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EXPERIMENTAL INVESTIGATION AND OPTIMIZATION OF PROCESS PARAMETERS IN FDM PRINTED ABS SAMPLES FOR UAV APPLICATION

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Abstract

Fused deposition modeling (FDM) is an additive manufacturing technique used to fabricate intricate parts in 3D, within the shortest possible time without using tools, dies, fixtures, or human intervention. With the development and application of additive manufacturing technology, the mechanical properties of parts have become more important. The performance of FDM built parts exhibit high dependence on process parameters. The present study focus on the effect of process parameters in the fused deposition modeling of ABS material. The input parameters taken as fill density, print speed, filling shape and layer thickness. Adesign of experiments are conducted based on Taguchi L9 orthogonal array. The output responses are taken as tensile strength and compression strength of test specimen.The current trend in aircraft structural design is to use composite materials as primary structural elements.The main motivation for this work is Comparative research, simply put, is the act of comparing two or more things with a view to discovering something about one or all of the things being compared. This technique often utilizes multiple disciplines in one study. When it comes to method, the majority agreement is that there is no methodology peculiar to comparative research. We are going to perform tests like Tensile on the 3D Printed standard specimens

Key words: Fused deposition modeling, Optimization, Tensile test.

1.Introduction

Since their invention in late 1903 by the Wright brothers', aircrafts have seen colossal improvements in their design, right from their engine to their outer structure and also from being manned airplane to an unmanned one. An Unmanned Air Vehicle (UAV), in simple terms is an aircraft without a human pilot on board. Its flight is controlled either autonomously by computers in the vehicle or under the remote control of a pilot on the ground or in another vehicle. The typical launch and recovery method of an unmanned aircraft is the function of an automatic system or an external operator on the ground. UAV's are usually deployed for the military and special operation applications, such as policing and firefighting and non-military security work such as surveillance of pipelines, aerial photography for mapping, survey and disaster control etc., UAV's are usually preferred for missions that are too dull, dirty or dangerous for manned aircraft.

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2. Experimental Setup and Procedure

2.1 Taguchi Method:

The Taguchi method involves reducing the variation in a process through robust design of experiments. The overall objective of the method is to produce high quality product at low cost to the manufacturer. The Taguchi method was developed by Genichi Taguchi. He developed a method for designing experiments to investigate how different parameters affect the mean and variance of a process performance characteristic that defines how well the process is functioning. The experimental design proposed by Taguchi involves using orthogonal arrays to organize the parameters affecting the process and the levels at which they should be varied. Instead of having to test all possible combinations like the factorial design, the Taguchi method tests pairs of combinations. This allows for the collection of the necessary data to determine which factors most affect the product quality with a minimum amount of experimentation, thus saving time and resources. The Taguchi method is best used when there is an intermediate number of variables (3 to 50), few interactions between variables, and when only a few variables contribute significantly.

2.2 Input Parameters:

Print speed(mm/sec)	60	80	100
Fill density	40	60	80
Layer Thickness (microns)	100	200	300

Table 1 - Input parameters

The Parameters involved in taguchi method in 3D printing:

PRINT SPEED:

It defines the lineal speed of the extruder head during its movements while printing the part.

INFILL:

It allows to vary the properties from the inside infill of the pieces.

(1) Fill density (2) Fill pattern (3) Fill pattern.

LAYER HEIGHT:

It is the thickness of each layer, and it is the step along the vertical axis taken before extruding a new layer atop the previous one. There are several factors that influence how high each layer should be.

The Taguchi method is applied to the parameters table in minitab software for optimization.

Print speed	Fill density	Layer Thickness
60	40	100
60	60	200
60	80	300
80	40	200
80	60	300
80	80	100
100	40	300
100	60	100
100	80	200

Table 2 - Taguchi Optimization Table

2.3 Specimen Preparation

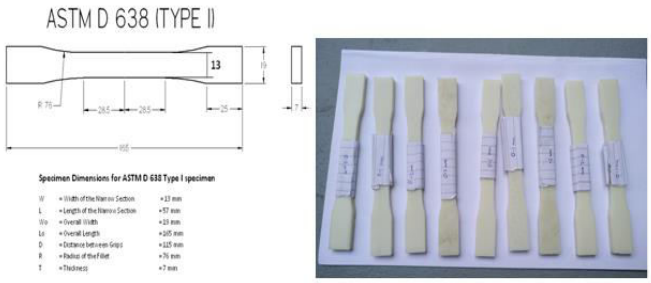

Fig 1 – Specimen Preparation & Before Testing

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Fig 2- Specimen After Testing

3. Results & Discussions

3.1 Tensile test:

The geometrical data input to the computer is taken from the tensile test configuration according to ASTM D 638 standards. The loading and boundary conditions are shown in Figures. The specimen is fixed in the testing machine and the movable jaw is adjusted for the gauge length of 45 mm. The tensile load is gradually applied till the specimen is broken at the average max. Values of ultimate tensile load(N)

Sl. No.	Ultimate Tensile Load(N)	Ultimate Tensile Strenght(MPa)
1	960	10.720
2	1260	14.164
3	2220	24.866
4	1140	13.064
5	1080	12.369
6	1080	12.265
7	1920	22.620
8	1800	21.337
9	1760	20.974

Table 3 - Tensile test results

The high ultimate tensile strength obtained for specimen with infill-80%, speed-100mm/min, layer thickness 0.2mm parameters from this analysis is 24.866 MPa tensile strength.

3.2 TAGUCHI ANALYSIS:

The obtained ultimate tensile strength values are used in minitab software for better optimization then the obtained graphs are shown below.

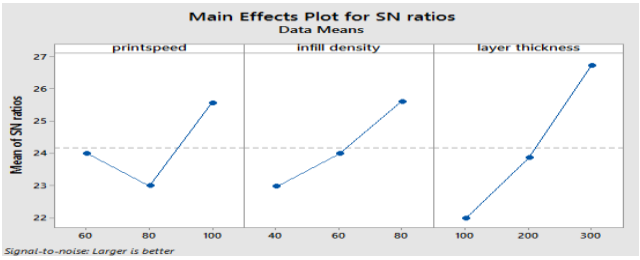

Fig 3 - Taguchi analysis sound-to-noise

4. Conclusions:

Successful design and fabrication of ABS material composite is carried out by FDMtechnique.

The ultimate tensile strength of different specimens are obtained and these ultimate tensile strengths are considered for the taguchi analysis to achieve the optimum process parameters. The achieved optimum parameters are print speed 100 cm/min, infill density 80%, layer thickness 100 m. These parameters gives the maximum ultimate tensile strength.

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