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LARGE AMPLITUDE STATIC DEFLECTION OF AXIALLY FUNCTIONALLY GRADED TIMOSHENKO BEAMS

Abstract:

Functionally graded materials possess the combined qualities of the constituent materials that results in better toughness, strength, as well as, thermal and wear resistance. Moreover, due to smooth variation of material properties, they do not suffer from subsequent stress concentration arising in case of laminated composites. Thus FGMs find a wide-spread usage in modern branches of civil and mechanical industries. FGM components are also used in aerospace, nuclear, ship-building and optical industries. The structures made of axially functionally graded (AFG) material are advantageous where cantilever and rotating structures are involved such as turbomachine and turbine blades, helicopter rotor blades, spacecraft with flexible appendages etc. The current paper investigates large amplitude static deflection analysis on axially functionally graded (AFG) beam. Three boundary conditions i.e. Clamped-Clamped (CC), Simply Supported – Simply Supported (SS) and Clamped- Simply Supported (CS) have been considered for the present work. Linear gradation of material properties is considered in the axial direction. The formulation is based on Timoshenko beam theory which includes shear deformation and rotary inertia effects. Von Karman nonlinear strain displacement equations have been taken into account to incorporate the geometric non-linearity which arises because of the large deflection. Minimum Potential Energy Principle has been used to generate the governing set of equations and generated equations are solved through the implementation of an iterative scheme (direct substitution with relaxation method). The effects of gradation factors on the deflection of AFG uniform beam is studied. The results that have been generated are successfully validated with previously published paper.

Keywords:

AFG beam, Timoshenko beam theory, geometric non-linearity, energy principle