On some recent developments of topology optimization of structures for additive manufacturing

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Topology optimization algorithms are known to produce optimal structural shapes which may be difficult to manufacture, either by classical methods (molding, milling). Additive manufacturing techniques are promising for building optimal structures since they seem without any limitations. Unfortunately, it is not exactly true and in this talk we shall discuss two related issues. First, we explain how some limitations of additive manufacturing can be taken into account in a topology optimization algorithm, the so-called level set method, which is a very attractive tool by its capacity of defining a clear notion of boundary for the admissible shapes. In this context, we introduce constraints on the minimal or maximal thickness, on the anisotropy and on the overhangs of the optimal structure, as well as on the thermal residual stresses, produced during the manufacturing process.

Second, we propose a resurrection of the homogenization method for optimizing structures build with lattice materials. Compared to the popular SIMP algorithm which considers artificial isotropic composite materials, the homogenization method relies on real microstructures with a possible anisotropy which is a real advantage in optimization of the macroscopic structure. This is a joint work with Ch. Dapogny, A. Faure, P. Geoffroy, L. Jakabcin, F. Jouve, G. Michailidis and O. Pantz.

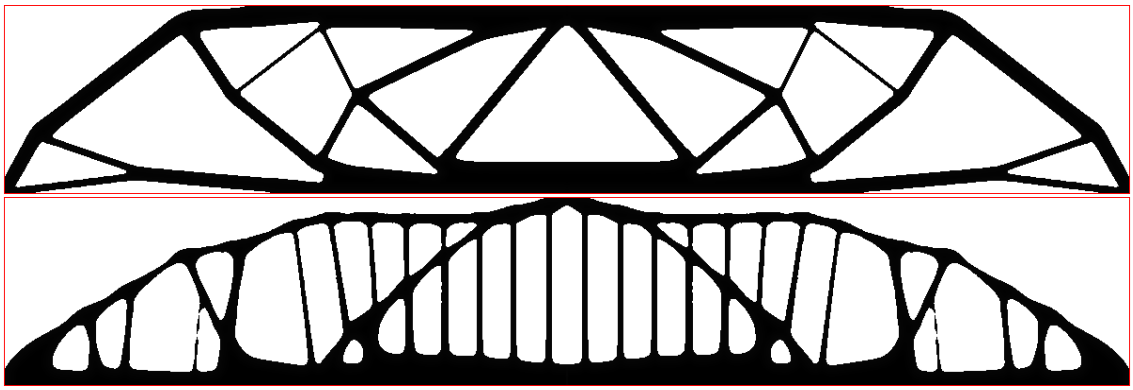

Figure 1: minimal compliance MBB beam: without (top) and with (bottom) a vertical build constraint to avoid overhangs.

References:

[1] G. Allaire, Ch. Dapogny, A. Faure, G. Michailidis, *Shape optimization of a layer by layer mechanical constraint for additive manufacturing,* submitted. HAL preprint: hal-01398877 (November 2016).

[2] C. Dapogny, A. Faure, G. Michailidis, G. Allaire, A. Couvelas, R. Estevez, *Geometric constraints for shape and topology optimization in architectural design,* to appear in Computational Mechanics. HAL preprint: hal-01354004 (August 2016).