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Influence of Manufacturing Parameters on The Mechanical Properties of PLA Components

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Abstract: -. Now a days most of industries are using AM technologies, in this one of the technologies of Fused Deposition Modeling (FDM) is a popular one, by using this technology so many are printing both basic and complex model By using printing parameters parts are printing, in this paper particularly concentrated on Infill, Layer Height and shell thickness are used to print. To get good-quality printed part with less material simultaneously with good strength is important. So, here investigation done on parts printed using selected parameters opted. Finally, after testing the printed parts with higher infill percentage, lower layer thickness and moderate shell thickness is suitable parameters to print the components with good tensile and impact strength compare to all other parameters and also inspection done.

Keywords: *FDM, PLA, Shell Thickness, Infill %, Layer Thickness, Strength*.

I. Introduction

The additive manufacturing process joins materials layer by layer. There are types of this manufacturing techniques are there in that FDM technology is the most popular technology compare to all technology. Now a days most of the industries are using this technology to print the models. A biodegradable material called PLA opted and its properties are displayed in Table 1. Most of the authors done research on printing parameters to print components, one of the researchers found that visco-elastic properties [1] and calculated stress and fracture in impact testing machines and found that strength is max at maximum of infill percentage [2]. Optimizing the parameters using ANOVA to find best combination of parameters. [3] and also evaluated the mechanical properties of compression, tension, and flexure [4]. Not only industrial use for biomedical and civil architect with in less print time and minimal material usage [5]. RSM technique is used find the best parameters [6].Process parameters like infill %, print speed and raster angle got good flexural strength[7]with low production cost and a high strength-to-weight ratio with less voids/flaws.[8,9].

II. Design and Experiment

The Taguchi method is used to improve the quality of products and processes. Improved quality results when a higher level of performance is consistently obtained. The highest possible performance is obtained by determining the optimum combination of design factors. In this project, there is a total of 4 parameters. They are shell thickness, Infill %, layer thickness and temperature. And for every parameter, there is a total of 3 values. They are one low value, intermediate value and high value. So, there are 3 factors and 3 level and last parameters is constant

Table: 1 Manufacturing Parameters for printing specimens.

Selected Printing Parameters	Level-1	Level-2	Level-3
Layer Thickness (LT)	0.1mm	0.2mm	0.3mm
Shell Thickness (ST)	2	4	8
Infill Percentage (IF)	40%	60%	80%
Print Temperature	210^{0}C		

As per ASTM standards designed in 2D and 3D Model Specimens are modelled by using Solid works 2021 as 1& 2and then converted into. stl fil after uploading file into Cura 15.3.0 software opting dynamic parameters displayed in table 1are layer thickness, infill percentage, shell thickness and fixed parameters and all other parameters are constant. After generation of G-Code sent it to Pratham 5.0 3D printer to print specimens. All components are fabricated using 3D Printer and tested on UTM and Impact tests to find its strength and the results are given below.

III. Result and Discussion

By seeing table 2, for tensile experimental result got high strength for high infill percentage& shell thickness of 80% & 0.8 and lower-layer thickness of 0.1mm. Similarly got low strength for infill percentage 40%, low layer thickness and high shell thickness of 0.3mm and 8. For impact experimental result got high strength for infill percentage of 80%- and high layer thickness and moderate shell thickness of 0.3mm and 4. Similarly got low strength for infill percentage 40%, moderate layer thickness and shell thickness of 0.2mm and 4.
Comparing results, **80% infill percentage,** is prominent parameter for both tensile and impact strength.

Table 2. Results of Tensile and Impact

S. No	LH	IF	ST	Tensile Strength	Impact Strength
1	0.1	40	2	14.58	14.69
2	0.1	60	4	17.4	19.25
3	0.1	80	8	**22.73**	23.79
4	0.2	40	4	14.05	**14.57**
5	0.2	60	8	17.07	20.41
6	0.2	80	2	20.36	23.85
7	0.3	40	8	**10**	20.2
8	0.3	60	2	12.58	20.14
9	0.3	80	4	16.09	**24.85**

Table 3. Anova Results of Tensile Strength

Source	DF	Adj SS	Adj MS	F-Value	P-Value
LH	2	47.979	23.9895	83.28	**0.012**
IF	2	71.148	35.5742	123.50	**0.008**
ST	2	1.145	0.5726	1.99	0.335
Error	2	0.576	0.2880		
Total	8	120.849			

Table 4. Anova Results of Impact Strength

Source	DF	Adj SS	Adj MS	F-Value	P-Value
LH	2	10.812	5.406	2.68	0.272
IF	2	88.704	44.352	21.95	**0.044**
ST	2	7.283	3.642	1.80	0.357
Error	2	4.041	2.020		
Total	8	110.84			

IV. Conclusions

From the study the proposed printing parameters namely layer thickness, infill percentage and shell thickness are numeric factor and print temperature as constant factor for printing process on FDM using Polylactic acid, it is found that **infill % parameter** is most significant factor were found that P- Value<= 0.05 for both tensile and impact as shown in table from this it concludes that models that are settled much effective and the experimental responses with in the production range.

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