Robust concurrent topological design of macrostructure and composite material with hybrid interval random modeled imprecise uncertainties via BESO

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Abstract

In this study, the robust concurrent topology optimization (RCTO) method is developed to design both static and dynamic structures and their periodic composite microstructure considering imprecise uncertainties. The hybrid interval random model is adopted to model the imprecise uncertain parameters with imprecise probabilistic distribution. A hybrid perturbation analysis for the worst case (HPAWC) method is proposed to determine the worst case of the uncertain objective function by estimating its expectation and standard variance. Thus, the elemental sensitivity information of the macrostructure and composite microstructure can also be derived. They are normalized to achieve the concurrent design through an overall weight fraction constraint. Combined with the deterministic concurrent topology optimization (DCTO) framework, the robust design of the two-scale structure and composite material subject to the worst case is carried out by the bi-direction evolutionary structural optimization (BESO) method, simultaneously. Several 2D and 3D numerical examples are presented to illustrate the effectiveness of the proposed method.

Keywords: Concurrent topology optimization; robust topology optimization; imprecise uncertainty; hybrid interval random model.