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TOPOLOGY OPTIMIZATION OF TRUSS AND FRAME STRUCTURES CONSIDERING CONSTRUCTABILITY COSTS

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Abstract

As topology optimization is a free-form approach to optimizing structural layout, it has a tendency to produce light-weight but complex structural solutions that are difficult to construct. In large-scale structures, such as building systems, construction labor cost typically governs, potentially making topology-optimized solutions impractical. This work examines constructability in the topology optimization of truss and frame structures, and proposes several new algorithms for influencing construction cost. These include cost metrics associated with repeatability of section sizes, cost of connection types and complexity, and cost premiums for non-standard sizes and subsystem patterns. Each of these algorithms is formulated in a continuous form, making use of regularized Heaviside functions, such that sensitivities are readily available for use with gradient-based optimizers. The algorithms are demonstrated on static and dynamic linear elastic design problems and solutions and the tradeoffs between constructability and material usage are explored.