The worst-case multiple load free material optimization problem revisited

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Abstract

We want to solve a worst-case multiple load formulation of the free material optimization (FMO) problem. The formulation used so far (for instance in the FMO code MOPED) leads to a (large-scale) linear semidefinite programming (SDP) problem. This has two main disadvantages:

a. the SDP problem is much more complex than a nonlinear program of the same dimension – consequently, we can only solve problems of much smaller dimension than in the single-load case;
b. the result gives us just indirect information about the properties of the optimal material – the full material matrix can only be obtained by expensive postprocessing.

We propose to solve the multiple load problem by means of another formulation which was known for some time but which has never been used for the numerical solution. The reason for that was that it leads to an SDP problem with bilinear matrix inequality (BMI) constraints. Until now, there was no software for this kind of problems available. We solve the problem by our recently developed code PENBMI. Using the BMI formulation, we can avoid the two difficulties mentioned above. Though nonlinear, the BMI formulation leads to problems with very sparse data that can be solved efficiently even for high dimensional problems. Further, the optimal material matrices can be obtained directly as Lagrangian multipliers of the BMI constraints, provided by PENBMI. Finally, the number and size of constraint matrices is independent of the number of load cases, contrary to the formulation used so far. Numerical comparison of the two formulations will conclude the presentation.