technische universität dortmund

Solids SPP 2256 Variational Methods

Material Design for Multiple Loads

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Abstract

We consider the optimization of the topology and geometry of an elastic structure subjected to a set of boundary loads. Specifically, we aim to minimize the energy, which is the sum of the material volume and the structure's compliance (defined as the work done by the load). This theory has been extensively developed by many authors, such as Allaire, Murat, and Kohn, in the case of a single load applied to the boundary of the geometry. However, only a few non-numerical results have been obtained for structures that are optimal with respect to a distribution of loads.

In this talk, we aim to characterize the optimal structures for the specific case of two uniaxial loads applied to the boundary. We observe how the choice of a suitable reference system connects the symmetry of the boundary data to certain optimality conditions for the elasticity tensor of our design. This approach allows us to explicitly compute a sharp lower bound for the energy and provides a characterization within the set of laminate designs.

The computations suggest a bifurcation in the solution for the case of “almost parallel angles”; that is, when the two uniaxial loads have nearly the same direction, we observe multiple optimal configurations in the set of rank-3 laminates, in contrast to the unique optimal configuration in the set of rank-2 laminates when the two uniaxial loads are almost perpendicular.

All computations are supported by numerical results obtained by optimizing the energy of the system in MATLAB.