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A Review on Effect of Process Parameters on Mechanical Properties of the FDM Printed ABS Specimens

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ABSTRACT: FDM (fused deposition modelling) is the additive manufacturing technique which is widely used to produce complex shapes and high strength job from below cost materials. ABS and PLA are most common used materials in the FDM. Mechanical properties of the FDM printed part is affected by some process parameters. Most important parameters considered influencing the mechanical strengths of FDM specimens are layer thickness, infill pattern, infill density, raster angle, contour width, air gap. This paper review the effect of process Parameters over the mechanical properties of the FDM printed ABS specimen.

KEYWORDS: Fused deposition method, three dimension printing, tensile, flexural, layer thickness, infill pattern, ABS (acrylonitrile butadiene styrene).

I. INTRODUCTION

Traditional manufacturing method lacks in many aspect in producing geometry of product. Especially, balancing the cost and techniques used to produce complicated geometries. To overcome such limitation of traditional manufacturing. Scientist focusing on investing new manufacturing techniques. In 1984 scientist name Chuck Hull invented 3D printing which is very convenient in producing complicated geometries with such a good accuracy. Even after 36 years of invention most of people in the world is not familiarize with it. Various parameter related to 3D printed technology which affect strength of 3D printed object need to be known. Most commonly use 3D printing process. Fused deposition method which is used to print thermoplastic material is the area where work is need to be done so as to understand FDM process parameter to guide mechanical design.

Some recent work on fused deposition method is reviewed. Tainyun Yon [1] Studies tensile failure of FDM specimen by varying printed angles and layer thickness. Ankita Jai singhsheoron [2] proposed review on current research on FDM printed objects parameter which enhancing part quality, mechanical properties build time etc. V Durga Prasad Rao[3] tested FDM printed tensile specimen for variation FDM parameter like print temperature, layer thickness, infill pattern etc. on poly lactic Acid (PLA). Also Ei EI Cho [4] investigation influence of layer thickness and infill pattern on mechanical strength of PLA material. All current research include PLA as testing material. Also the variation parameters which are selected are not contributing much to help in guiding mechanical design. Also generally researcher focusing only on tensile behavior of FDM printed object.

According to interpretation of knowledge in this field we think that FDM parameters like infill pattern and layer thickness contribute more in guiding mechanical design. Using infill pattern material reducing without reducing strength can be obtained. So we are using infill pattern which are very much common in all slicing software and their geometries are easy to understand. Also the layer thickness variation not only contribute to strength but also the quality of FDM printed object. We are performing tensile, bending and charpy test to understand strength according to respective variation, our aim is to provide data of tensile, bending strengths and strain energy so as manufacturer understand which infill pattern should be used with particular layer thickness to get desired strength & toughness using ABS material which has much advantages compare to other thermoplastic material.

In recent years FDM found variety of applications in the manufacturing industry as the learning tool and to make a prototype of the end-use product. It is essential to know the mechanical behavior of 3D printed product with respect to factors affecting the strength of the specimen.[2] FDM (fused deposition modelling) is most used 3D-printing technique. In the FDM printing first the filament is feeded in between the two extrusion rollers in the extrusion head. ABS and PLA are the most used materials for filament. By the application of heat the filament material is transformed into semi solid state and then extrusion takes place. Layer-by-layer the specimen is manufacture additively. The FDM process and some key features of extrusion is highlighted in the figure [1]

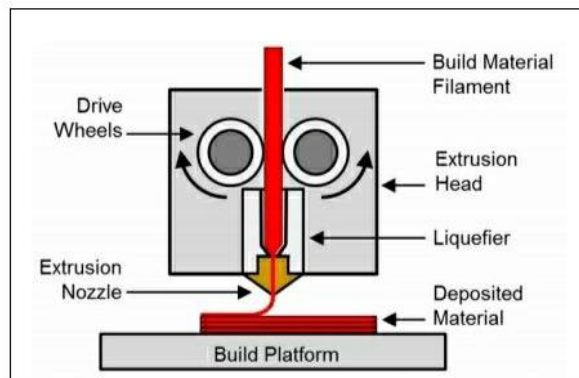


Fig.1 FDM process with key features [1]

The quality, dimensional accuracy and mechanical properties of FDM specimens are deeply affected by the process parameters. So it is necessary to study them in brief [.8] in this paper parameters which are affects the mechanical properties are to be reviewed, these are:

- **Layer Height/thickness** is a thickness of layer placed by nozzle on the bed. Thickness can be controlled by nozzle fig2.1[4]

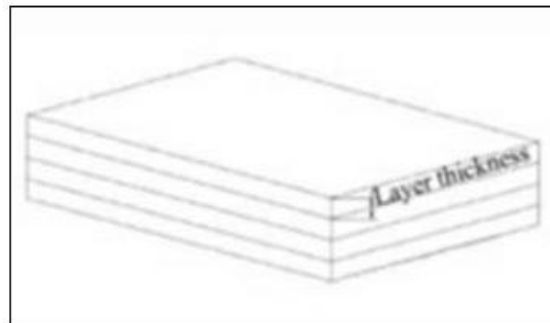


Fig. 2.1

- **Structure/Infill Pattern** is the interior of manufactured specimen.Fig.2.2[2]

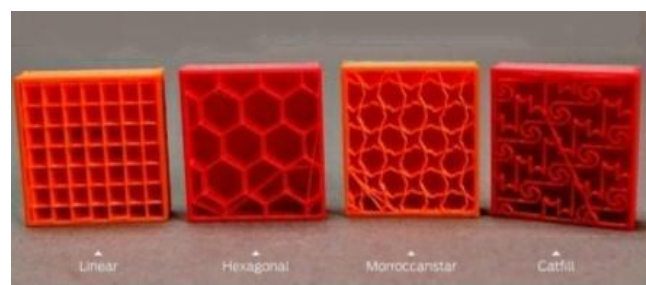


Fig. 2.2

- **Infill Density** means the amount of material used in the specimen. Fig.2.3[2]

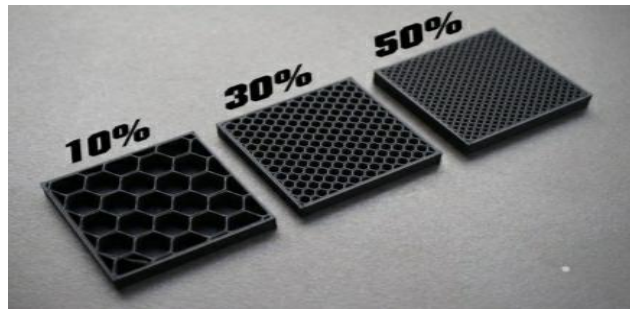


Fig. 2.3

- **Built orientation** means the orientation of the specimen inside the platform with respect to x, y and z Cartesian axis.

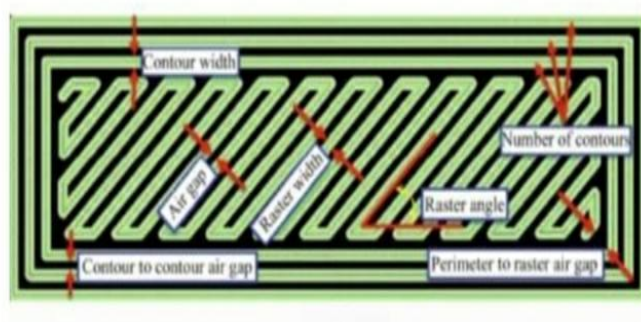


Fig. 2.4

- **Air gap** is the distance between coherent raster tool paths on same layer Fig.2.4[4]
- **Raster angle** is the angle made by raster with respect to horizontal. Raster angle varies between 0 to 90. Fig.2.4[4]
- **Contour width** is the width of contour tool. Fig.2.4[4]

II. CONCLUSION

In this paper, the effect of various process parameters over the mechanical properties of the FDM printed ABS specimen were studied. By this study we can say that, mechanical properties of FDM Printed specimen deeply affects by the variations in the process parameters. The results in FDM shows that,

- Honeycomb pattern with maximum density has the superior tensile and flexural strength.
- Tensile strength and flexural strength decrease with decreasing infill density
- For manufacturing the layer thickness of the ABS specimen must be kept and small as possible in order to get higher mechanical strengths.
- For the raster angle [0/90] mechanical strength of ABS printed specimen is higher.

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