Lattice structure design optimisation for additive manufacturing

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ABSTRACT

The aim of this research is to propose an optimised lightweight lattice structure design method. The progress in metallic additive manufacturing technology enables the manufacturing of complex forms such as lattice structures and topologically optimised parts [1]. Lattice structures are lightweight and have high strength mechanical properties [2], which are suitable for requirements in the aerospace, biomedical and automotive industries [3]. Lighter aeroplanes can significantly improve fuel consumption and are more environmentally friendly. However, the breakthrough in manufacturing technology is yet to be followed by a breakthrough in design methods [4]. Optimised lattice structure design methods are required to fully reach the potential of additive manufacturing capability in manufacturing lightweight high strength parts. Therefore, a study was made to optimise current lattice structure design methods.

The methodology used in this in research consists of conducting finite element analysis on solid CAD models to observe the stress and strain distribution. From the results obtained, an optimised lattice structure design method is proposed consisting of a guideline to define partitions within the design volume consisting of different lattice structure relative densities. The partitions are defined by mapping the stress distribution to the lattice structure. The proposed design method optimises lattice structure design by enabling the choice of different relative densities in certain areas of the lattice structure and reduces the mass. For example, in areas where there is lower stress, a lower relative density is chosen, whereas in areas with higher stress, higher relative density is chosen.

In conclusion, current lattice structure designs for additive manufacturing can be further optimised and reduce mass by defining partitions based on the stress and strain distribution. This outcome contributes to the design of lightweight high strength parts in the aerospace and automotive industry to reduce fuel consumption and increase performances. The lattice structure design method is validated through a case study on a lattice structure part.

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REFERENCES


