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

OPTIMIZATION BASED ANALYSIS OF THE EFFECT OF PARTICLE SPATIAL DISTRIBUTION ON THE ELASTIC BEHAVIOUR OF PRMMC

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KEY WORDS: *MMCS, SMBO, KRIGING, UNCERTAINTY, COMPUTATIONAL HOMOGENIZATION.*

A study of particle reinforced metal matrix composite (PRMMCs) by means of periodic multi-particle unit cells is presented. The inhomogeneous particle spatial distribution, as well as the effect of matrix/particles interface, strongly influences the heterogeneous material behaviour. The effect of both particle spatial distribution and particle size effect on the uniaxial elastic response of PRMMCs is addressed. The uniaxial tensile loading on cubicshaped cells with a different number of spherical particles (up to 50) and different fraction volumes (up to 25\%) is studied by using Abaqus FEA [1] Matlab Global Optimisation Toolbox and the R Sequential Parameter Optimisation Toolbox SPOT [2]. Three different optimisation processes are used i.e. high-fidelity optimisation, low-fidelity optimisation and surrogate assisted optimisation that takes into account the uncertainty in particle spatial distribution. Accurate finite element analyses (FEA) on different representative volume elements (RVEs) have been conducted by means of Abaqus-optimizer coupling and computational homogenization. Numerical upper bound (UB) and lower bound (LB) of the homogenized uniaxial Young's modulus Ex, based on High Fidelity Model Based Optimisation techniques (HFMBO), are reported. A memetic algorithm with adaptive parameter control optimisation process based on a model derived by sensitivities analysis is proposed. The results are compared to the ones using a Surrogate Model Based Optimisation (SMBO) employing Kriging. In the latter case, uncertainty in particle spatial distribution has been considered in regard to the current limited control in manufacturing techniques. The results show that the analytical upper bounds' models overestimate predictions especially in configurations with a low number of particles per RVE. The results of the different optimisation processes have been compared and, the importance of the critical parameters on Ex has been addressed.

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