

Large-scale robust topology optimization under load-uncertainty

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Abstract

Structures designed by topology optimization (TO) are frequently sensitive to loads different from the ones accounted for in the optimization. In extreme cases this means that loads differing ever so slightly from the ones it was designed to carry may cause a structure to collapse. It is therefore clear that handling uncertainty regarding the actual loadings is important. To address this issue in a systematic manner is one of the main goals in the field of robust TO. In this work we present a deterministic robust formulation of TO for maximum stiffness design which accounts for uncertain variations around a set of nominal loads. The idea is to find a design which minimizes the maximum compliance obtained as the loads vary in infinite, so-called uncertainty sets. This naturally gives rise to a semi-infinite optimization problem, which we here reformulate into a non-linear, semi-definite program. With appropriate numerical algorithms this optimization problem can be solved at a cost similar to that of solving a standard multiple load-case TO problem with the number of loads equal to the number of spatial dimensions plus one, times the number of nominal loads. In contrast to most previously suggested methods, which can only be applied to small-scale problems, the presented method is – as illustrated by a numerical example – well-suited for large-scale TO problems.

Keywords: Robust optimization, Topology optimization, Large-scale optimization, Non-linear semi-definite programming.