Inverse homogenization using the topological derivative

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Abstract

Purpose – The purpose of this study is to solve the inverse homogenization problem, or so-called material design problem, using the topological derivative concept.

Design/methodology/approach – The optimal topology is obtained through a relaxed formulation of the problem by replacing the characteristic function with a continuous design variable, so-called density variable. The constitutive tensor is then parametrized with the density variable through an analytical interpolation scheme that is based on the topological derivative concept. The intermediate values that may appear in the optimal topologies are removed by penalizing the perimeter functional.

Findings – The optimization process benefits from the intermediate values that provide the proposed method reaching to solutions that the topological derivative had not been able to find before. In addition, the presented theory opens the path to propose a new framework of research where the topological derivative uses classical optimization algorithms.

Originality/value – The proposed methodology allows us to use the topological derivative concept for solving the inverse homogenization problem and to fulfil the optimality conditions of the problem with the use of classical optimization algorithms. The authors solved several material design examples through a projected gradient algorithm to show the advantages of the proposed method.

Keywords Synthesis of materials, Topology optimization, Material design, Inverse homogenization, Architectured materials, Relaxed formulation, SIMP-ALL

Paper type Research paper