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On the influence of interface models on the optimum layout of multi-component structures and material systems

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Abstract

When designing the layout of structures consisting of multiple bodies or material systems composed of multiple phases by topology optimization, a perfect bond at the interfaces is typically assumed. While this assumption simplifies the structural model and circumvents the need for explicitly describing the interface geometry, it ignores interface phenomena that may dominate the structural response, such as contact, friction, and delamination. In this paper we study the influence of such interface phenomena on the optimum structural layout and composition of heterogeneous materials. To this end, we adopt a topology optimization method that describes the geometry by an explicit level set method (LSM) and predicts the structural response by the extended finite element method (XFEM). The combination of LSM and XFEM allows accurate resolution of interface geometry and related interface phenomena. The formulation of the optimization problem with focus on the structural and interface models is presented. We study two-phase optimization problems considering perfect bonding, adhesive bonding, and contact with and without friction. The optimization results demonstrate that interface phenomena may strongly influence the optimum design and that, in general, the interface conditions need to be accurately captured to obtain reliable optimization results.