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A PARAMETRIC ANALYSIS OF CL50WS STUFF PARTS USING DEFINITE LASER SINTERING OPERATION

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Abstract

The main objective of this is paper is to test the mechanical properties like strength and surface roughness of part affected by changing thickness of layer and orientation of the part material during fabrication by Selective Laser Sintering technique. The parts will be tested for tensile strength ,first they will be designed and developed and then analyzed using taguchi approach .

Keywords*-Strength; surface roughness; design; selective laser sintering; taguchi approach.*

INTRODUCTION

Rapid Prototyping (RP) can be defined as a group of techniques which is used to quickly fabricate a scale model of a part or assembly using three-dimensional computer aided design (CAD) data. The term rapid prototyping (RP) refers to a class of technologies that can automatically construct physical models from Computer-Aided Design (CAD) data. RP also used for Rapid manufacturing of 3-D model in various fields where high strength and higher Surface finishing required. Main techniques of rapid prototyping are Stereo Lithograpgy, Selective Laser Sintering(SLS) etc.

I. EXPERIMENTAL SETUP

Specification from material of IGTR, Ahemedabad

Table 1. Material Specification

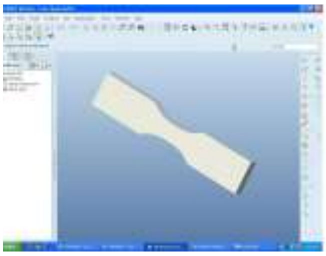
Material Code	Equivalent Code	Material Group	Yield Strength **(N/mm²)**	Tensile Strength **(N/mm²)**	Hardness
CL 50WS	1.2709	Hot work steel	950	1.100	35-48

Figure1 SLS Cusing Machine

The specification of the above machine as shown in figure is as follows

- Technology: Laser Cusing
- Part Built size X,Y,Z: 250mm X 250mm X 250mm
- Layer thickness: 20-80 microns
- Focus Diameter: 70-200 microns
- Orientation: 0-90 degree

Figure 2 Tensile Strength Specimen built on PRO-E



In Experiment parts are modeled on PRO-E and then fabricated by SLS process. Part size of Specimen is 60mm length X 12mm height x 4mm thickness as per ASTM E8/ E8M-11.

II. EXPERIMENTAL DESIGN

Table 2. Orthogonal Array L9(On Minitab Software)

PART NUMBER	LAYER THICKNESS(Microns)	ORIENTATION (Microns)
1	30	0
2	30	15
3	30	30
4	50	0
5	50	15
6	50	30
7	70	0
8	70	15
9	70	30

Table 3. Level of Process Parameter

Factors	Unit	level		
		-1	0	1
Layer Thickness(A)	Micron	30	50	70
Orientation(B)	Degree	0	15	30

Total nine parts will be fabricated by varying layer thickness and orientation and then after tensile test will be carried out for analysis . By such testing different output parameters such as tensile and yield strength and surface roughness is obtained.

The fixed parameter are power (120 watt), speed (600 mm/s) and focus diameter (0.15 mm).

Figure 2 Test Specimen

The surface roughness measurement will be carried out by profile meter named SJ-210.
The yield and tensile strength will be carried by a universal testing machine.

III. RESULT AND ANALYSIS

3.1 Result of Tensile strength, Yield Strength & Surface Roughness

3.1.1 Analysis of Tensile Strength

Table 4. Input and Output Parameters

Part Number	Layer Thickness (microns)	Orientation (degree)	Tensile Strength (N/mm^2)	Yield Point (N/mm^2)	Surface Roughness (Microns)
	Input parameters		Output parameters		
1	30	0	1049.62	935.37	7.87
2		15	1021.42	945.54	10.436
3		30	982.87	910.42	5.475
4	50	0	1001.17	936.39	8.638
5		15	982.77	935.46	9.963
6		30	990.74	931.34	7.451
7	70	0	969.64	947.21	12.386
8		15	961.75	949.55	14.133
9		30	945.98	936.49	5.547

Figure 3 Print Screen of ANOVA Minitab software for Tensile Strength

Figure 4 Graph of Minitab software for Tensile Strength

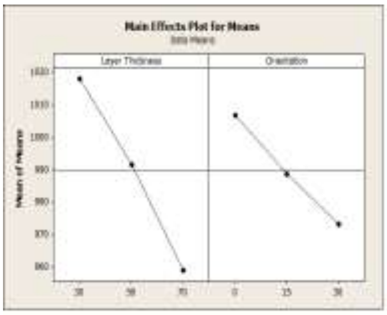


Table 5.Percentage contribution of process parameter for Tensile Strength

Sources of variation	DOF	Sum of squares S	Variance (mean Square)	Variance ratio F	Percenta contribu
Layer Thickness	2	5212.555	2606.2778	10.3453	65.8256
Orientation	2	1698.4653	849.2326	3.3709	21.4487
Error E	4	1007.7051	251.9262	1	12.7255
Total	8	7918.7254			100

Table 5 shows values found out by with the use of developed software Minitab 16 and by manual calculations, so by using this software; the value is as same as calculated value as shown in figure 3. Figure 3, Figure 4 and table 5 shows that as we increase layer thickness and orientation of part for fabrication by SLS, tensile strength is decrease of fabricated part. Graphs shows that layer thickness is 30 microns and 0 degree orientation is best for tensile strength. Table 5 shows the analysis of percentage contribution of individual parameters on Tensile Strength. So Layer Thickness is main affecting parameter on Tensile Strength

3.1.2 Analysis of Yield Strength

Figure 5 Print Screen of ANOVA Minitab software for Yield Strength

Figure 5 Graph of Minitab software for Yield Strength

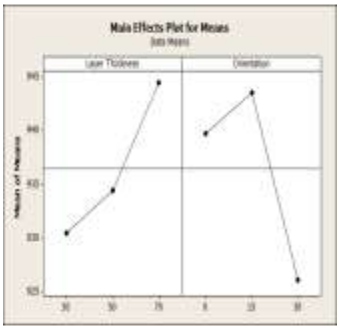


Table 6. Percentage contribution of process parameter for Yield Point

Sources of variation	**DOF**	**Sum of squares S**	**Variance (mean Square)**	**Variance ratio F**	**Percentage contribution P**
Layer Thickness	2	311.2835	155.6417	2.3808	28.9341
Orientation	2	503.0563	251.5281	3.8475	46.7597
Error E	4	261.4923	65.3730	1	24.3060
Total	8	1075.831			100

Table 6 shows the analysis of percentage contribution of individual parameters on Yield Point Strength. The percentage contribution of Layer Thickness is 28.93% and Orientation is 46.75 %.Figure 5 shows the analysis of results for yield point strength and also gives optimum value for yield point strength (output parameter). We saw that Orientation is increasing at some level so Yield strength is increase but after that level Yield Strength decrease. Yield Strength increase with increasing layer thickness.Graph shows that layer thickness of 70 microns and orientation with 15° gives best yield point strength.

3.1.3 Analysis of Variance for Surface Roughness

Figure 6 Print Screen of ANOVA Minitab software for Surface Roughness

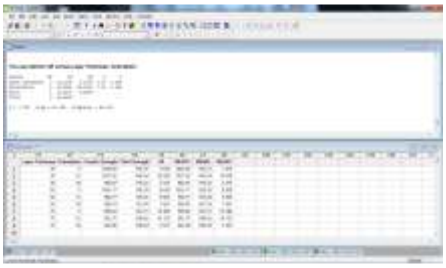


Figure 7 Graph of Minitab software for Surface Roughness

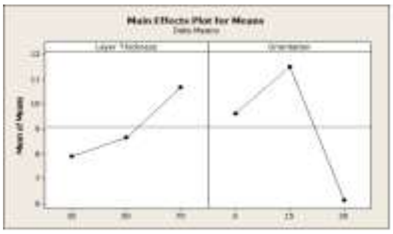


Table 7 Percentage contribution of process parameter for Surface Roughness

Sources of variation	**DOF**	**Sum of squares S**	**Variance (mean Square)**	**Variance ratio F**	**Percentage contribution**
Layer Thickness	2	12.21854	6.10927	1.971189	17.7418
Orientation	2	44.25286	22.12643	7.139213	64.257
Error E	4	12.39713	3.099281	1	18.0011
Total	8	68.86853			100

Above table no.7 shows the analysis of percentage contribution of individual parameters on Surface roughness. The percentage contribution of Layer Thickness is 17.74% and Orientation is 64.25%. Figure 6 shows the analysis of results for surface roughness and also gives optimum value for surface roughness (output parameter). Graph shows that layer thickness of 30 microns and orientation 30 degrees gives best surface roughness.We can get better surface with decrease in layer thickness and with increase in orientation of part as per above graph and table.

IV. Conclusion

From this research it can be concluded that Layer Thickness and Orientation plays an important role in tensile strength, Yield Strength and Surface Roughness of Part fabricated by Selective Laser Sintering Process. In general aspect of obtained results, It can be clearly found that as we increase layer thickness there is decrease in tensile strength.Surface Roughness and Yield Strength increases with increases Layer Thickness.Layer Thickness is main affecting parameter for tensile strength than the Orientation.We saw that the Orientation is main affecting parameter for Yield Strength and Surface Roughness than the Layer Thickness.

V. REFERENCES

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