Weibull-Based Statistical Assessment of Layer Thickness Effect on Breaking Strength Variability in 3D-Printed PLA

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Abstract

This study investigates the breaking strength of 3D-printed PLA samples according to the effect of layer thickness. For this purpose, tensile tests were conducted through sample failure, with a particular focus on two values of layer thickness, 200 µm and 280 µm. The other printing parameters, like temperatures, printing speed, and raster angle, were maintained constant. The experimental data were analyzed using the two-parameter Weibull distribution to highlight the variability associated with layer thickness. The obtained results show a significantly low dispersion in both cases. This is reflected in the high values of the Weibull parameter for both layer thicknesses, indicating more predictable failure performance. Despite the slight difference in breaking strength in both cases of layer thickness, the Weibull parameter of samples with 280 µm of layer thickness is largely greater. Regarding the failure mode, the experimental results probably indicate a clear dependence of fracture location on layer thickness, especially for samples with 200 µm, where the failure location appears exclusively near the tangent of the calibrated zone and the fillet. Overall, Weibull analysis proved useful for quantifying reliability and the mechanical performance of 3D-printed PLA components under tensile loading.

Keywords

Weibull distribution, Breaking strength, 3D-printed PLA.