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Extremal Material and Structure Design by Topology Optimization

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Extremal material and structure design by topology optimization

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Due to rapid advances in additive manufacturing (AM) technologies, there is virtually no limits on designing materials and structures that optimize structural and multidisciplinary criteria such as stiffness to weight ratio, buckling resistance, thermal, dynamic or acoustic responses, etc. Apart from many theoretical and intuitive studies, topology optimization has been a major driver in developing tools for systematic generation of such optimal structures and materials [1].

The original works on topology optimization considered distribution of optimal anisotropic microstructures [2] but this approach was later abandoned in favour of the simpler density approach (c.f. [3,4]). However, recent developments in AM techniques have respurred the interest in the microstructure approach with the aim of producing simple and manufacturable structural designs from optimal microstructures through efficient mapping techniques [5,6,7]. This approach entails performing a multi-variable homogenization-based topology optimization on a coarse structure, followed by mappings to fine scale designs including steps to control minimum/maximum feature sizes and manufacturability [6].

The talk will present extensions of this concept to shell structures, multiple load cases and three dimensions. So far, this design approach has only been applied to linear elasticity problems with the aim of maximizing structural stiffness. Initial studies regarding design of microstructures for maximum buckling resistance will also be discussed [8].

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