Smooth Lower Bound Topology Optimization Using Truss Elementary Cells

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Abstract:
This study presents a smooth lower-bound topology optimization framework for plastic structural design using a continuum-like truss-cell representation. The proposed methodology combines lower-bound limit analysis, grouped design variables, and admissible stress-transfer mechanisms within a unified linear programming formulation. The computational domain is discretized using elementary square truss cells composed of side members and diagonal braces. Unlike classical ground-structure optimization methods, the optimization variables are defined at the cell-group level rather than at the individual member level. Structural topology therefore emerges through the interaction of grouped cell variables and shared side-member variables governed by hierarchy constraints. The formulation preserves statically admissible force-transfer mechanisms while allowing smooth topology evolution through continuous design variables. Numerical investigations including Michell truss, short cantilever beam, and bridge examples demonstrate that the proposed framework generates stable and mechanically meaningful topology layouts under ultimate loading conditions. The results exhibit consistent convergence behavior and progressive stabilization under mesh refinement, while reproducing load-transfer patterns comparable to reference solutions reported in the literature.

Keywords:
lower-bound, limit analysis, topology optimization, truss medium, linear programming, elementary cell.