Study the effect of the support structure on surface quality and mechanical properties of PLA part 3D printed by FDM

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Abstract

Statement of the Problem: This study investigates experimentally the effect of support infill angle of the added support in the overhang structures on surface roughness and mechanical properties of 3D printed parts using FDM process. **Methodology & Theoretical Orientation**: Three support infill angle (transverse at 90°, inclined at 45°, axial direction at (0°) and crossed filament by (0°/90°), (45°/-45°) and (0°/45°) are used in three support strategies (line, rectilinear and grid) in the FDM process as it shown in Figure 1, the white regions presented the part and red regions presented the supports as it shown in Figure 1. The surface roughness and flexural properties of the specimens are analyzed and compared as well as the material waste and printing time. **Findings:** line of (0°) support infill angle costs the lightest mass, followed by zigzag and grid, concerning the printing time, Line and Zigzag of the same angle (0°) cost the least time for finishing the printing of all part. For the mechanical behavior of the specimens, (90°) has the highest maximum force value in the combination of line and Zigzag. Followed by Grid support strategy of (0°/45°) in support infill angle. The roughness measurement of each combination showed that the zigzag of (90°) support infill angle had a better surface quality.

Conclusion & Significance: the different of support infill angle led to varied flexural strength and print qualities. Table 1 collects all the results for comparison. In term of printing time, Line support strategy of (0°) is the best option, in term of surface roughness, Line of (90°) is the best choice. There is no definitive rule for selecting the optimum infill angle, because the choice depends on the specific requirements of the final structural in each case.

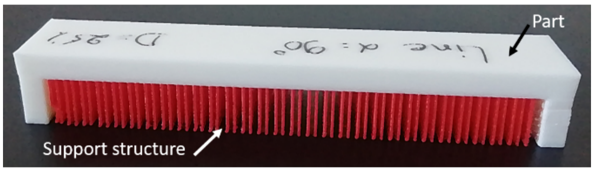


Figure 1. The part and its support.

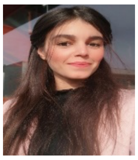
Support strategy	Support infill Angle	Mass of support (g)	Printing time (min)	Max Load (N)	Max displacement (mm)	Flexural stress (MPa)
Line	0	6.6737	105	278.23	7.749	68.7200277
	45	7.0077	115	282.911	7.453	69.8761879
	90	6.9087	118	286.876	7.656	70.8555032
Zigzag	0	7.0514	105	213.14	6.06	52.6434486
	45	7.7777	112	237.19	6.415	58.5835581
	90	7.7471	113	277.79	7.73	68.6113521
Grid	0/90	7.1423	115	211.33	6.297	52.1963967
	45/-45	7.2795	118	154.1	6.141	38.061159
	0/45	7.3702	113	259.66	7.242	64.1334234

Table 1. Printing and bending characteristics of tested parts.

Recent Publications

1. Antar, M. Othmani, K. Zarbane, M. El Oumami, Z. Beidouri, bending behavior of a topologically optimized ABS mesostructures 3D printed by the FDM process: numerical and experimental study, Journal of Achievements in Materials and Manufacturing Engineering 120/2(2023) 66-74.
2. Antar, I., Othmani, M., Zarbane, K., El Oumami, M., & Beidouri, Z. (2022). Topology optimization of a 3D part virtually printed by FDM. Journal of Achievements in Materials and Manufacturing Engineering, 112(1).
3. Antar, I., Othmani, M., Zarbane, K., El Oumami, M., & Beidouri, Z. (2022, November). Numerical Study of Mechanical Behavior of the Topologically Optimized Part Produced Virtually by Fused Deposition Modeling. In Casablanca International Conference on Additive Manufacturing (pp. 115-125). Cham: Springer Nature Switzerland.

Photograph



Biography

Intissar ANTAR, PhD student at Laboratory of Advanced Research on Industrial and Logistic Engineering, National Higher School of Electricity and Mechanics, Hassan II University of Casablanca, Casablanca, Morocco. My research is centered on investigating the behavior of 3D printed structures by the FDM process including topology optimization of these parts.

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