Static Analysis of Functionally Graded Piezoelectromagnetic Cylindrical Panels under Magneto-electro-mechanical Loads

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Abstract:

Due to their simultaneous functionally graded material and piezoelectromagnetic property qualities, functionally graded piezoelectromagnetic materials (FGPMMs) may satisfy a wide variety of needs in different disciplines and businesses. The state-space Fourier approach was used in this study to examine the three-dimensional behavior of a FGPMM cylindrical panel with simply supported edges under magneto-electro-mechanical loads within the context of the theory of elasticity. The material's mechanical characteristics are believed to vary radially according to a power-law distribution. State-space differential equations were formulated from the equilibrium and constitutive equations. The governing equations can be turned into an ordinary differential system that can be solved analytically by expanding the Fourier series for stresses and displacements in both the axial and circumferential directions. Besides evaluating the method's convergence, the proposed methodology's validity is substantiated by juxtaposing the numerical results with those available in the existing literature. A comprehensive parametric study is conducted to examine the effects of geometric factors, magneto-electromechanical properties, and boundary conditions on the stress and displacement distribution over the thickness of FGPMMs. The impact of different power-law exponents on the overall structural response is also examined. The findings of this work, grounded in elasticity theory and derived analytically, may be utilized to assess the correctness and reliability of conventional three-dimensional formulations used in the analysis of FGPMM structures.

Keywords:

Functionally graded piezoelectromagnetic materials, three-dimensional elasticity, magneto-electro-mechanical.