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Thermal Postbuckling Behaviors of Functionally Graded Panel with Temperature-Dependent Material Properties in Supersonic Airflows

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Functionally graded materials(FGMs) are types of advanced composites with continuously varying material composition to achieve the desired goals. One of the paramount characteristics is that the material avoid stress concentration induced by the interface of layers for the conventional composite due to a sudden transition of the material composition. Thus, the stress distributions are smooth. Therefore, FGMs are applied to the thermal barrier structures for the space shuttle, combustion chamber and nuclear plants, etc.

Substantial research works have been done concerning the postbuckling analysis of FG plate under thermal and airflow loading. Park and Kim [1] studied the thermal postbuckling analyses of FG plates. Prakash and Ganapathi [2] examined supersonic flutter characteristics of FG panels including thermal effects.

In this study, it is investigated that the thermal postbuckling characteristics of FG panel under the heat and supersonic airflow. Material properties are assumed to be temperature dependent and vary continuously through the thickness direction of the panel according to a simple power law distribution in terms of the volume fraction of the constituents, from metal to ceramic. The panel is modeled as a plate that is based on the first-order shear deformation theory (FSDT). Further, to consider the geometric nonlinearity due to large deformation, the von Karman strain-displacement relations are adopted. A uniform temperature elevation throughout the FG panel is considered to simulate aerodynamic heating. Also, the first-order piston theory is used to present supersonic aerodynamic load acting on the panel. Numerical results are summarized to reveal the thermal postbuckling behaviors of FG panels with various volume fractions, temperature conditions and aerodynamic pressures.

[1] Jae-Sang Park and Ji-Hwan Kim., "Thermal postbuckling and vibration analyses of functionally graded plates" Journal of Sound and Vibration, Vol. 289(1-2), 2006, pp. 77-93

[2] T. Prakash and M. Ganapathi., "Supersonic Flutter Characteristics of Functionally Graded Flat Panels including Thermal effects" Computers & Structures, Vol. 72(1), 2006, pp. 10-18

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