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The Isotropic and Cubic Material Designs. Recovery of the Underlying Microstructures Appearing in the Least Compliant Continuum Bodies

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Abstract

The paper discusses the problem of manufacturability of the minimum compliance designs of the structural elements made of two kinds of inhomogeneous materials: the isotropic and cubic. In both the cases the unit cost of the design is assumed as equal to the trace of the Hooke tensor. The Isotropic Material Design (IMD) delivers the optimal distribution of the bulk and shear moduli within the design domain. The Cubic Material Design (CMD) leads to the optimal material orientation and optimal distribution of the invariant moduli in the body made of the material of cubic symmetry. The present paper proves that the varying underlying microstructures (i.e., the representative volume elements (RVE) constructed of one or two isotropic materials) corresponding to the optimal designs constructed by IMD and CMD methods can be recovered by matching the values of the optimal moduli with the values of the effective moduli of the RVE computed by the theory of homogenization. The CMD method leads to a larger set of results, i.e., the set of pairs of optimal moduli. Moreover, special attention is focused on proper recovery of the microstructures in the auxetic sub-domains of the optimal designs.