Global Optimization of Trusses with Constraints on Number of Different Cross-sections: A Mixed-Integer Second-Order Cone Programming Approach

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Structural optimization is a powerful methodology for designing structures by means of mathematical optimization. A truss topology optimization problem that minimizes the compliance is one of the most fundamental problems in structural optimization. At an optimal solution of this problem, the member cross-sectional areas can possibly take all different values. This is not acceptable for commercial and manufacturability reasons. Indeed, in design practice only a small number of different member cross-sections is used to design a truss. Developed in this study is a new modeling of the design constraint such that only a limited number of different member cross-sections are adopted. It is shown that the truss topology optimization problem under this constraint can be recast as mixed-integer second-order cone programming. Therefore, the global optimal solution of the proposed design optimization problem can be found by using an existing mixed-integer programming solver. Numerical experiments show that the proposed approach is applicable to moderately large-scale problems.