Topology Optimization for Structural Design of Glass: Numerical and Experimental Study

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Abstract

The application of structural topology optimization to glass may enable the design of architectural and lightweight glass structures. There is still a lack of specific topology optimization tool for such a brittle material. Thus, the purpose of this work is to develop a custom numerical topology optimization for the design of wide-span glass structures. This allows to obtain monolithic load-bearing glass components which can have high strength-to-weight ratio. Here, we consider two volume minimization problems in which global displacement and global maximum principal stress are taken into account. The optimization algorithm is developed based on density method with robust filtering method and the Method of Moving Asymptote (MMA) is used as the standard optimizer. Two benchmark examples with parametric study of the algorithm are presented in both 2D and 3D design problems. We find that the custom topology optimization tool enabled not only to minimize the volume of the structure but also to increase the structural performance (stress distribution). Finally, validation experiments are performed on the topologically optimal structures for the MBB beam cut by abrasive waterjet.

Keywords: Topology optimization, lightweight glass structure, Failure behaviour

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