Advances in Multiscale Concurrent Topology Optimization of Lattice Materials

Yan Jun[†] **Hu Wenbo** **Duan Zunyi**

† Department of Engineering Mechanics, State Key Laboratory for Structural Analysis of Industrial Equipment, Dalian University of Technology, Dalian, 116024
yanjun@dlut.edu.cn

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ABSTRACT

This paper presents an optimization technique for structures composed of periodic lattice materials based on Extended Multiscale Finite Element Method(EMsFEM). Considering micro unit cells with finite size, the optimization aims at to obtain optimal configurations of macro scale structures and the sectional areas of micro components under assumption of homogeneity of the microstructure with specified base material volume to achieve minimum compliance of structures. A concurrent topology optimization method is proposed for structures and materials. Adopting PAMP(Porous Anisotropic Material with Penalty) in macro-scale and Heaviside function density filtration to ensure clear topologies. Optimizations in two scales are integrated into one system with EMsFEM and the distribution of base material between the two scales can be decided automatically by sequential quadratic programming algorithm. The changes of macro and micro topologies caused by the size effect of microstructure of lattice material are considered. The superiority of concurrent optimization relative to the design of micro structure individual is indicated. Numerical experiments under linear boundary conditions and periodic boundary conditions validate the proposed model and algorithm. Optimization results show that distribution of base material at the structure and material levels have a little impact for the compliance of structures composed of periodic lattice materials.