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THERMAL BUCKLING OF SIMPLY SUPPORTED MODERATELY THICK FUNCTIONALLY GRADED PLATES

Abstract

Functionally graded material (FGM) was a new type of composite, and generally composed of two or more materials. The properties of FGM showed a continuous gradient changes along a certain direction. Because of its higher temperature resistance, FGM had been considered to be one of the most promising composites in high temperature conditions. So the analysis of the thermal buckling of FGM structures in high temperature conditions was very meaningful for aerospace and aeronautical engineering. Traditionally, analysis of buckling of plates was based on the classical thin plate theory, which did not take into account the influence of shear deformation and may lead to larger errors for thick plates and FGM plates. In this paper, a moderately thick rectangular FGM plate composed of metal and ceramic was studied and Reddy higher-order shear deformation theory was adopted in analyzing thermal buckling of this FGM plate. It was assumed that the material properties of the FGM plate vary as a power function of thickness coordinate variable and the plate was loaded two types of thermal loadings, namely, uniform temperature rise and non-linear temperature rise along the thickness. The equilibrium equations and thermal buckling controlling equations were deduced corresponding to the two loadings. Buckling controlling equations are solved analytically for a plate with four simply-supported edges and the corresponding buckling critical temperatures were derived. The effects of the power law index, the aspect ratio and the relative thickness of the FGM plate on buckling critical temperature were discussed. The results obtained in this paper indicated that: (1) higher-order shear deformation theory should be used in the analysis of the thermal buckling of moderately thick FGM plates; (2) the critical buckling temperature of FGM plates decreased with the increase of the power law index and the increase of the aspect ratio and increased with the increase of the relative thickness ; (3) the buckling critical temperature of FGM plates in non-linear temperature rise along the thickness was larger than that in uniform temperature rise.

Keywordshigher-order shear deformation theory ; functionally graded material; moderately thick plate; thermal buckling