Stochastic Meshless Local Petrov-Galerkin (MLPG) Method for Thermo-Elastic Wave Propagation Analysis in Functionally Graded Thick Hollow Cylinders

Seyed Mahmoud Hosseini¹, Farzad Shahabian², Jan Sladek³ and Vladimir Sladek³

Abstract: The thermo-elastic wave propagation based on Green-Naghdi (GN) coupled thermo-elasticity (without energy dissipation) is studied in a functionally graded thick hollow cylinder considering uncertainty in constitutive mechanical properties under thermal shock loading. The meshless local Petrov-Galerkin method accompanied with Monte-Carlo simulation is developed to solve the stochastic boundary value problem. In the presented method, the mechanical properties of FGM are considered to be as random variables with Gaussian distribution and mean values equal to deterministic values reported in previous works, which are generated using Monte-Carlo simulation with various coefficients of variations (COVs). The time evolution for transient problems is treated by using the Newmark finite difference method. The FG cylinder is assumed to be under axisymmetric and plane strain conditions. The mechanical properties of FGM are nonlinearly graded along the radial direction. A weak formulation for the set of coupled governing equations is transformed into local integral equations on local subdomains by using a Heaviside test function. All nodal points are regularly distributed along the thickness of the FG cylinder in radial direction and each node is located in a uni-directional subdomain to which a local integral equation is applied. The distributions of the temperature and radial displacements as well as the time history of them are obtained for some grading patterns of FGM at several time instants and for some COVs. The propagation of thermal and elastic waves along the radial direction in the FG thick hollow cylinder as well as the statistical characteristics of the variance and maximum values of the temperature and displacement are discussed in details.

¹ Industrial Engineering Department, Engineering Faculty, Ferdowsi University of Mashhad, Mashhad, Iran.
² Civil Engineering Department, Engineering Faculty, Ferdowsi University of Mashhad, Mashhad, Iran.
³ Institute of Construction and Architecture, Slovak Academy of Sciences, 84503 Bratislava, Slovakia.