

TOPOLOGY OPTIMIZATION OF NONPERIODIC LATTICES BY INVERSE HOMOGENIZATION

Federico Ferrari, Ole Sigmund

DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING, SECTION OF SOLID
MECHANICS, TECHNICAL UNIVERSITY OF DENMARK, KOPPELS ALLE 404, 2800
LYNGBY, DENMARK

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Abstract

We discuss methods for computing the effective response of non-periodic, possibly stochastic media, and their use in Topology Optimization (TO). Homogenization computes the effective response of media with small inhomogeneities, avoiding the numerical difficulties of classical methods. For periodic media homogenization theory is very mature and has been extensively used for the inverse design and optimization of extreme lattices

.Homogenization of non-periodic materials is far less investigated, and considerably more challenging. The lack of periodicity makes it difficult to soundly define a length-scale, as this becomes inherently linked to the specific excitation and response of interest [1]. Non-periodic homogenization methods are under development, mainly based on a piecewise application of periodic homogenization, or on the introduction of spatial filters separating the scales in the heterogeneity pattern [2], the generation of a statistically appropriate RVE, or again on the explicit perturbation of the periodic boundary conditions [3]. These methods are computationally demanding, compared to periodic homogenization, and thus seem to be difficult to apply in TO.

We explore the use of simplified methods for the analysis and inverse design of non-periodic structures, based on perturbations, either of the strain or stress field applied to the unit cell, or of the cell geometry itself. The perturbations shall then be stochastically treated, to effectively represent the non-periodicity. A similar approach has been recently devised for speeding up the homogenization problem [4], but has not been systematically introduced in the topology optimization problem. The talk will present quantitative results about the optimal design of lattices accounting for different sources of non-periodicity, discussing the computational benefits of a perturbation based approach

References

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