A fuzzy finite element analysis technique for structural static analysis based on interval fields

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Keywords: *fuzzy finite elements; interval analysis; interval fields.*

Abstract

One of the main shortcomings of current fuzzy and interval finite element procedures is that mutual dependency between multiple uncertain model parameters cannot be included in the analysis. This limit is posed by the classical interval concept, where multi-dimensional interval quantities are generally treated as hypercubes, thus ignoring all possible dependency between vector components. For this reason, most literature on this subject focuses on one-dimensional output quantities (see e.g. Moens (2005)).

In order to cope with this problem, this work discusses the application of the concept of interval fields for static analysis of uncertain mechanical structures in the context of fuzzy finite element analysis. The theoretic background of the concept is explained, and it is shown how it can be applied to represent dependency between parametric uncertainties in the model definition phase and in the post-processing phase.

Further, the paper concentrates on the calculation of interval fields resulting from static structural analysis. A procedure is introduced that enables the calculation of a joint representation of multiple output quantities of a single interval finite element problem while preserving the mutual dependency between the components of the output vector. This procedure is based on a projection of the original problem on the space composed by the classical static deformation modes, augmented with deviatoric parts.

Finally, a numerical case study illustrates the procedure and indicates the added value of the technique when post-processing is applied in a fuzzy or interval context.

References

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