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Adaptive topology optimization based on fully error control for separated fields

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ABSTRACT

This paper develops a novel adaptive method for topology optimization by separately refining the analysis mesh and the density field according to different refinement criteria. Two indicators measuring the analysis accuracy and the boundary description quality are used as independent refinement criteria for the displacement and density fields, namely the energy error indicator and the so-called gray transitional region indicator. The analysis mesh is refined to improve the computational accuracy of local regions, as well as to ensure the numerical stability of the optimal solutions. Meanwhile, the material density field, which is interpolated by a given set of density points, is refined to enable a high-quality description of the structural boundaries. With such a strategy, the refinements of the analysis mesh and the density points are not bounded together anymore. Actually, each refinement process is independently performed only when and where necessary. Compared with non-adaptive solutions with globally fine analysis meshes and fine distributed density points, the proposed adaptive method is able to remarkably improve the numerical efficiency of the optimization process, as well as to reduce the percentage of gray regions in the optimal solutions.

Keywords: Topology optimization; refinement; error control; nodal design variable; gray transitional region indicator