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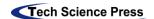
PROCEEDINGS

Thermal-Mechanical Buckling and Postbuckling Analysis of Thin-Walled Structures Using a Reduced Order Method

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ABSTRACT

Thermal-mechanical buckling has become one of the major failure modes of thin-walled structures which suffer from the high temperature service environment. These structures, such as plates and shells, are commonly involved in many branches of engineering, especially for the aerospace structures. Thermal-mechanical buckling analysis plays an important role for lightweight design of aircrafts and launch vehicles, which significantly influences the load-carrying capability of the structure. Geometrical nonlinearities should be well considered to determine an accurate value of the critical buckling temperature/load as well as the postbuckling response.

In this work, a reduced-order method is proposed for geometrically nonlinear thermal-mechanical analysis of thin-walled structures. The initial temperature field is converted into a thermal load imposed on the structure. The thermal load is treated as an independently unchanged load corresponding to the initial temperature field. The internal force space is expanded using the mechanical load, thermal load and predefined perturbation loads. The thermal-mechanical reduced-order model is constructed using the first to fourth-order derivatives of strain energy with thermal effects in terms of the degrees of freedom. An additional degree of freedom related to the thermal load appears in the construction of reduced-order model based on the novel Koiter theory. A path-following scheme is proposed to make the method able to trace the entire geometrically nonlinear thermoelastic response. A much larger step size can be achieved benefiting from the favorable prediction of the reduced-order model, compared to the classical Newton-like methods. Various numerical results have been used to validate the excellent performance of the proposed method in thermal-mechanical buckling analysis [1,2].

KEYWORDS

Thermal-mechanical buckling; geometrical nonlinearities; reduced-order method; temperature field

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

References

1. Liang, K., Li, Z. (2022). The reformulated Koiter-Newton method for thermal-mechanical buckling and postbuckling analysis of thin-walled structures. *International Journal for Numerical Methods in Engineering, 123(9),* 1933-1953.

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