World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:16, No:07, 2022

Optimization of the Mechanical Performance of Fused Filament Fabrication Parts

Authors : Iván Rivet, Narges Dialami, Miguel Cervera, Michele Chiumenti

Abstract : Process parameters in Additive Manufacturing (AM) play a critical role in the mechanical performance of the final component. In order to find the input configuration that guarantees the optimal performance of the printed part, the process-performance relationship must be found. Fused Filament Fabrication (FFF) is the selected demonstrative AM technology due to its great popularity in the industrial manufacturing world. A material model that considers the different printing patterns present in a FFF part is used. A voxelized mesh is built from the manufacturing toolpaths described in the G-Code file. An Adaptive Mesh Refinement (AMR) based on the octree strategy is used in order to reduce the complexity of the mesh while maintaining its accuracy. High-fidelity and cost-efficient Finite Element (FE) simulations are performed and the influence of key process parameters in the mechanical performance of the component is analyzed. A robust optimization process based on appropriate failure criteria is developed to find the printing direction that leads to the optimal mechanical performance of the component. The Tsai-Wu failure criterion is implemented due to the orthotropy and heterogeneity constitutive nature of FFF components and because of the differences between the strengths in tension and compression. The optimization loop implements a modified version of an Anomaly Detection (AD) algorithm and uses the computed metrics to obtain the optimal printing direction. The developed methodology is verified with a case study on an industrial demonstrator.

Keywords : additive manufacturing, optimization, printing direction, mechanical performance, voxelization
Conference Title : ICAMTFDM 2022 : International Conference on Additive Manufacturing Technologies and Fused Deposition Modelling
Conference Location : Rome, Italy
Conference Dates : July 21-22, 2022