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Stochastic static analysis of Euler-Bernoulli type functionally graded structures

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Abstract

In this study, the uncertain static analysis of Euler-Bernoulli type functionally graded structures with probabilistic parameters is investigated. An effective, yet efficient, computational method is proposed within the framework of the finite element analysis (FEA). Various uncertain systematic parameters, which are including the material properties, dimensions of structural elements, as well as applied forces, can be simultaneously incorporated within the unified analysis framework. By meticulously combining the matrix perturbation theory with Tayler's series expansion, both first and second order statistical characteristics (i.e., mean and variances) of the concerned structural responses can be robustly estimated for practically motivated functionally graded structures. In order to illustrate the applicability, accuracy, as well as efficiency of the proposed computational approach, three distinctive functionally graded engineering structures are thoroughly investigated by comparing the performance of the proposed approach with the simulation based reference method. Furthermore, complementary parametric investigations are also conducted to explore the sensitivity of the Euler-Bernoulli type functionally graded structures against various degrees of uncertainty of each considered uncertain system parameter.

Keywords:

A. Functional composites; B. Defects; C. Computational mechanics; C. Finite element analysis (FEA); Uncertainty analysis.

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