Multiscale topology optimization of structures and non-periodic cellular materials

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Topology optimization allows designers to obtain lightweight structures traditionally made of homogeneous materials. Relevant efforts have been made to include cellular material constitutive models with a prescribed morphology [1]. The incorporation of cellular materials in topology optimization results in lighter structures compared to the ones obtained with the homogeneous models. Further material savings and increased performance can be achieved if the material and the structure topologies are concurrently optimized [2]. More recent publications in multiscale topology optimization address multiscale topology optimization assuming a periodic cellular meso-structure, for which the periodic homogenization approaches are well established [3]. The objective of this investigation is to develop a multiscale approach for material and structural topology optimization relaxing the periodicity condition. The resulting structures correspond to an optimal distribution of functionally graded meso-structure of highest material saving. Since no preconceived meso and macrostructures are considered, the proposed multiscale topology optimization approach drives the design to non-intuitive configurations at both length-scales. The proposed approach makes use of non-periodic homogenization techniques to make the multiscale analysis numerically tractable. This method is evaluated in the realm of minimum compliance problems and compared to more traditional homogeneous and cellular material designs.

References

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