Investigation on the Effect of Build Orientation and Heat Treatment on Tensile Strength and Fracture Mechanism of FDM 3D Printed PLA

Nanang Fatchurrohman, Nurul Najihah Najlaa Noor Hamdan, Mebrahitom Asmelash Gebremariam, Kushendarsyah Saptaji

1. Faculty of Mechanical and Manufacturing Engineering, Universiti Malaysia Pahang Pekan Malaysia
2. Faculty of Engineering and Technology, Mechanical Engineering Department, Sampoerna , University Jakarta Indonesia
fatchurrohman@ump.edu.my

Abstract:
Three-dimensional (3D) printing is one of the many popular types additive manufacturing. Current FDM product has low tensile strength due to the printing orientation that affect to the low bonding layer by layer inside the material. Furthermore, experimental work of FDM using different printing orientation are still limited. The aim of this investigation is to characterize the effect of build orientation and heat treatment on the mechanical performance of PLA samples manufactured using fused deposition modelling (FDM) - 3D printer. Specimens were fabricated according to ASTM-D638 type IV. The next investigation was to analyse the effect of build orientation and heat treatment on the printed specimens. Tensile tests were carried out to determine the mechanical response of the printed specimens. The highest result for ultimate strength and yield strength achieved by heat-treated on-edge orientation, 47.84 MPa and 43.94 MPa respectively while the highest elastic modulus is untreated upright orientation, 8.96 GPa. The results showed that different orientations effect the behaviour of tensile strength and yield strength of the 3D printed PLA. Heat treatment process effected the layer bonding of the specimen as it strengthens the bonding between the layer. In addition, the results have highlighted different fracture behaviour for the upright orientation, on-edge and flat orientations.

Keywords: FDM; 3D printing; PLA; Build Orientation; Heat Treatment

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