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COMPARATIVE ANALYSIS ON COMPRESSIVE STRENGTH OF PVC COUPLING WITH 3D PRINTED PLA COUPLING

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ABSTRACT - In the world of emergent technology, 3D printing has been replaced the entire industrialized firm/system with its improved version of building parts layer by layer using additive approach and new trends. A wide study has been carried out for comparing it with conventional manufacturing technique intended designed for production of components, compound objects for hundreds of different applications. 3D printing technology is extremely adaptable and quick process, speed up innovation and reduce energy usage, minimize material and compress supply chains. This paper also describes the feed mechanism and process related information, sustaining material, software used in 3D printer and some recent developments on 3D printing technology. Rapid manufacturing defined as the direct production of completed goods from a rapid prototyping device remains at present more a goal than reality for industry. The application of 3D printing technologies, however, promises to combine rapid prototyping capabilities with the high-volume output of traditional developed. Proponents consider that these processes may soon guide to the too less production of finished goods and the mass production of independently modified parts.

Keywords- 3D printing; Rapid prototyping; Fused Deposition Modeling; Additive manufacturing; Polylactic Acid(PLA); Polyvinyl chloride(PVC).

1. INTRODUCTION

In the current era a new technology has proven to be very promising and is called rapid prototyping also called as additive manufacturing technology. This technology has been appreciably enhanced and has developed gradually into a helpful tool for several fields like researchers, manufacturers, designers, engineers and Scientists. 3D printing is the method of manufacturing a component with material layer by layer deposition in 3D formations. The difference between conventional approach and 3D printing is that the 3d printer involves additive approach but most of the traditional manufacturing processes involve subtractive approach.

3D printing method allows layer-by-layer build-up of a part by the deposition of thermoplastic material through a nozzle. The method allows for difficult shapes to be made with a degree of design freedom unattainable with traditional manufacturing methods.

One of the common materials utilized by material extrusion 3D printing is Acrylonitrile Butadiene Styrene (ABS) and Polylactic Acid (PLA). Additive manufacturing, now more commonly referred to as 3D printing (3DP), has gained recognition and popularity in manufacturing, educational, and home-use settings. Material extrusion 3D printers are similar in function to the fused deposition modeling (FDM) method and are the most common type of equipment used in 3D Printing and rely on a process by which a polymeric filament is extruded and deposited in a layer-by-layer manner until a 3D object is created. Parts are made-up from a thermoplastic polymer that has rubbery, tacky phase above the glass transition temperature and facilitates fusion between succeeding layers.

A. FDM process

The principle of fused deposition modeling process is based on layer by layer manufacturing technique.

It is a solid based rapid prototyping system.

Components of FDM system –

The fused deposition modeling system consists of following components:

1. Pre-processing computer
2. FDM system computer
3. Control unit

4. FDM head with dual tip nozzle
5. Platform heating system
6. Build platform

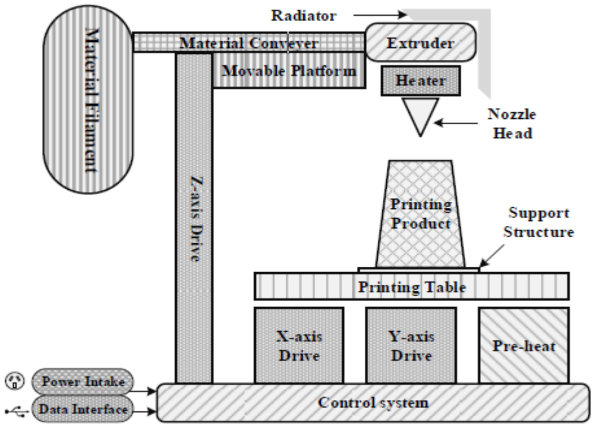

Fig 1 . Schematic diagram of 3D Printer

FDM Process consists of few basic steps Pre- processing, production and post-processing.

Pre-processing - Build Preparation software first slices & position 3D STL file and Calculate the path for extruding thermoplastic material and any necessary support structure needed.

Production - The FDM head heats the spool or cartage form thermoplastic material, into a semi liquid state an deposited it in ultrafine beads along the extrusion path. While extruding from the nozzle, it cools and solidifies to form required model. When supports or buffering is required, buffer head deposits water soluble or break-away support material.

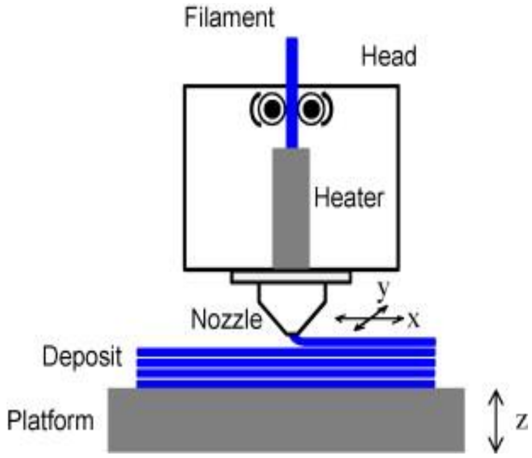

Fig 2 . FDM process

Post-processing - The user breaks-away support structure or dissolves it by using water. The component is ready to use.

B. **Materials**

In FDM process materials are used in two forms, build material for building parts and support material for generating support structure. Most of the FDM machines use the thermoplastic materials as build material. Acrylonitrile Butadine Styrene (ABS) and Polylactide (PLA) are the common materials use in FDM Process. Apart from this the materials such as polycarbonate, ABS plus Thermoplastic, ABS- M30 thermoplastic, ABS M30i thermoplastic, PC-ABS thermoplastic, PC-ISO thermoplastic, PPSF/PPSU thermoplastic, ULTEM 9085 are also used.

2. PROBLEM STATEMENT

In this scenario the objective of this proposal is to target the current capabilities for 3D printing in rapid prototyping and determine what the impediments to utilizing these capabilities are. A study will be carried out for comparing Additive Manufactured product with traditionally manufactured product.

3. LITERATURE REVIEW

L. G. Blok et al., 2018, studied the state of the art of 3Dprinted composite parts and the performance of two of the most advanced solutions currently available have been benchmarked with mechanical testing and optical microscopy[1].

Laxmi Poudel et al., 2018, studied that how parameters such as the chunk slope angle, the overlapping depth, and the number of perimeter shells affect the tensile strength of chunk-based printed parts [2]. M. Vishwas et al., 2016 studied the effect of FDM process parameters over ultimate tensile strength and dimensional accuracy of nylon[3]. Tao Peng et al., 2015 does the analysis of energy utilization in 3D printing process by investigating the relationship between the different parameters and total energy[4]. K. Gawel et al., 2009 described a test of a method of rapid prototyping of electrically conductive components [5]. Torgeir Welo et al., 2018 studied the dimensional accuracy of threads manufactured by FDM and the methods of improving the dimensional accuracy of threads [6]. Amogh V. et al., 2018 studied the surface texture of FDM at different process settings and inclination[7]. Pero Raos et al., 2016 studied the influence of structure on mechanical properties of 3D printed objects[8]. Namhun Kim et al., 2017 studied the mechanical properties of single and dual material 3D printed products [9]. Vaibhav S. Jadhav et al., 2017 reviewed working process of FDM [10].

4. SOFTWARE MODELING

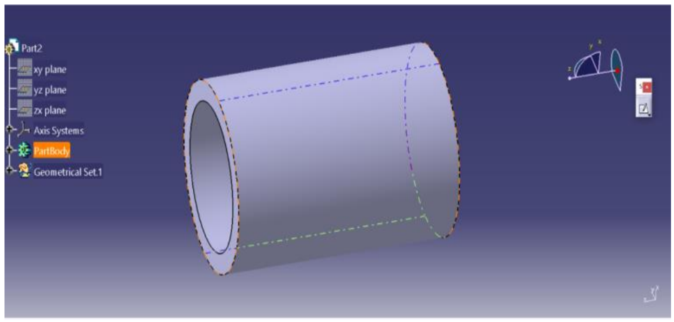

Fig 3. CAD model of coupling.

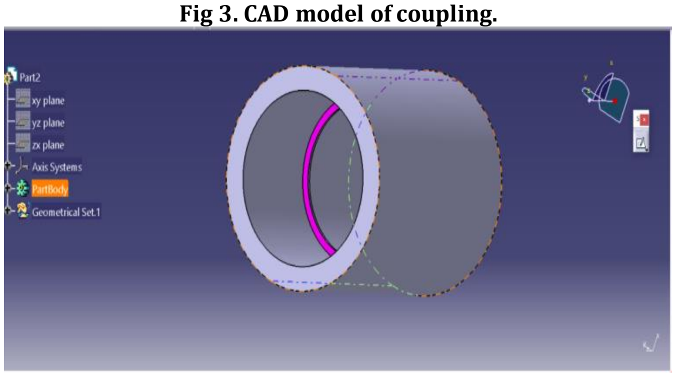

Fig 4 . CAD model of coupling

5. TESTING SETUP

The compression test is conducted on compressive testing machine. The sample object is vertically mounted in a machine. The samples are loaded at constant rate. And sample is loaded until the failure occurs. Ultimate compressive strength is chosen as measure of mechanical properties. In the test all, the failures take place at the bottom of the sample.

6. RESULT AND DISCUSSION

The result of compressive test for the three different meshing density of PLA material i.e. (80%, 90% & 100%) and PVC material of 100% meshing density is plotted in table. For the comparative analysis of compressive strength for the PLA material which has nearly same material density with 80%, 90% & 100% meshing density.

Table No. 1- Measured values of compressive strength

Sr. No.	Material	Meshing Density in %	Max Load Applied in N	Compressive Strength in N/mm^2
1	PVC	100%	39000 N	69.28 N/mm^2
2	PLA	80%	30000 N	53.29 N/mm^2
3	PLA	90%	30500 N	54.18 N/mm^2
4	PLA	100%	30900 N	54.89 N/mm^2

Based on the values found during testing, it is possible to use the PLA material of 90% meshing density instead of PVC of 100% density.

CONCLUSION

From the above results we conclude that the specimen which have 90% meshing density is optimum with compared to 100% PVC specimen on the aspects such as economy, optimum strength, material weight.

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