6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Sensitivity analysis as a tool for optimal material design

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Keywords: *Material design, FEM, Multiscale methods (FE^2) and homogenisation, Variational sensitivity analysis, Structural optimisation, Shape optimisation*

Structural optimisation has a long tradition and has been investigated for many years and in a variety of fields. Techniques for numerical homogenisation, i.e. FE^2 methods, allow investigations of the physical behaviour of complex heterogeneous materials and lead to a remarkable number of several applications and real world problems, see [3, 4] and references therein for details. A combination of both established methods leads to a significant increase of possible fields of applications and justifies its eminent importance. Besides mathematical algorithms, sensitivity analysis is a fundamental topic within solution strategies for optimisation problems, especially within techniques based on gradient information. Its realisation is responsible for the efficiency and accuracy of used methods. In this context several works conclude that performing sensitivity analysis using variational methods is the most promising approach, see [1, 2] and references therein. The resulting gradients contain sensitivity information on the given overall mechanical system as well as on the stated boundary value problem, and can be used for further purposes.

Essential steps and principal investigations for sensitivity analysis and formulations of optimisation problems on multiple scales in order to design micro-structures and to improve the overall physical behaviour under certain constraints will be outlined and accentuated by some illustrative examples. Consequently, descriptions for objective functions, constraints and design parameters on different scales are necessary and will be discussed.

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