Investigation of Processing Parameters in Waste Materials Management for FDM-3D Printing

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Background

- Fused Deposition Modeling (FDM) is a widely used 3D printing technique for fabricating polymeric materials.
- For materials printing, support structures are needed to print the design provided through a CAD model to the FDM printer.
- The support structures are the waste materials after the fabrication process.

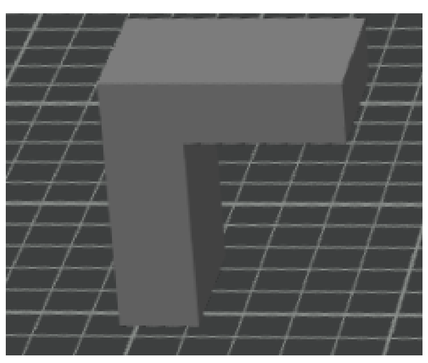
Objectives

- To find the influence of process parameters on material wastage during the fabrication process.

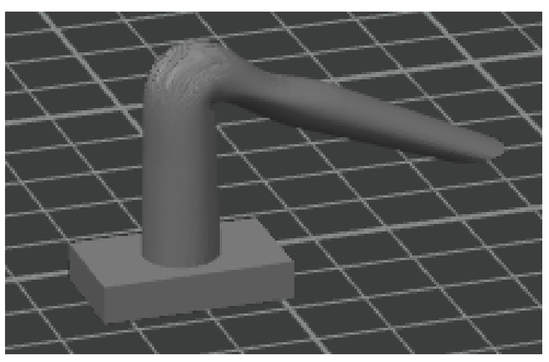
Experimental Method

- The design structures (Design 1, Design 2, and Design 3) were produced using a CAD (Computer-Aided Design) model. The designs require support structures to complete the printing process.
- Polylactic acid (PLA) was chosen as a material for fabricating the design using the FDM printer.
- The model was fed to the FDM printer. Multiple sets of processing parameters were used to fabricate the design structures.
- In the post-processing cycle, the support structures were removed from the sample and weighed using a digital analytical measurement scale.

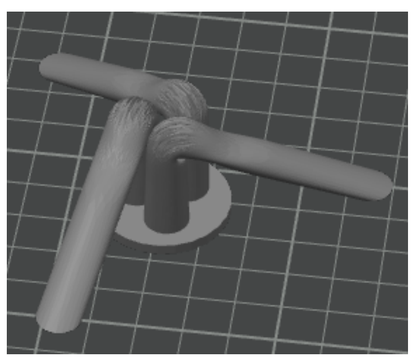
Design.



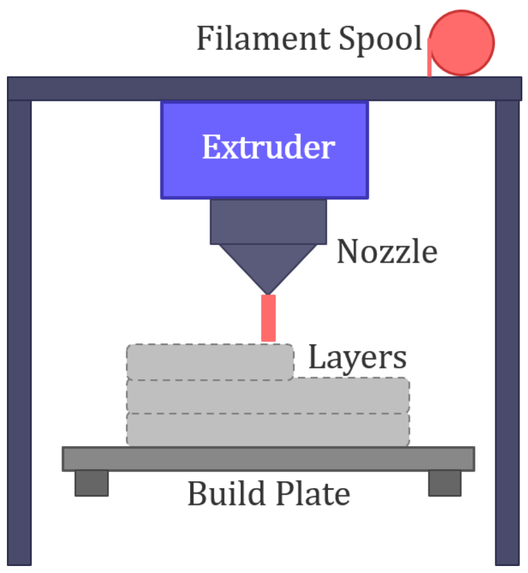
Design 1



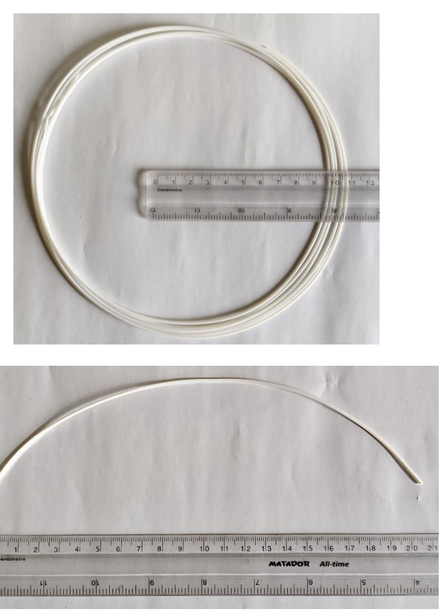
Design 2



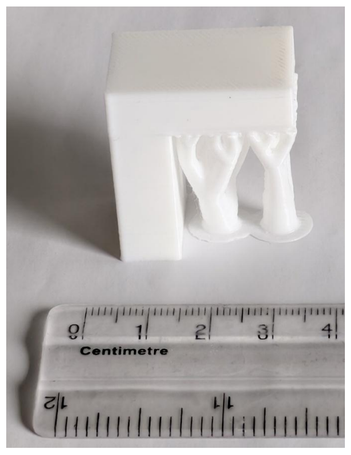
Design 3



FDM Printer



PLA Filament



FDM Printed Design 1, Design 2, and Design 3 with Support

Filament **Result**

FDM Process Parameters

Design 1 Readings	Layer thickness (mm)	Bed Temperature (°C)	Nozzle Temp. (°C)	Print Speed (mm/s)
1	0.08	55	220	100
2	0.16	55	220	100
3	0.24	55	220	100
4	0.32	55	220	100

Design 1 Readings	Layer thickness (mm)	Bed Temperature (°C)	Nozzle Temp. (°C)	Print Speed (mm/s)
1	0.24	55	210	100
2	0.24	55	220	100
3	0.24	55	230	100
4	0.24	55	240	100

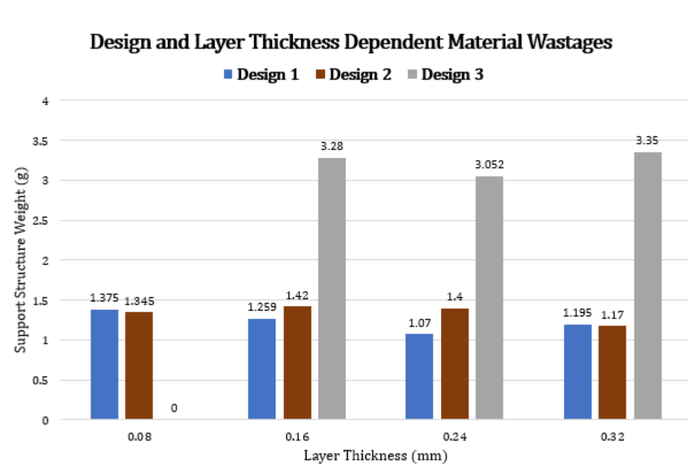
Design 2 Readings	Layer thickness (mm)	Bed Temperature (°C)	Nozzle Temp. (°C)	Print Speed (mm/s)
1	0.08	55	220	100
2	0.16	55	220	100
3	0.24	55	220	100
4	0.32	55	220	100

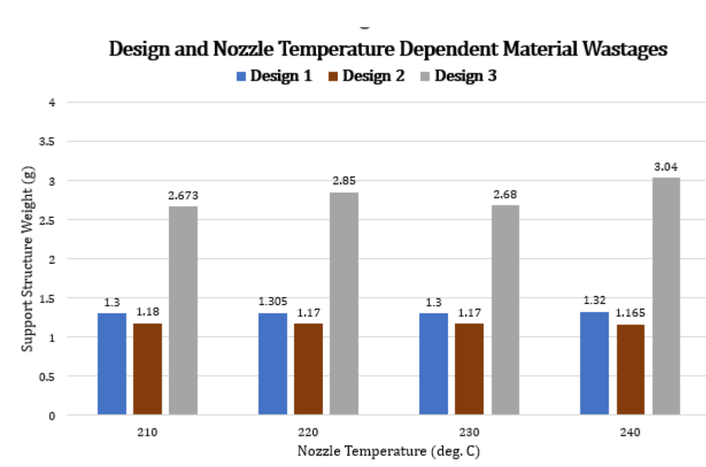
Design 2 Readings	Layer thickness (mm)	Bed Temperature (°C)	Nozzle Temp. (°C)	Print Speed (mm/s)
1	0.24	55	210	100
2	0.24	55	220	100
3	0.24	55	230	100
4	0.24	55	240	100

Design 3 Readings	Layer thickness (mm)	Bed Temperature (°C)	Nozzle Temp. (°C)	Print Speed (mm/s)
1	Defected	55	220	100
2	0.16	55	220	100
3	0.24	55	220	100
4	0.32	55	220	100

Design 3 Readings	Layer thickness (mm)	Bed Temperature (°C)	Nozzle Temp. (°C)	Print Speed (mm/s)
1	0.24	55	210	100
2	0.24	55	220	100
3	0.24	55	230	100
4	0.24	55	240	100

Diameter
$1.76 \pm 0.02\ mm$
Density
$1.2\ g/cm^3$
Best Extruder Temp. (°C)
$190 - 230°C$
Bed Plate Temp.
$45 - 60°C$
Printing Speed
$40 - 100\ mm/s$





Discussion

- It was observed that, depending on process parameters, the waste materials were reduced.
- Between layer thickness and nozzle temperature, the nozzle temperature change produced less waste material.

Acknowledgment

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