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ON RECENT DEVELOPMENTS IN LAYOUT OPTIMIZATION OF LARGE-SCALE TRUSSES

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Abstract: The paper deals with a specific ground structure method for topology optimization of large-scale trusses approximating Michell structures. The ground structure methods are expensive but robust. The optimization process consists in finding the optimal subset of active bars from a prescribed set of possible bars connecting nodes. The bars that do not transmit any forces disappear and are eliminated in the final solution. The nodes have fixed positions (coordinates). Therefore, they must be arranged quite densely to obtain good approximations of exact solutions. This leads to huge optimization problems that are expensive and hard to solve in a direct way. This obstacle can be overcome by the adaptive ground structure method proposed by Gilbert and Tyas [1] and later developed by the author [2]. On the other hand, due to fixed positions of nodes the topology optimization problem can be formulated and solved in the framework of linear programming (which is convex and free of local minima). This enables finding a globally optimal solution. In the present paper we discuss different strategies of reducing the size of the optimization problem by applying selective subsets of active bars and nodes. An important improvement to adaptive ground structure methods is proposed. This improvement allows better reduction of the problem size by eliminating greater number of unnecessary bars. This reduction is possible thanks to adjusting adjoint displacement field in empty regions where no material is needed. This adjusting phase requires solving an auxiliary linear programming problem of relatively small size. This improvement is particularly important for multi-load 3D problems because the optimal spatial trusses tend to assume forms of lattice surfaces while most of design space becomes empty. It is worth noting that despite the iterative character, the method guaranties the convergence to the optimal solution because at the end the strains in all potential bars have to satisfy Michell optimality criteria. The newest version of the implemented method allows solving tasks with billions of potential bars and enabled to obtain new important solutions which extend the class of known Michell trusses to 3D space and multiple load conditions.

References

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