Dimensional Analysis Of 3D Printed Parts

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Abstract- *The main aim of this experiment is to primary focusing on getting optimum temperature of extruder as well as optimum print speed at which the dimensional accuracy of output product is obtained. In 3D printing operation the temperature of extruder and Print speed these are most important input parameters which affect the output characteristic of product. Improvement in 3D printing process efficiency can be obtained by optimization of temperature of extruder and print speed as input parameters which lead to required or desired output with acceptable variation in dimensional values.*

In this experimental process the selected temperature of extruder and print speed are as major input parameters. The work material which selected is Acrylonitrile butadiene styrene (ABS). In this project for the 3D printing operations the extruder temperature is kept in between 190 - 240°C also the print speed is consider in between 40-60 mm/sec. By this experiment numerous comparisons between output products at different extruder temperature and print speed then it shows specific dimensional value of best output product as compare to other.

Keywords- Acrylonitrile butadiene styrene, Extruder Temperature, Print speed, Dimensional accuracy.

I. INTRODUCTION

3D printing operations have been the core of the Manufacturing industries for rapid prototyping since early 2000. Rapid prototyping with 3D printing is the quick, easy, cost effective way to turn great ideas into successful products. Additive Manufacturing (AM) is an appropriate name to describe the technologies that build 3D objects by adding layer-upon-layer of material, whether the material is plastic, metal, concrete. Additive Manufacturing application is limitless.

Early use of Additive Manufacturing in the form of Rapid Prototyping focused on preproduction visualization models. Process oriented involving use of thermoplastic (polymer that changes to a liquid upon the application of heat and solidifies to a solid when cooled) materials injected through indexing nozzles onto a platform. The nozzles trace the cross-section pattern for each particular layer with the thermoplastic material hardening prior to the application of the next layer. The process repeats until the build or model is completed theory

The Additive Manufacturing or 3D printing process is programmed by print speed, feed rate, Extruder Temperature, Heat bed Temperature which are frequently determine best on the product experience. However the product characteristic & quality of product are not guaranteed to be acceptable. Therefore, the optimum conditions have to be accomplished. The extruder Temperature will affect the performance of printing process. Optimum input extruder temperature parameter will give best dimensional accuracy.

In Modern industries the goal is to prototype any object at a low cost, high quality product in short time.3D printing system were employed for achieving low processing time for making of visualize models, complicated design parts etc.

Work piece Material :-

In this experiment the Acrylonitrile butadiene styrene (ABS) is selected as a material. It is a common thermoplastic polymer typically used for injection molding applications. This engineering plastic is popular due to its low production cost and the ease with which the material is machined by plastic manufacturers.

Nozzle Material :-

Nozzles are made from Some of the most popular materials which are brass and steel, but there are also other options. Brass is used as nozzle material because brass having some properties like it is a good thermal conductor, which means it is easy to maintain a consistent extrusion temperature. Brass is also corrosion resistant. This helps lengthen the lifespan of the nozzle. Brass is a reasonably durable metal as well. It is a soft metal, but can hold up very well when non-abrasive filaments are used.

Heatbed Material :-

Aluminium PCB is used as a heatbed material. Aluminum PCBs consist of a metal-based, copper-clad laminate that delivers high performance, including excellent

thermal conductivity and electrical insulation. High temperatures are the cause of heavy damage to electronics. Aluminum conducts and transfers heat away from critical parts to minimize damage to the printed circuit board. Aluminum is stronger and more durable than base materials like ceramic and fiberglass. It is very sturdy, and reduces accidental breakages that can occur throughout the manufacturing process, and during handling and everyday use. Considering its durability, aluminum is very lightweight. It adds strength and resilience to PCBs without adding additional weight.

II. RESEARCH & TECHNICLE WORK

Literature Survey:

Richard J. Jackson et al. (2018)-They conducted an experiment on 3d printing of asphalt and its effect on mechanical properties. The properties of the 3d printed asphalt were studied and compared with the cast asphalt. New type of extruder was used in the process and influencing input parameter were print speed, z-offset, layer thickness, extruder temperature. Work material used was asphalt and the process to be considered was FDM. Rotation speed of the auger screw was the influencing factor for the 3dprinting of asphalt.

Naotaka Nakamura et al. (2018)-They conducted experiment on bending of sheet metals using plastic tools with the 3d printer. They compared the plastic tools with the steel tools and the dimensional accuracy was examined. Work material used was poly-lactic acid polymer for the printing of plastic tools. Strength of the material was the influencing factor in this.

U. Hari Krishan et al. (2018)-They conducted an experiment on 3d printing of full complement bearings using fdm. They studied the fabrication of moving assembly of full complement bearings in single steps by using fdm. Work materials used as abs, pla andnylon-66. Surface roughness and hardness of the materials were the influencing factor.

Khaled G. Mostafa et al. (2018)-They conducted an experiment on strength to cost ratio analysis of nylon 12 3d printer parts by fdm. They studied an experimental design methodology based on taguci design of experiment. The main parameters included in this study are material infill density, number of contours, layer thickness.

L.G. Blok et al. (2018)-They conducted an comparative experiment on 3d printing of carbon fiber processing parameters dictating the final part quality work material used ABS and PLA along with the comparative CRPF. Sorin Cristian Albu (2018)[6]They conducted an experiment on development on the production of a new type of extruder use din additive manufacturing in fdm. Using different software an extruder was designed and printed by fdm technology, after which it was cast.

Madhuri Chaudhari et al. (2018)-They conducted an experiment on comparative study of part characteristics built using additive manufacturing .the parameter selected in this experiment as response variables were layer thickness infill density part.

Kira Pusch et al. (2018)-They conducted on experiment on development of large volume syringe pump .extruder for desktop 3d printer. An all open source 3d printer compatible LVE was developed at low cost for printing with large volumes.

Paolo Minetola et al. (2018)-They conducted an experiment on the use of self-replicated parts forts for improving the design and the accuracy of a low cost 3d printed objects was compared with the modified printer and the original printer.

Tao Peng and Fei Yan (2018)-They conducted an experiment on dual objective analysis for desktop fdm printer. Energy consumption and surface roughness. The parameter considered in this experiment are layer thickness printing path, infill ratio, build orientation work material used in this experiment was PLA.

A.P.Valerga et al. (2017)-They conducted a preliminary study of PLA wire color effects on geometric characteristics of parts manufacture by the roughness and geometrical deviation due to color were studied in this experiment.

K. Gnanasekaran et al. (2017)-They have conducted an experiment of 3d printing CNT and graphene based polymer nano composition by FDM. They have shown the preparation, filament extrusion and 3d printing of CNT and graphene based conductive polymer nano composites into functional 3d model structure and PBT was using as base polymer as in fdm.

L.M.Galantucci et al. (2015)-They have conducted an experiment on comparison between industrial RP machines and 3d open source home printer. They studied the optimization of process parameters such as deposition velocity, layer thickness, and Speed movement. Work material used was ABS a thermoplastic polymer. Speed movement was the influencing factor.

V.Jaiganesh et al. (2014)-They conducted an experiment on rapid prototyping machines. They studied the rapid prototyping processes for the manufacturing of poly methyl methacrylate cam shaft. Conventional cast iron. Material and PMMM material

III. EXPERIMENTAL PARAMETERS

The process parameters are to be selected on the basis of 3D printing operations and the material characteristics. The extruder temperature and print speed is the major input parameters used in this experiment.

Selection Of Print Speed-

The print speed has a great influence on the quality of product. Improvement in accuracy can be obtained by maintaining proper print speed. In this Experiment a 3D printer is used which have minimum print speed 40mm/sec & maximum print speed 60mm/sec.

Selection Of Layer thickness-

Layer thickness is one of the important factors to consider when implementing any 3D printing approach. Change in layer thickness can give various effective qualities. In this experiment selected layer thickness is 0.2mm & the first layer on the hot bed is 0.3mm.

Selection of Heat Bed Temperature-

The heat bed temperature has main influence on the base layer in any prototype. The selected heat bed temperature is at 75°C.

Selection of Extruder Temperature-

The Extruder Temperature has influence on the strength and quality of product. Improvement in product accuracy can be obtained by maintaining a proper extruder temperature. In this experiment the extruder temperature is kept between minimum 190°C & Maximum temperature is 240°C.

No of parts	Extruder Temperature	Desired Size	Output
1	190	25	25.185
2	200	25	25.343
3	210	25	25.232
4	220	25	25.467
5	230	25	25.022
6	240	25	25.344

Table1: Extruder Temperature

No of parts	Print speed	Desired size	Output
1	40	10	10.148
2	44	10	10.469
3	48	10	10.222
4	52	10	10.341
5	56	10	10.496
6	60	10	10.487

Table2: Print Speed

Fig2: Digital Micrometer Screw Gauge

IV. EXPERIMENT PROCEDURE

In this Experiment a desired value of experimental parts is 10mm for print speed parts and 25mm for extruder temperature parts. All parts measured by using digital Vernier calliper and digital Micrometer screw gauge.

Consider, a part made on 40mm/sec print speed which having desired value is 10mm but when it measured by Micrometer screw gauge it shown dimensional error of positive 0.148mm, This procedure is conducted on varies print speeds like 44,48,52,56,60 mm/sec.

Consider, a part made on 190°C Extruder temperature which having desired value is 25mm but when it measured by digital Vernier calliper it shown dimensional error of positive 0.191mm, This procedure is conducted on varies extruder temperature like 200,210,220,230,240°C.

Calculating difference between desired value and output value these values shown the error in total dimension .by finding errors at all three planes and then takes its average values. By using this value it gives best point of print speed and extruder temperature which improves accuracy.

By doing all the calculations and getting some experimental outputs as values the tables are made as below. That table includes print speed, desired value (A), output value (x,y,z plane), error values at all planes(X,Y,Z plane), average value of error.

Using above table values it gives values for graphs. Because of that graph it gives results as best value for print speed and extruder temperature.

Result

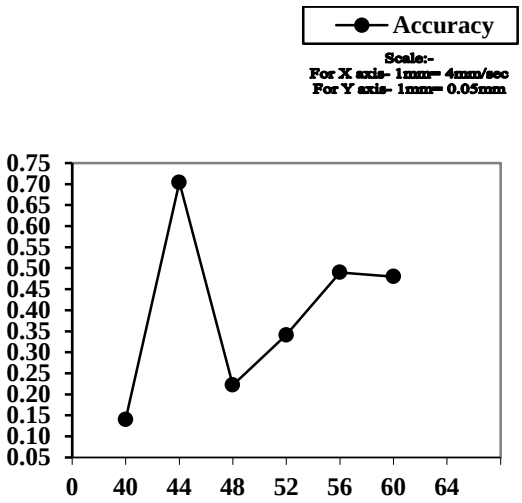

Fig3: Print Speed Experiment

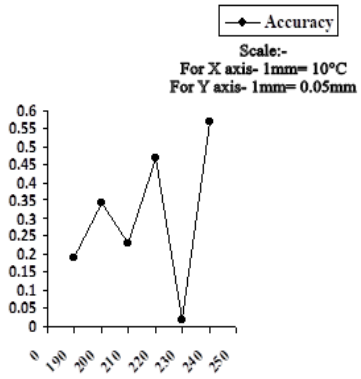

Fig 4: Extruder Temprature

V. CONCLUSION

The Experiment allows learn an easy way to improve the Dimensional accuracy of 3D printed parts by varying Extruder temperature and print speed. It allows print a new piece having less error than before, which involves in direct improvement of printing accuracy.

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