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On the optimality of Michell structures

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Abstract

Optimal analytical Michell frame structures have been extensively used as benchmark examples in topology optimization, including truss, frame, homogenization, density and levelset based approaches. However, limiting structural topology to frame-like structures is a rather severe design restriction and results in structures that are quite far from being stiffness optimal. The paper compares various topology optimization results obtained with the frame restriction to cases with no design restrictions. For all examples considered, the true stiffness optimal structures are mainly composed of sheets (2d) or closed-walled shell structures (3d) with variable thickness. For optimization problems with one load case, results in 2 and 3 dimensions indicate that compliance can be reduced by 10-20\% when dropping the frame restriction. It is also demonstrated how too coarse design discretizations in 3d can result in unintended restrictions on the design freedom.

Numerical experiments are based on publicly available research codes for truss, density, homogenization and super-large scale topology optimization. Examples include cases from civil engineering and architecture.