Dimensional reduction in topology optimization with vibration constraints

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Abstract

Topology optimization (TO) is a well-established technique of designing stiff and lightweight structures. The basic FMO model has limitations, though. For example, structures may fail due to lack of stability of the optimal structure. In order to prevent this undesirable behavior, additional requirements have to be taken into account in the TO model. Such modifications lead to additional constraints on the set of admissible materials and/or the set of admissible displacements. These constraints usually destroy the favorable mathematical structure of the original problem. The particular cause of structural failure we want to investigate in this article is vibration resonance. Structural optimization problems with eigenvalue constraints have been intensively studied in the context of truss and topology optimization.

We will formulate the problem as a Semidefinite Optimization Program (SDP) and present an approach to the decomposition of large matrix inequalities into several smaller ones with the goal to efficiently use existing SDP solvers. The approaches will be demonstrated on an SDP problem arising in topology optimization of mechanical structures with vibration constraints. The technique is based on the decomposition of chordal graphs. We will show that it leads to a significant reduction of the CPU time.