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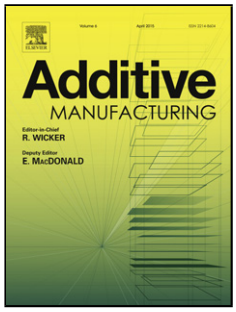

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Authors: Tino Stanković, Jochen Mueller, Kristina Shea

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The Effect of Anisotropy on the Optimization of Additively Manufactured Lattice Structures

Tino Stanković[a,*], Jochen Mueller[a], and Kristina Shea[a]

[a]Engineering Design and Computing Laboratory (EDAC), Dept. of Mechanical and Process Engineering, Swiss Federal Institute of Technology Zurich, Zurich, Switzerland

[*]Corresponding author.
E-mail address: tinos@ethz.ch (T. Stanković)

Highlights

- Material anisotropy model formulation for the full three dimensional space
- Efficient optimization of lattice structures with respect to material anisotropy
- Effects of the material anisotropy on lightweight lattice structures
- Finding the optimized build orientation with respect to the material anisotropy
- Large increase in accuracy, hence, safety compared to conventional approaches

Abstract

The build orientation is one the most influential factors on material properties in additively manufactured parts. Advanced applications, such as lattice structures optimized for lightweight, often rely on small safety margins and are, hence, particularly affected, but research has not gone far beyond the pure empirical characterization. The focus of this paper is to investigate in detail the influence of anisotropy induced through fabrication on the mechanical performance and build orientation of whole structures when subject to optimization. First, a material property model for both compression and tension states is formulated. Then, the Generalized Optimality Criteria method is extended for fixed topology lattice structures with respect to constraints in displacement, stress, and Euler buckling. The two latter are formulated as local constraints that are handled in combination with Fully-Stressed Design recursion. The results reveal significant safety threads likely leading to premature failure when using properties from one-directional tests, as is so far the case, rather than the full anisotropy model developed herein. If used inversely, the algorithm yields the optimal orientation of a structure on the build platform, allowing further weight reduction while maintaining the mechanical properties.

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