# Numerical and Experimental Crushing Behaviour Investigation of EBM Printed Auxetic Chiral Lattices


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## ABSTRACT

In aeronautics, aerospace, automotive and military applications, lightweight structures such as sandwich structures have an important role considering crush resistance during impact and blast situations. For crashworthy structures, a different type of sandwich structures has proposed with different cores such as foams, lattices and trusses. The lattice cores have come forward regarding crashworthiness, and one of the most promising lattice structures are auxetic cellular structures [1]. Auxetic lattice structures are special structures experiencing negative Poisson's ratio, so that they behave differently from conventional materials with shrinkage under a compressive load and expansion under a tensile load. Chiral structures are one of the prominent auxetic structures that show -1 Poisson's ratio [2].

In this study, Electron Beam Melting (EBM) is used to produce chiral auxetic lattices, and the crashworthiness of chiral auxetic lattice is investigated experimentally and numerically in the edgewise direction, where auxeticity can be experienced. EBM is an additive manufacturing (AM) process that uses an electron beam to melt metallic powders [3]. Titanium Alloy (Ti6Al4V) metallic powder is used in this study. To understand mechanical behavior and characterize EBM printed parts tensile tests are conducted. Additionally, three-point flexural tests are performed to understand the ligaments bending behavior in the chiral structures. According to the tensile and flexural test results a constitutive equation is selected, calibrated and adopted to represent the materials behaviour. Furthermore, a chiral unit manufactured through EBM is tested with a different tensile and compressive load profiles to investigate its displacement limit by applying large displacements without experiencing permanent deformations, degradation or failures. Finally, crush tests are performed to obtain energy absorption value. The same scenarios explored in the experiments are then analyzed by means of non-linear computational models using ABAQUS commercial software to validate a numerical approach for optimal design and performance prediction.


## REFERENCES


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