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Abstract

Cellular Materials Optimisation Framework †

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The methods used to achieve optimal solutions to an engineering problem are diverse. Uniquely analytical approaches are directly dependent on mathematical analysis methods, which implies a high level of complexity or even numerous intractable engineering problems. Conventional topological optimisation approaches focus on empirical knowledge or parameterised studies (e.g., numerical simulation). On the other hand, in heterogeneous materials with a complex internal microstructure, mechanical properties can be difficult to calculate using analytical prediction methods.

In this study, an optimisation framework is proposed for the design and mechanical properties evaluation of cellular materials. Several computational tools for integrated topology optimisation and numerical homogenisation were developed. Furthermore, as both computational tools used the finite element method (MEF), a commercial program (AbaqusCAE6.14-1) and the object-oriented programming language Python for the MEF and calculation modules were used, respectively.

The results show that optimized repetitive volume elements (RVE) solutions were achieved by setting up different initial designs based on density restrictions or forces. Moreover, the proposed framework enabled the design and analysis of complex geometries RVE with a wide range of mechanical properties.

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