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ABSTRACT

Mechanical Behavior of Periodic and Stochastic Architected Materials

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In the search for lightweight structures with tailored performance, microarchitected materials have been the subject of several studies. One of their main benefits explored is energy absorption, especially for applications such as protective equipment and crashworthiness of vehicles. In this regard, the literature is dedicated to the assessment of structures based on periodic, strut or stochastic topologies, consisting of already available as well as newly developed architectures [1, 2]. In addition, Additive Manufacturing (AM) has been an important ally in enabling the fabrication of more intricate designs [3, 4]. The emergence of defects in the 3D printed part inherent to the manufacturing process should, however, be taken into account in order to adequately predict the performance of the structure.

With this in mind, this study aims to analyse the effect of random spatial variations in periodic lattice structures, particularly distortions at the edges of 2D unit cells, on their compressive behaviour and energy absorption capabilities using numerical and experimental approaches. The stocasticity is generated by perturbing the property fields by Gaussian random fields [5]. With the help of AM technology Fused Filament Fabrication (FFF), samples can be easily produced and tested for experimental validation. Polymers are the traditional material used in FFF machines but the investigations can also be extended to the most recently developed metal-infused filaments. Preliminary numerical results reveal a positive influence of increasing distortions in the original cells on the specific energy absorption of the structures in quasi-static compression. This shows not only the potential for using stocasticity but also a viewpoint for proposing modifications to the lattices with intentional distortions for improved mechanical performance. Furthermore, these investigations can contribute on the estimation of acceptable variations in the manufacturing process of these architectures.

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