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Nonlinear transient thermal stress and elastic wave propagation analyses of thick temperature-dependent FGM cylinders, using a second-order point-collocation method.

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Summary: Nonlinear transient thermal stress and elastic wave propagation analyses are developed for hollow thick temperature-dependent FGM cylinders subjected to dynamic thermomechanical loads. Stress wave propagation, wave shape distortion, and speed variation under impulsive mechanical loads in thermal environments are also investigated. In contrast to researches accomplished so far, a second-order formulation rather than a first-order one is employed to improve the accuracy. The FDM method (as a point-collocation FEM method) is used. It is known that other FEM methods cannot show the actual trend jumps due to distributing the abrupt changes in the quantities as the numerical errors and the residuals of the governing equations among the nodal results. Furthermore, the required computational time and allocated computer memory are much reduced by the present solution algorithm. The cylinder is not divided into isotropic sub-cylinders. Therefore, artificial wave reflections from the hard interfaces are avoided. Time variations of the temperatures, displacements, and stresses due to the dynamic or impulsive loads are determined by solving the resulted highly nonlinear governing equations using an iterative updating solution scheme. A sensitivity analysis includes effects of the volume fraction indices, dimensions, and temperature-dependency of the material properties is performed. Results reveal the significant effect of the temperature-dependency of the material properties on the thermoelastic stresses and present some interesting characteristics of the thermoelastic and wave propagation behaviors.

MSC:

74F05 Thermal effects in solid mechanics
65M70 Spectral, collocation and related methods for initial value and initial-boundary value problems involving PDEs
74S20 Finite difference methods applied to problems in solid mechanics

Keywords:

thick-walled cylinder; thermoelastic stresses; wave propagation; point-collocation; FGM; temperature-dependency

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