Structural Topology Optimization with Eigenvalues

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Abstract

The paper considers different problem formulations of topology optimization of discrete or discretized structures with eigenvalues as constraints or as objective functions. We study multiple load case formulations of minimum weight, minimum compliance problems and of the problem of maximizing the minimal eigenvalue of the structure including the effect of non-structural mass. The paper discusses interrelations of the problems and, in particular, shows how solutions of one problem can be derived from solutions of the other ones. Moreover, we present equivalent reformulations as semidefinite programming problems with the property that, for the minimum weight and minimum compliance problem, each local optimizer of these problems is also a global one. This allows for the calculation of guaranteed global optimizers of the original problems by the use of modern solution techniques of semidefinite programming. For the problem of maximization of the minimum eigenvalue we show how to verify the global optimality and present an algorithm for finding a tight approximation of a globally optimal solution. Numerical examples are provided for truss structures. Examples of both academic and larger size illustrate the theoretical results achieved and demonstrate the practical use of this approach. We conclude with an extension on multiple non-structural mass conditions.

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