The Influence of Initial Deflection on Nonlinear Flutter Response of Functionally Graded Plates

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Abstract: Panel flutter arises from the aeroelastic instability of the skin structures on the high-speed vehicles, usually in supersonic regime and combined with thermal environment. Unlike the catastrophic flutter of the wings, panel flutter tends to be treated as non-catastrophic one. The nonlinear panel flutter response is of great interest to find the fatigue loading spectra. Present work introduces an aeroelastic model for a thermal isolating panel made from functionally graded materials (FGMs). The Mindlin plate theory is employed to establish the structural equations, the first-order piston theory is adopted for the supersonic aerodynamic loads, and the von-Karman strain-displacement relation is used to model the geometric nonlinearity arises from the large deflection of the plate. The FGMs are homogenized by using the rule of mixture and assuming the constitutive component vary through the thickness of the plate according to the simple power law distribution. The flutter boundary of the FGM plate is determined and the equilibriums of the aeroelastic system are studied based on the reduce-order model. Nonlinear flutter response is simulated by solving the aeroelastic equations in time domain. Numerical results show that in a regime with relatively low dynamic pressure (flow speed) and high temperature, the initial deflection has important effects on the flutter response of the FGM plate. It reveals that besides the classical mode coupling mechanism of the panel flutter, there exists another flutter mechanism related with the multiple stable equilibriums and the saddle-node bifurcation of the FGM plate system.

Keywords: Panel flutter; functionally graded materials; geometric nonlinearity

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