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Lattice Structures for 3D-Printing

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Abstract

In recent years 3D-Printing, also known as additive manufacturing, has become a broad technology movement. By large its fame is driven by rapidly growing consumer adoption. However, rapid growth has been seen in particular in biomedical applications, and initial successes have also been showcased for aerospace and other fields. 3D-Printing offers almost unlimited freedom for design shape and form, hence offers the perfect combination with topology optimization for creation of most efficient structures. Many successful designs created with topology optimization have been presented in real product environment by leading global companies.

In this paper we focus on design of a unique capability that 3D-Printing offers - lattice structures of very small size relative to the overall structural dimension. The solution is achieved through two optimization phases. Phase I carries out classic Topology Optimization, albeit reduced penalty options are provided to allow more porous material with intermediate density to exist. Phase II transforms porous zones from Phase I into explicit lattice structure. Then lattice member dimensions are optimized in the second phase, typically with detailed constraints on stress, displacements etc. The final result is a structure blended with solid parts and lattice zones of varying material volume. This capability is introduced in the commercial software Altair OptiStruct 13.0.210 release in January 2015. It offers two types of lattice cell layout: tetrahedron and pyramid/diamond cells. Ongoing R&D is moving toward designing lattice cells with directional behavior, and eventually attempt to create lattice cell layout simultaneously in a multi-scale scheme.