Mechanical Behavior of Additively Manufactured Auxetic and Conventional Geometries at Different Test Speeds

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Abstract:

Auxetic structures are considered to be highly promising candidates for energy absorption applications due to their negative Poisson's ratios. In this study, the mechanical behaviour of two different geometrical structures with additive manufacturing at different compression speeds (2 mm/min, 5 mm/min and 10 mm/min) were experimentally investigated. The geometries of the fabricated structures are conventional vertical cell (V) and auxetic re-entrant cell (R). The samples manufactured from Nylon 12 material by means of Selective Laser Sintering (SLS) were subjected to a compression test. The results were then analysed in terms of maximum force, absorbed energy, and specific absorbed energy. The vertical cell specimens showed a single maximum force during the test and the highest mechanical properties were obtained at a compression speed of 5 mm/min. The maximum force, absorbed energy and specific absorbed energy values of this specimen were calculated as 516 N, 2.587 J and 131 J/Kg, respectively. Re-entrant specimens showed maximum force values in two regions due to densification at all three test speeds. Although the maximum force value in the re-entrant specimen was lower than the vertical cell specimen, the absorbed energy value reached approximately 3.7 times compared to the vertical cell specimen. At 10 mm/min test speed, the maximum force in the first region, absorbed energy and specific absorbed energy values during the whole test were calculated as 231 N, 9.486 J and 445 J/kg, respectively. The findings of the compression test indicate that geometrical changes have a substantial impact on the material's capacity for energy absorption.

Keywords:

Additive Manufacturing, Nylon 12, Auxetic, Compression.