A computational procedure for frequency maximization in topology optimization

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KEYWORDS: *Topology optimization, Frequency maximization, Quasi-static approximation*

Maximizing the eigenfrequencies of a structure using topological optimization methods poses a significant computational challenge due to the fact that each optimization step requires a numerical solution to the eigenvalue problem. An additional difficulty during the optimization process is the so-called mode switching phenomenon. To solve this problem, an approach known in the literature as the so-called *bound formulation*, has been proposed. This approach, along with its numerical implementation, can be found in the work of Olhoff and Du [1]. In this implementation, optimization is performed using two nested loops, the first of which is responsible for solving the eigenvalue problem and determining the sensitivity of the frequencies and eigenvectors, while the second determines the increments of the design variables using mathematical programming.

Due to the significant computational cost of the *bound formulation* method, approximate methods for frequency maximization have been proposed, including the approach presented in the work of Yuksel and Yilmaz [2]. In this approach, solving the eigenvalue problem at each iterative step is replaced by a two-stage static optimization. The first stage approximates the basic eigenmode using a unit force, while the second optimizes the structure by introducing quasi-static modal forces.

A similar approach was used in this paper. Instead of two-stage static optimization, a single-stage approach was proposed [3], where the eigenmode is approximated by first solving the eigenvalue problem once at the beginning of the optimization process. The result of this procedure makes the proposed approach more intuitive and eliminates the need to introduce a fictitious unit force. The paper will compare the performance of the three methods using a benchmark example of a simply supported beam modelled as a plate system in a plane stress state.

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