IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
ISSN(e) : 2278-1684, ISSN(p) : 2320–334X, PP : 01-06
www.iosrjournals.org

Development of Mechanical Components by Additive Manufacturing & Study of Material Characteristics

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Abstract: *Additive manufacturing technology is helpful and productive technique for future industrialization. Which will also help in prototyping of the mechanical parts for effective teaching and understanding of the curriculum. The 3D printer parts are assembled and fabricated in order to know the different parts, working and processes of the 3D printing, and different machine handling and operating procedure and also we will design the mechanical parts. Rather than that we also work on the material characteristics of the Additive manufacturing filaments by testing of the filament for better understanding of the different properties of the filaments such as strength, tensile and compression properties and to compare the results obtained after solving problems of Prototyping model by both Standard object and printed component obtain results of designing and testing, which will ensure the use of Additive manufacturing in future aspects.*

Keywords: *Additive Manufacturing, Additive Manufacturing Working and Processes, 3D Printing Material Characteristics.*

I. Introduction

The evolution of ADDITIVE MANUFACTURING (rapid prototyping. 3d printing free form fabrication) has changed the face of direct, digital technologies for the rapid production of models, prototypes, patterns, and fit & functional parts, since its introduction, AM technology has changed design, engineering, and manufacturing processes within the aerospace, automotive, electrical & electronics, consumer industries, biomedical and dental devices & implants. Due to wide applications, rapid prototyping technology has become a revolutionary field in manufacturing. Additive manufacturing will be extensively help for future and smart industrialization. Due to 3d design and material characteristics of the 3d filaments.

Additive manufacturing also 3d printer works under Fused Deposition Modeling (FDM) technology as the layer by-layer fabrication of three-dimensional physical models directly from a computer-aided design (CAD) data.

The material which is operated on the machine such as Acrylonitrile butadiene styrene (ABS), Polylactic acid (PLA), Carbon Fibre Filled (PLA Carbon fibre), and Wood filled (PLA Wood) will be tested on the basis of strength, tensile, compression, hardness etc. Which will provide the information of the future use of the materials.

II. Literature Survey

The authors proposed the business markets look for up- to-date manufacturing technologies to find a quick response for high demands of variability, efficient supply chain, and optimized energy consumption. As a solution, Industry 4.0 uses the benefits of the integration of modern manufacturing technologies and information systems to promote production capabilities. In this context, smart manufacturing improves long-term competitiveness by optimizing labor, energy, and material to produce a high- quality product, and find a rapid response for variation in market demands and delivery time, smart factories represent a new generation of the production system in the concepts of industry and smart manufacturing and support advanced technologies such as computerization manufacturing, cyber-physical systems (CPS), big data, internet of things (IoT), cloud computing, and automated and robotic systems. [1]

Additive manufacturing processes take the information from a computer-aided design (CAD) file that is later converted to a stereo lithography (STL) file. In this process, the drawing made in the CAD software is approximated by triangles and sliced containing the information of each layer that is going to be printed. There is a discussion of the relevant additive manufacturing processes and their applications. The aerospace industry employs them because of the possibility of manufacturing lighter structures to reduce weight. Additive manufacturing is transforming the practice of medicine and making work easier for architects. Studies are reviewed which were about the strength of products made in additive manufacturing processes. The accuracy needs improvement to eliminate the necessity of a finishing process. The continuous and increasing growth

experienced since the early days and the successful results up to the present time allow for optimism that additive manufacturing has a significant place in the future of manufacturing [2]

3D technology utilizes a print head to lay down raw materials in successive layers to fabricate a three-dimensional object. Testing of the printed automotive prototypes will be executed using the different technologies offered by Object 3D printing manufacturers. These casestudies include fabrication, a visionary design for a high-rise product of prototype. The original contribution of this research is in the primary field survey of practices and emerging trends within the construction and parallel industries. Original contributions are also made in the synthesis of selected practices identified from literature review and the field surveys to form novel design and construction methodologies. These methodologies have been tested through the design of unique architectural projects focused on fabrication using construction 3D printing. [3]

III. Methodology

The fig. 1 depicts the disassembled image of 3D printer. The 3D printer Creality Ender 3 is assembled and work on FDM printing technology. It has the maximum build volume as 220 X 220 X 225 mm and has the standard nozzle diameter of 0.4 mm. the different parts such as extruder, cooler, printing bed, stepper motors are being assembled and gives the overall architecture of 3D printer.

Fig. 1. Image of Disassembled 3D printer

Before the main working starts the 3D printer setup is to be completed such as leveling of bed surface and filament loading and unloading. The machine bed is levelled with the small piece of paper passing between the extruder and bed with adequate amount of resistance offered by the extruder, the bed knobs are used to level the surface by turning clockwise to adjust the positive vertical height and anticlockwise for negative vertical height. The loading of the filament is done by pressing and holding the extruder lever. Continue feeding until the filament comes out of nozzle and for unloading pre heat the extruder and then pull out the exiting filament.
Next the preparation of the 3D component in Additive manufacturing is to be established CAD software's such as CREO, CURA, Solid edge, solid works etc.

Steps for Designing and Processing of the Components in CAD:

- Firstly, to design the mechanical components the software PTC CREO 3.0 is used CREO application serves unique purpose of product development. Hence CREO software can handle every aspect of product design like concept development, designing and analysis.
- Select the 'new' plane and then click on 'part' to prepare the solid component lastly click on 'solid', click on 'OK' to continue to next step.

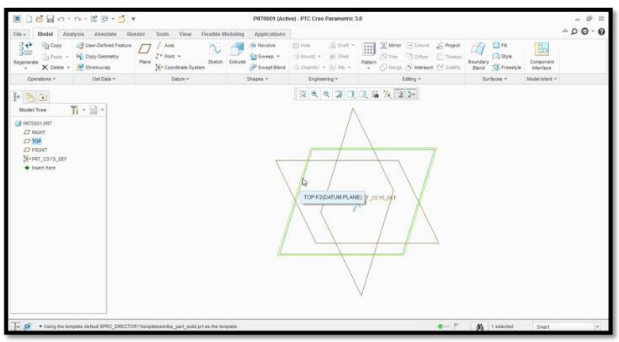

Fig 2 Image of Creo application Step 3

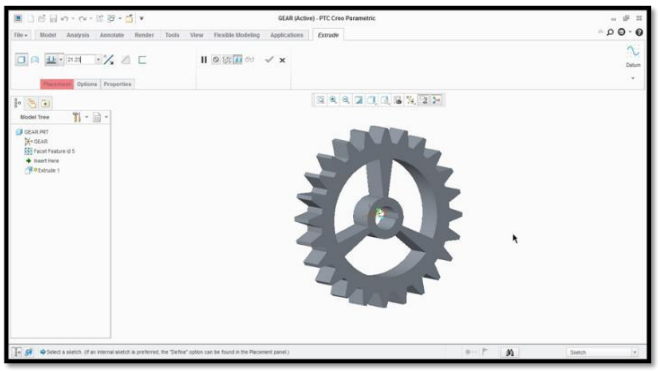

Fig 3 Image of Creo application Step 4

- After opening of the main screen of the Creo select the datum plane for the component to be designed by clicking on 'plane' option.
- Select the 'Sketch' option and sketch the components using tools on the above tool bar and then click on the 'Extrude' and provide the required thickness.
- After completion of the designing of component then save the file 'save as' as the STL or as .OBC file in PTC CREO 3.0 and open the saved file in 3D printer software Ultimaker Cura software.
- There are three options on the display screen (Prepare/Preview/Monitor), select the 'Prepare' options and provide the filament material (PLA/ABS) to be used for additive manufacturing of the mechanical component and next, select the

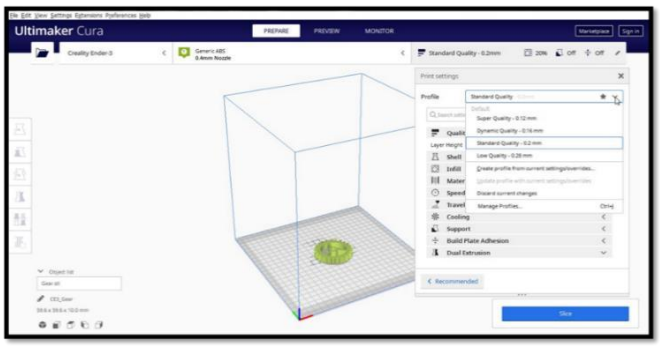

Fig 4 Image of Cura application Step 8

default extruder nozzle size.

- For changing of the printing settings from low to high or high to low quality respectively is done in the 'Dynamic profile' dialogue box.

We can calibrate low to super quality of the printing component, as low quality will have poor finish and super quality will have fine finish on the component.

- From the same 'Dynamic profile' setting dialogue box we need to change the temperature required for the different filament for 3D printing.
- There are some of the advanced setting in which Ultimaker Cura allow us to prefer for the setting of the component printing on the machine.

Some advanced settings are: Retractions, Shell, Travel, Cooling, Supportbuild Plate Adhesion, and Duel Extrusion.

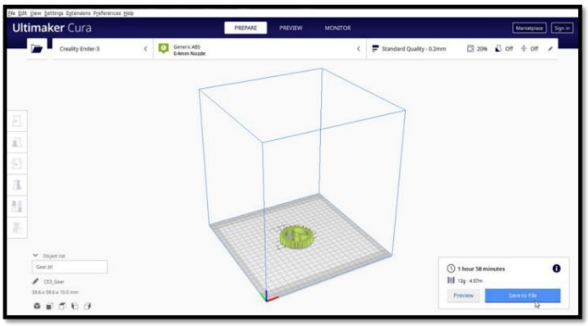

Fig 5 Image of Cura application Step 9

IV. Working

There are many technologies for the Additive manufacturing most likely and easy is Fused deposition modelling (FDM) technique. In this type of 3D printing, the material such as PLA, ABS etc. are being melted in the extruder head of the printer at certain temperature of respective materials. This melted material is laid down by the extruder on the printing bed, layer by layer to form a 3D model and each layer fuses with previous layer as the temperature decreases.

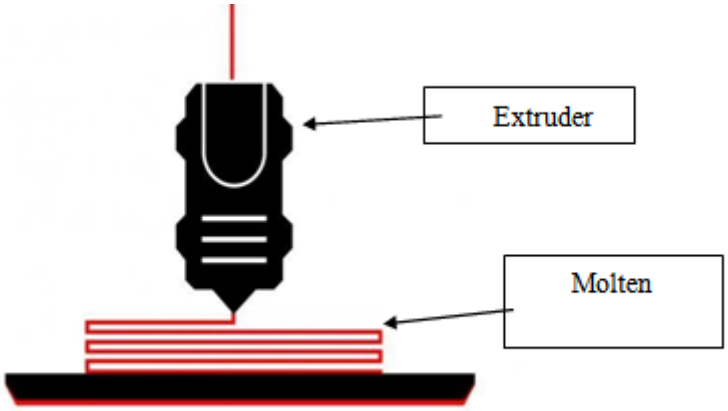

Fig 6 Image of working principle

The precision of this printing technology depends on the quality of the motors that controls the position of the head of the extruder to bed surface. Smoothness of the products depends on the filaments which is built layer by layer.

In FDM technique extruder heads can print in a soluble support material that dissolves when immersed in certain chemicals and multiple extruder heads also allow FDM printers to print in multiple colors or materials, expanding their capabilities.

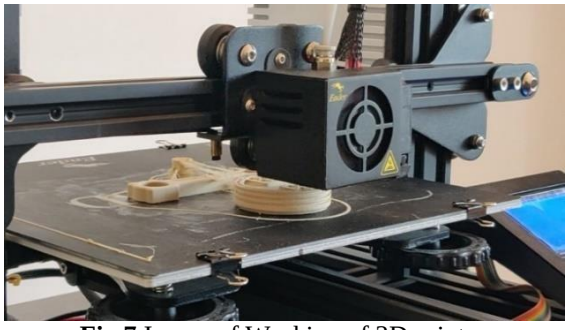

Fig 7 Image of Working of 3D printer

V. Testing of Strength of the Filament Materials according to infill pattern

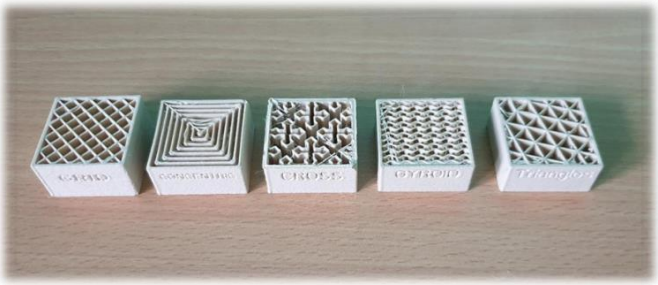

Fig 8 Image of different infill patterns

The Testing of the strength of different filaments basted on the infill entity is one of the methods to know the strength of the material. The test is known as hoke test, a hook is made up of different materials and with different infill patterns and provided the hook to lift the weight and the weight is increased until the hook

gets snapped. The higher the weightlifting capacity is the higher strength of material depending on different infill pattern and entity.

There are many types of infill pattern as shown in the fig 8 they are: Grid, Cross, Gyroid, Triangular and many more which provide the strength to the Additive Manufacturing components.

VI. Results and Final output

The final output of designing of mechanical component and manufacturing it through Additive Manufacturing is provided by the good quality compared to conventional manufacturing and required less time for building a prototype of the mechanical components.

These mechanical components produced are designed and has the references of the respective original mechanical components. These prototyping of the mechanical parts provides the scalable models to effective understanding of the curriculum and the working/processes of Additive Manufacturing.

VII. Stroke Engine Model with Valves:

The 4-stroke engine model is the prototype model of new generation engine provided with two valves and one cylinder. The moment of this prototype engine model is given by two supportive gears with lever as shown in above figure which allows the clear working of the 4-stroke engine model

Fig 9 Images of 4 stroke engine prototype

- **Differential assembly with Propeller Shaft:**

This Differential assembly is designed and produced from three types of material filaments black carbon fibre added, white ABS and Florescent ABS. provide with the design of the propeller shaft, which shows the working example of the differential in the automobile.

Fig 10 Images of Differential assembly

- **Rack and Pinion Steering Mechanism:**

The Rack and pinion mechanism prototype of early automobile sector is designed with white ABS and black carbon fibre filled ABS material. Which provides the better understanding of the steering mechanisms of the automobile.

Fig 11 Images of Rack &Pinion Steering Mechanism

Many such prototypes are being prepared such as kinematic links, Crank and slotted lever mechanism, radial engines etc.

VIII. Conclusion

The results obtained by Additive Manufacturing, 3D printing technologies are welcome within the part business as a result to manufacture lighter structures to cut back weight, that is the common goal of craft and satellite designers. within the automotive business, 3D printing is advantageous in reproducing difficult-to-find elements, as an example, elements for traditional cars. Additive Manufacturing is reworking the observe of medicine; currently it is attainable to own a definite model of a bone before a surgery and therefore the risk of making associate degree correct transplant. Additive manufacturing is creating work easier for architects, Agency currently will print the 3D models of no matter advanced form for a civil project they need in mind. additionally, studies are reviewed that were regarding the strength of product created in additive producing processes. The accuracy desires improvement to eliminate the need of a finishing method and to be ready to manufacture elements that need the absolute best levels of preciseness. In this project we attain the additive manufacturing product will be concluded as below

The results obtained in all type of testing of material methods are equal in every way.

To understand the working and processes of additive manufacturing of 3D printer for advance study of the subject.

To solve the mechanical requirements of the 3D printer faced during the time of fabrications of the printer.

Avail the study of all Additive manufacturing processes and study of filament materials for the effective knowledge in the individual and institute.

References

[1]. Additive Manufacturing in Smart Factory Industrial
[2]. A Review MehrshadMehrpouya, Amir Dehghanghadikolaei, BehzadFotovvati, AlirezaVosooghnia, Sattar S. Emamian and Annamaria Gisario Manuraj Sahu (et.al): Analysis of heat transfer from fins using finite difference method. ISSN 2454-132X. 2018
[3]. An investigation into 3D printing of fibre reinforced thermoplastic composites L.G.Blok M.L.LonganaH.YuB. K.S.Woods Rakesh Kumar: Analysis of one dimensional inverse heat conduction problem: a review. ISSN 2231-6477, vol 2, 2012
[4]. A Review of Additive Manufacturing:
[5]. Kaufui V. Wong and Aldo Hernandez ISSN 2231-6477, vol 2, Iss- 3, 2012
[6]. Application of Additive Manufacturing on Three Dimensional Printing :
[7]. Alok Kumar Chandrakar, Amit Kachhawaha M. Tech Scholar, C.V.R.U., Kota. Bilaspur (C.G.) India
[8]. Assistant Professor, .Department of Mechanical Engineering,
[9]. C.V.RU, Kota Bilaspur (C.G.) India
[10]. Additive Manufacturing Technologies & Rapid Prototyping to Direct Digital: Gibson l D. W. Rosen l B. Stucker.
[11]. Introduction to Additive Manufacturing technology: European powder metallurgy association