

PROCEEDINGS

Multiscale Optimization of Non-Linear Structures

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ABSTRACT

In this work we describe the multiscale optimization of non-linear structures. This work moves beyond classical multiscale optimization for linear problems to account for large deformations occurring across the scales of the problem. A multiscale approach is adopted based on the homogenization theory which is used to characterize a parameterized representative volume element (RVE). This RVE characterization is undertaken for both changes in the geometry and the strain applied to the RVE. This latter is a key difference between multiscale approaches for non-linear problems and those for linear problems. This is because the characteristics of the RVE are no longer a function of the geometry alone, but also of the local strain field the RVE is subject to. The result of this is that the parameter space needed to represent the behavior of the RVE becomes prohibitively large if it is to be computationally constructed in its entirety. In the case presented to be presented it would require more than 24 million simulations. To overcome the challenge presented by size of the parameter space a concurrent approach is used with simulations only undertaken when required by the large-scale simulation and optimization process. This overcomes the computational bottleneck in an efficient way, requiring less than 1% of the parameter space to be simulated to both analyze and optimize the large scale geometry and spatial distribution of the small-scale geometric parameters. The Hill-Mandell condition is used to couple of the scales and ensure that energy transfer between scales is consistent. Finally, comparison is made between the optimized multiscale solution and a single scale, high fidelity simulation. Agreement is seen to be extremely good for challenging problems such prescribing a displacement profile the geometry needs to follow.

KEYWORDS

Structural metamaterials; non-linear multiscale methods

Funding Statement: This work was supported by the UK EPSRC OncoEng Programme (Grant number: EP/W007096/1).

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.



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