Design and modelling of bioinspired 3D printed structures

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ABSTRACT

3D printed metamaterials are a human-designed class of material capable of providing uncommon properties unseen in nature. However, the freedom power of design provided by additive manufacturing in metamaterials is useless if reliable and efficient modelling design tools are not available. The objective of this work is to evaluate, validate and study the different options for finite element simulation of bio-inspired metamaterials to provide the best solutions in terms of material properties accuracy and computational efficiency. Based on this study we have developed a new hybrid material agnostic modelling method to compute the mechanical response of beam based bioinspired metamaterials with similar precision of 3D explicit meshed models.

Different variables in the latticed models were investigated, these included different element sizes and element types (volumetric and beam elements). The effects of these variables on the elastic modulus and yield strength of a lattice structure were addressed. The geometrical models were printed in Ti6Al4V using selective laser melting technique and experimentally tested for the validation of the computational results. On the basis of the volumetric results, multi-material beam models were constructed and evaluated providing with accurate results in low computational times and recreating the plastic failure phenomena observed experimentally.

Figure: Computational modelling and experimentation of bio-inspired lattices