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Munise Didem Demirbas

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Thermal stress analysis of functionally graded plates with temperature-dependent material properties using theory of elasticity

Munise Didem Demirbas[a,1]

[a]Department of Mechanical Engineering, Erciyes University, Kayseri 38039, Turkey

Abstract

Based on the three-dimensional elasticity theory, the transient thermal residual stress analyses of one-dimensional functionally graded rectangular plates (FGPs) have been performed under in-plane constant heat flux for different compositional gradient exponents. The thermo-mechanical properties of FGPs were assumed to be vary with a power law along an in-plane direction, not through the plate thickness direction and temperature-dependent/independent. The Heat Transfer and Navier's Equations in cartesian coordinates which represent the two-dimensional thermoelastic problem were resolved by means of the Finite-Difference Method (FDM), and the set of linear equations were solved using the pseudo singular value method. The effect of the coordinate derivatives of material properties were considered in both Heat Transfer and Navier's Equations. The current study aims at determining the effect of temperature dependence and temperature independence of material properties and the compositional gradient exponents in FGPs on the levels of temperature, strain and stress. The FGPs with temperature-dependent material properties showed higher levels of temperature, strain and stress than those with temperature-independent material properties. In order to verify the results of this study, two-dimensional thermo-elastic problem was resolved using the Finite Element Method (FEM) and the results are compared.

*Corresponding author
Email address: mddemirbas@erciyes.edu.tr (Munise Didem Demirbas)

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