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Experimental and finite element modeling of partial infill patterns for thermoplastic polymer extrusion 3D printed material using elasto-plastic method

Absract

Fused Deposition Modeling is known as one of the 3D printing technology where it used a thermoplastic filament to produce a prototype or a 3D part. FDM will print out the 3D part, layer by layer on the platform of the 3D printer from bottom to top using the extruded molten thermoplastic. However, there is no information about the volume enclosed by the boundary surface of the 3D part by commonly used model data format such as STL file, since the volume enclosed can be completely or partially filled. Therefore, the study and research have been carried out to investigate the strength of the 3D part affected by the design of the infill pattern where three methods being used which are design, experiment and simulation. The 3D parts were designed using CATIA V5 following the ASTM D638 for tensile test and ASTM D695 for compression test. The 3D design was then being printed using the Fused Deposition Modeling (FDM) technique for experimental purposes and to perform the quasi-static test. Furthermore, the 3D printed with infill pattern test data were then being imported to ABAQUS/Explicit software for non-linear finite element analysis using elasto-plastic approach. The best infill patterns that exhibit a better strength after the 100% fill part is the 30% fill Lines pattern. It can be concluded that the average percentage error of stress and strain values between experimental test and simulations in tensile and compression for all specimens is below than 10%.