Fuzzy static analysis of engineering structures involving functionally graded materials

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Abstract

This work is focusing on the uncertain static analysis of functionally graded structures with fuzzy parameters. The non-deterministic Young's moduli of functionally graded structural elements, as well as the applied loads are modeled as fuzzy variables with associated membership functions. By applying the $\alpha-$level strategy, the fuzzy linear problem can be meticulously transformed into a series of interval system of linear equation. Within the context of interval static analysis of functionally graded structures, the mathematical programming approach is adopted such that the extreme bounds (i.e., upper and lower bounds) of any concerned structural responses (i.e., structural displacement and stress) at any specific $\alpha-$sublevel can be robustly determined. Consequently, the membership functions of the concerned structural responses are respectively established. In order to demonstrate the effectiveness and efficiency of the proposed method, one practically motivated functionally graded structure is thoroughly investigated. In addition, some numerical experiments are conducted such that various theoretical and practical aspects regarding the uncertain static analysis of functionally graded structures can be further explored.

Keywords: Fuzzy static analysis; Functionally graded materials; $\alpha-$level strategy; Mathematical programming approach; Uncertainty analysis.