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TOPOLOGY OPTIMIZATION OF PERIODIC 3D HEAT TRANSFER PROBLEMS WITH A 2D DESIGN

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Abstract: In this paper we consider a model for density-based topology optimization of stationary heat transfer problems in 3D structures with periodic design, subjected to design-dependent internal convection. The internal convection discussed in the paper takes place at the interface between a solid material and a cooling fluid flowing in internal channels through the design domain. The periodic design calls for use of periodic boundary conditions (BC). In addition to the periodic BC, there are given BC of prescribed temperature and convection. The objective is to minimize the maximum temperature, which is approximated by means of an L_p-norm. A continuous formulation of the state and optimization problem is derived and discretized by the finite element method. The internal convection is modelled to be proportional to the design variable gradient in the continuous problem. In discrete form, it is approximated as proportional to the difference in design densities of two adjacent elements in the finite element mesh. Additionally, the design is considered to be a 2D design, extruded in 3D. This is achieved through a filtering process, which means that the number of design variables are reduced to the number of elements in one plane of the structure. The resulting optimization problem is solved using gradient-based methods. The problem is illustrated through some numerical examples on geometries related to gas turbine applications, where we show the basic behaviour and characteristics of the model. In addition, we investigate different parameter settings, such as the exponent in the L_p-norm.