Composite Structures
Volume 237 | 2020 | ISSN: 0263-8223

Machine learning based stochastic dynamic analysis of functionally graded shells

Vaishali[a], T. Mukhopadhyay[b], P. K. Karsh[c], B.Basu[d], S.Dey[a]
[a]*Department of Mechanical Engineering, National Institute of Technology Silchar, Silchar, India*
[b]*Department of Aerospace Engineering, Indian Institute of Technology Kanpur, Kanpur, India*
[c]*Department of Mechanical Engineering, Parul Institute of Engineering & Technology, Parul University, Vadodara, India*
[d]*Department of Civil, Structural & Environmental Engineering, Trinity College Dublin, Dublin, Ireland*

Abstract:
This paper presents stochastic dynamic characterization of functionally graded shells based on an efficient Support Vector Machine assisted finite element (FE) approach. Different shell geometries such as cylindrical, spherical, elliptical paraboloid and hyperbolic paraboloid are investigated for the stochastic dynamic analysis. Monte Carlo Simulation is carried out in conjunction with the machine learning based FE computational framework for obtaining the complete probabilistic description of the natural frequencies. Here the coupled machine learning based FE model is found to reduce the computational time and cost significantly without compromising the accuracy of results. In the stochastic approach, both individual and compound effect of depth-wise source-uncertainty in material properties of FGM shells are considered taking into account the influences of different critical parameters such as the power-law exponent, temperature, thickness and variation of shell geometries. A moment-independent sensitivity analysis is carried out to enumerate the relative significance of different random input parameters considering depth-wise variation and collectively. The presented numerical results clearly indicate that it is imperative to take into account the relative stochastic deviations (including their probabilistic characterization) of the global dynamic characteristics for different shell geometries to ensure adequate safety and serviceability of the system while having an economical structural design.

Link: https://www.sciencedirect.com/science/article/abs/pii/S0263822319334555