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Modelling of anisotropic damage of 3D printed polymers under severe compression

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Additive manufacturing is a new technology of enables the building of 3D objects based on digital models [1-2]. A wide spectrum of processes and technologies of additive manufacturing falls within this definition, among them is the fused filament techniques widly known for processing polymeric feedstock materials [3]. This process is known to generate an anisotropic mechanical behaviour. This study aims at exploring the genuine effect of filament structuring on the anisotropic damage induced by severe compression of acrylonitrile butadiene styrene (ABS). This study combines a numerical and experimental approch. Compression up to densification is undertaken for printed ABS under various printing angles. X-ray µ-tomography imaging is conduted prior and after testing to quantify the amount and extent of generated damage. Finite element computation is attempted to predict the damage mechanism infeered to compression loading under severe conditions. The results show a significant dependance of the mechanical response to the inter-filament layout. Damage is identified to induce shear behaviour under compresion loadingThe varied amount of shearing is directly dependant on the ability to ease the inteer-filament damage during the irreversible straining. Finite element results also show
the prevailing role of pore opening in triggering the damage extension under compression.
This study concludes on the treemndus possibilities offered by fused deposition to tailor mechanical response of polymeric structures if the filament trajectories are appropriately addressed when building 3D technical parts.

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