Bending analysis of a functionally graded rotating disk based on the first order shear deformation theory

ABSTRACT

The theoretical formulation for bending analysis of functionally graded (FG) rotating disks based on first order shear deformation theory (FSDT) is presented. The material properties of the disk are assumed to be graded in the radial direction by a power law distribution of volume fractions of the constituents. New set of equilibrium equations with small deflections are developed. A semi-analytical solution for displacement field is given under three types of boundary conditions applied for solid and annular disks. Results are verified with known results reported in the literature. Also, mechanical responses are compared between homogeneous and FG disks. It is found that the stress couple resultants in a FG solid disk are less than the stress resultants in full-ceramic and full-metal disk. It is observed that the vertical displacements for FG mounted disk with free condition at the outer surface do not occur between the vertical displacements of the full-metal and full-ceramic disk. More specifically, the vertical displacement in a FG mounted disk with free condition at the outer surface can even be greater than vertical displacement in a full-metal disk. It can be concluded from this work that the gradation of the constitutive components is a significant parameter that can influence the mechanical responses of FG disks.

Keyword: Functionally graded materials; Rotating disk; Shear deformation