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ON SOLVING LARGE-SCALE PLASTIC LAYOUT OPTIMIZATION OF TRUSSES BY INTERIOR POINT METHODS

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Abstract: We are concerned with solving the plastic design formulation traditionally written as a linear program and its extension that belongs to the so-called semidefinite programming to address linear buckling. The optimization problems are modelled following the well-known ground structure approach in which a finite set of nodes are distributed in the design domain and all the possible interconnecting bars are generated. The main goal is then to determine the optimal cross-sectional areas of these bars and obtain the lightest structure that can sustain a given set of applied loads. The excessive connectivity of the nodes results in a huge number of potential bars making the optimization problems computationally difficult for standard solution techniques. Therefore, we propose a specialized primal-dual interior point method in which we employ several novel techniques. We apply a member adding procedure where the problems are initially solved for minimal connecting bars and subsequently members are added until the final optimal design is obtained. We additionally exploit the algebraic structure of the problems to reduce the normal equations system originating from the interior point algorithm, which are often assumed as the smallest possible linear systems by any standard primal-dual interior point algorithms, to much smaller systems. Moreover, the already reduced linear systems are solved using iterative methods instead of the more expensive direct methods. Finally, due to high degree of similarity among the subsequent sub-problems in the last few member adding iterations, we use a warm-start strategy to determine initial point and achieve convergence within fewer interior point iterations. The efficiency and robustness of the method is supported with several numerical experiments.