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An Exact Three Dimensional Solution for Bending of Thick Rectangular FGM Plate

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Abstract:

This study uses the displacement potential function, DPF, to present an exact solution for bending of functionally graded, FGM, thick plates. The plates are simply-supported rectangular, isotropic, and nonhomogeneous, with exponential variation of Young's modulus along their thickness Using the DPF, the governing equations are simplified to second and fourth order partial differential equations solved by using the separation of variables method and applying exact boundary conditions. The solution is applicable to any plate with no restriction on its thickness as well as to all FGM plates. The results are compared with other existing analytical and numerical results for thin, moderately thick, and thick plate. Comparisons show excellent agreement making the method applicable and reliable for various kinds of material properties, thickness ratios and loading conditions without any simplifying assumptions such as for strain or stress distribution in plate thickness. Various inhomogeneity, thicknesses, and aspect ratios are also investigated with respect to plate responses with results showing that increase in inhomogeneity, and decrease of aspect ratio and FGM plate thickness result in decrease in the dimensionless transverse displacement of the plate. Moreover, the effects of increasing inhomogeneity on transverse displacement are more significant for thicker plates and higher aspect ratios.

Key words: Exact solution; Thick rectangular plates; FGM; Displacement potential function

1 Introduction

Functionally graded materials (FGMs) are a class of advanced composite materials with nonhomogeneous microstructure and variable properties in one or more dimension. Classical composite material structures have discontinuity of properties in layers interface, and as a result, stress concentration occurs at high temperatures, particularly where two metals with different coefficients of expansion are used [1, 2], and functionally graded materials have emerged as a