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Truss Topology Optimization under Constraints on Number of Different Design Variables

Yoshihiro Kanno[1]

[1] Tokyo Institute of Technology, Japan

Abstract

This paper presents a new modeling of truss topology optimization for obtaining the stiffest truss design that are practically advantageous in some aspects. In design practice it is often that the structural components of a truss are selected from among easily available discrete candidates and a number of different candidates used in a structure is restricted to be small. In contrast, optimization with the continuous design variables usually results in a truss design with the member cross-sectional areas that take all different values. Such a design is not acceptable for commercial and manufacturability reasons. Therefore, formulations and algorithms for truss optimization with discrete design variables have been studied extensively.

In the discrete truss optimization it is usual that each member cross-sectional area is chosen from a set of predetermined candidate values. If the available discrete sizes are closely spaced, the obtained discrete design may probably use a large number of different available sizes. If a quite small number of available discrete sizes is postulated, then the optimal solution could be expected to use only a small number of different sizes. However, the optimal solution highly depends on the set of predetermined available discrete sizes. Therefore, it is not clear how one can choose values of widely-spaced sizes, in advance, to assure high quality of mechanical performance of the discrete optimal solution.

In this paper the member cross-sectional areas are considered continuous design variables and we attempt to find the optimal truss design that consists of only a limited number of different member cross-sectional areas. It is shown that this problem can be handled within the framework of mixed-integer programming. Numerical experiments are presented to show that the proposed approach is applicable to moderately large-scale problems.