Optimal Design of Fused Deposition Modeling Structures Using COMSOL Multiphysics® Software

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Abstract

Combination of additive manufacturing (AM) and topological optimization with COMSOL Multiphysics® software offer new opportunities in mechanical design without limitation on structure geometry. Fused Deposition Modeling is a widely used AM process which is affordable with a free control of process parameters. In this paper, we try to improve the design of structures using first topological optimization to define the external geometry and then to use either heterogeneous internal filling or multimaterials. Indeed, based on structural mechanics simulation, parts of the structures where stresses field are high are printed with high density internal filling or alternatively we add a new material with improved mechanical properties. In our example, two materials are combined: red ABS and black conductive ABS (ABS with carbon black). In our optimization approach, conductive ABS can be replaced with other materials like ABS with reinforced fillers to increase the stiffness. While the optimal inner and outer designs are defined, another challenge is to find the best manufacturing parameters. During the 3D printing of variable densities filled parts or multimaterials parts, weak interfaces are created. The mechanical strength of these interfaces is strongly linked to the printing patterns. This particular point is considered at the end paper.

Reference

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Figures used in the abstract

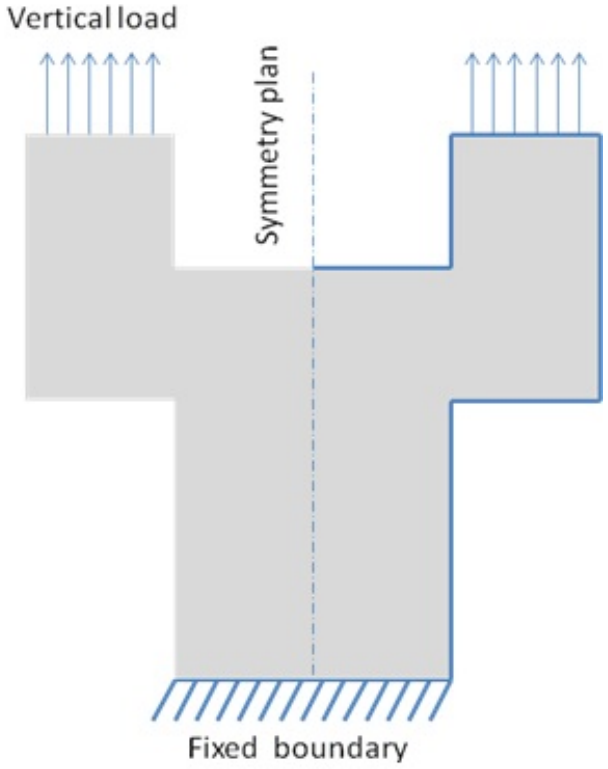

Figure 1: Initial geometry and boundary conditions for the topological optimization

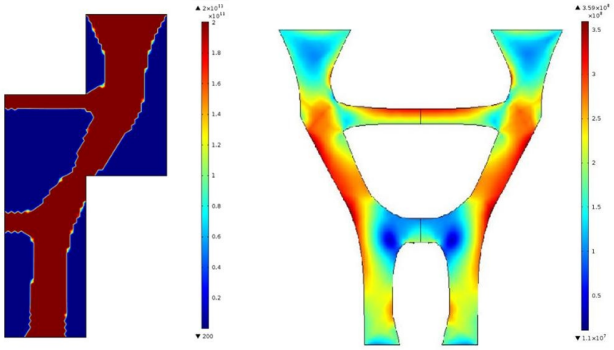

Figure 2: Optimal part and corresponding stresses field

Figure 3: 3d printed optimized part with heterogeneous infill (left) and multimaterials (right)