated von Kármán formulation. The co-rotational formulation is selected to calculate the internal force and tangent stiffness of a structure; whereas the third- and fourth-order strain energy derivatives are achieved by the updated von Kármán formulation. For geometrically nonlinear problems with a large deflection, reduced-order models with 1 degree of freedom are constructed using the perturbation theory, otherwise more degrees of freedom are involved when buckling occurs. The application of mixed nonlinear kinematics greatly improves the computational efficiency in construction of a reduced-order model. The solutions of reduced-order models are treated as nonlinear predictors to the geometrically nonlinear response. Nonlinear predictors are required to be corrected using internal force-based residuals to ensure the accuracy of the geometrically nonlinear analysis. The geometrically nonlinear response is achieved efficiently and accurately, using large step sizes in the path-following geometrically nonlinear structural analysis. A series of numerical examples demonstrates the good numerical accuracy and efficiency of the proposed method.

KEYWORDS

Geometrically nonlinear response; reduced-order method; mixed nonlinear kinematics; buckling

Funding Statement: This work was supported by the National Natural Science Foundation of China (Grant Nos. 12272308 and 11972300), the Aeronautical Science Foundation of China (Grant No. 2023Z073053005), the Fundamental Research Funds for the Central Universities of China (Grant No. D5000220177).

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

References

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