THREE DIMENSIONAL MECHANICAL BUCKLING OF FGM PLATES WITH VARIOUS BOUNDARY CONDITIONS

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Summary. The mechanical buckling analysis of rectangular functionally graded plates under different axial loadings is considered. The analysis is based on the small strain elasticity theory with different boundary conditions. The material properties of the plate vary through the thickness direction according to a simple power law. Three dimensional buckling solutions are obtained using the Ritz method with Chebyshev polynomials as assumed displacement functions. The convergence and comparison studies are presented and effects of the different material composition and the plate geometry (side-side, side-thickness) on the critical buckling loads and mode shapes are investigated.

1 INTRODUCTION

Functionally graded materials (FGM) are microscopically inhomogeneous and the mechanical properties vary smoothly or continuously from one surface to the other. This continuous variation of material properties along some preferred directions of FGM ensured that overcome interface problems and provide high thermal resistant and mechanical strength. Many studies on the mechanical and thermal buckling analysis of functionally graded plates exist in the literature. Due to these advantages of FGM structures make them an important subject for engineering applications; however, have necessitated more research in this area.

Na and Kim [1], investigated the three dimensional thermal buckling analysis of FGM plates using the finite element method. Zhao et al. [2], discussed FGM plates including solid plates and plates with holes based on the first-order shear deformation plate theory, in conjunction with the element-free-kp-Ritz method. In this study the material property of each plate varies exponentially through the thickness. Shariat and Eslami [3], are presented mechanical and thermal buckling analysis of functionally graded plates based on the third order shear deformation theory with simply supported boundary conditions. Lanhe [4], analysed thermal buckling of a functionally graded plate analytically based on the first order shear deformation theory. Matsunaga [5] presented thermal buckling of functionally graded plates according to quasi-static theory of linear thermoelasticity, the coupling between the heat conduction problem and the elasticity problem is neglected. The writer derived a
fundamental set of equations of a 2D higher-order plate theory based on the power series expansions of continuous displacement components through the principle of virtual work. Aydogdu [6], considered vibration and buckling of axially functionally graded simply supported beams by using the semi-inverse method. Oyekoya, Mba and El-Zafrany [7], derived two new Mindlin-type plate bending elements for the modeling of functionally graded plate subjected to various loading conditions such as tensile loading, in-plane bending and out-of-plane bending. The authors used the finite element derivation based on Lagrangian interpolation. Ganapathi and Prakash [8], investigated thermal buckling of a simply supported functionally graded skew plate using first-order shear deformation theory in conjunction with the finite element approach.

The mechanical buckling analysis is investigated for three types of in-plane loading conditions which are uniaxial compression (UA-C), biaxial compression (BA-C), biaxial compression-tension (BA-CT). Three dimensional buckling solutions are obtained using the Ritz method and assumed displacement functions are in the form of the triplicate series of Chebyshev polynomials multiplied by a boundary function which provide that the displacement components satisfy the geometric boundary conditions of the plate. Considered boundary conditions are simply supported, at least, at their opposite two edges and can be subjected to any one of the free (F), simply supported (S) and clamped (C) edge boundary conditions at the remaining ones.

REFERENCES