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EXPERIMENTAL INVESTIGATION OF 3D FDM PRINTING BY USING PVC AND POLYCARBONATE MATERIAL TO ENHANCE MECHANICAL PROPERTIES

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ABSTRACT:

In the present situation, the term additive manufacturing (AM) is being used to produce complicated and effective components for a variety of applications. 3D printing is a common method of creating three-dimensional solid structures from a computer model. The proper selection of printing parameters is critical for producing high-quality 3D printed pieces. Fused deposition modelling (FDM) is the most widely used extrusion-based AM technique for creating 3D components layer by layer. The present work is based on FDM method to develop and analyze Polyvinyl Chloride (PVC) and clear polycarbonate parts for automotive applications. The mechanical properties of the final component are clearly affected by individual or simultaneous changes in FDM processing technique. The impact of some of the most important parameters, such as infill pattern and component selection with orientation, has been investigated in this study. There are degrees of variation in the parameters. It has been discovered that the parameters chosen have an effect on the compressive, tensile and bending power of manufactured components. To gain a better understanding of the effects of specimen form on mechanical and physical properties of 3D printed structures, a systematic testing was performed.

Keywords: FDM Technique, AM Technique,PVC, Polycarbonate materials.

I. INTRODUCTION

3D printing is any of various processes in which material is joined or solidified under computer control to create a three-dimensional object with material being added together (such as liquid molecules or powder grains being fused together), typically layer by layer. In the 1990s, 3D printing techniques were considered suitable only for the production of functional or aesthetical prototypes and a more appropriate term was rapid prototyping. Today, the precision, repeatability and material range have increased to the point that 3D printing is considered as an industrial production technology, with the name of additive manufacturing. 3D printed objects can have a very complex shape or geometry and are always produced starting from a digital 3D model or a CAD file.

The most commonly used 3D Printing process is a material extrusion technique called fused deposition modeling (FDM). Metal Powder bed fusion is gaining prominence lately during the immense applications of metal parts in the industry. In 3D Printing, a three-dimensional object is built from computer-aided design (CAD) model, usually by successively adding material layer by layer, unlike the conventional machining process, where material is removed from a stock item, or the casting and forging processes which date to antiquity.

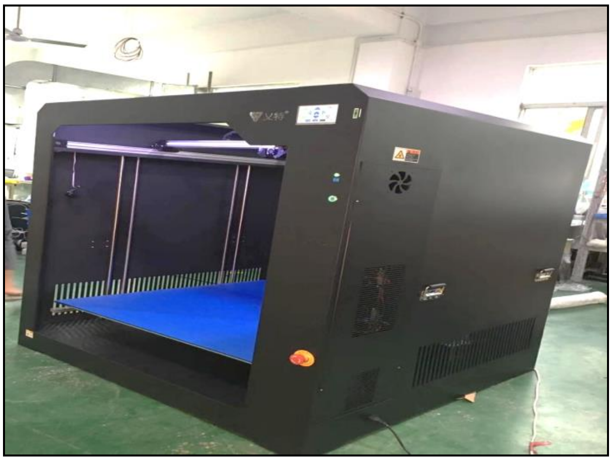


Fig 1: FBM (Fused Deposition Modelling) Machine.

Although, Material information for Laser Cutting of materials: Materials that are made of two or more materials joined together. Typical examples from this segment in which Laser Cutting is used are the machining or processing of fibre Composite made of glass, carbon, aramid and polyester. A great deal of effort has been put into laser processing different types of largely two-dimensional composites and both IR solid-state and far-IR CO_2 gas lasers have been used.

Fig 2: Cutting Materials through Laser Cutting.

II. EQUATIONS

The flexural strength of a composite is the maximum tensile stress that it can withstand during bending before reaching the breaking point. The three point bend test is conducted on glass epoxy and aluminium powder filled glass epoxy composite samples using a testing machine UNIVERSAL TESTING MACINE (UTM) 5906 as per ASTM D790-10 standard test method. The dimension of each specimen is 60 mm ×12 mm × 6 mm with a span of 50 mm length and a constant cross head-speed of 1.5 mm/min is maintained. The arrangement for the test and the test specimen are shown in Figure 4.5. For both flexural strength and ILSS, the test is repeated three times for each composite type and the mean value is reported. The flexural strength of the composite specimen is determined using the following equation:

Flexural strength = (3PL)/(2bt^2)

where L is the span length of the sample (mm); P is maximum load (N); b the width of specimen (mm); t the thickness of specimen (mm).

The data recorded during the three-point bend test is used to evaluate the Inter laminar shear strength (ILSS). The ILSS values are calculated as follows:

ILSS= (3P)/ (4bt).

- We will get those stress-strain graphs and other information in the monitor.
- Save that result information in CD-drive.
- Before starting the experiment, we need required values like poison’s ratio and dimensions in the software.

III.EXPERIMENTATION

The tensile tests are conducted on UNIVERSAL TESTING MACINE (UTM) 5906 as per ASTM D3039-07 standards test method for tensile properties of composite specimens. This test method determines the in plane tensile properties of glass epoxy composites with or without aluminium particulate filler. The dimension of the sample is 150 mm x 12 mm x 6 mm with a fixed gauge length of 100 mm. Tests are conducted for the samples at normal room temperature (27ºC) and quasi-static strain-rate of 10E-4/s. At least three specimens for each composite are tested to get the mean value of the tensile strength. UNIVERSAL TESTING MACINE (UTM) 5906 with tensile test setup and the test specifications.

IV.FIGURES AND TABLES

The experiment consisted of tensile tests and 3-Point Bending tests to test the specimens using the UNIVERSAL TESTING MACINE (UTM) 5906 testing machine with different specimen made of different materials to extract and compare the mechanical properties of each. In order to test the various parameters a set of axes were defined for all test specimens. These were the length, width and thickness axes whose orientation relative to a test specimen.

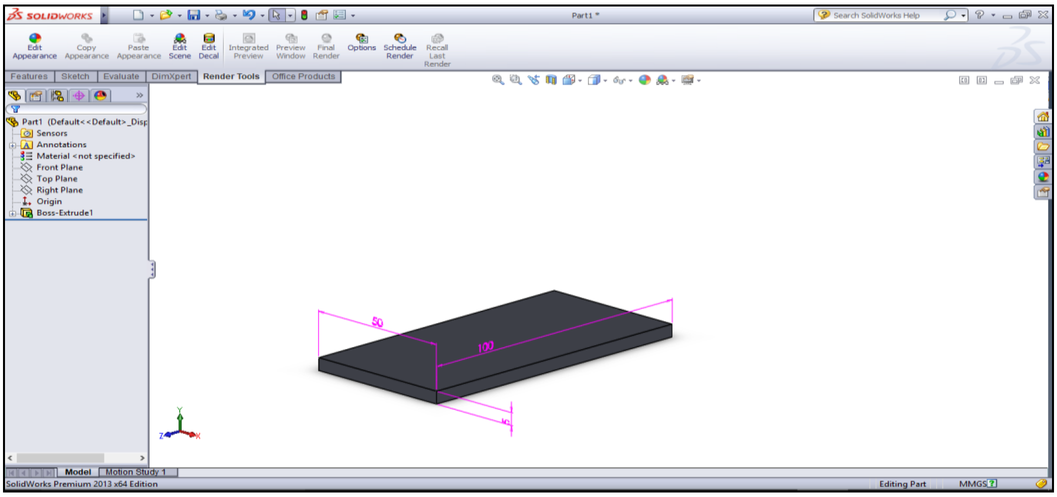


Fig 3**:** The rectangular specimen which was used for testing on UNIVERSAL TESTING MACHINE 5906.

LAMINATE STRUCTURE: FLEXURE TESTING PVC:

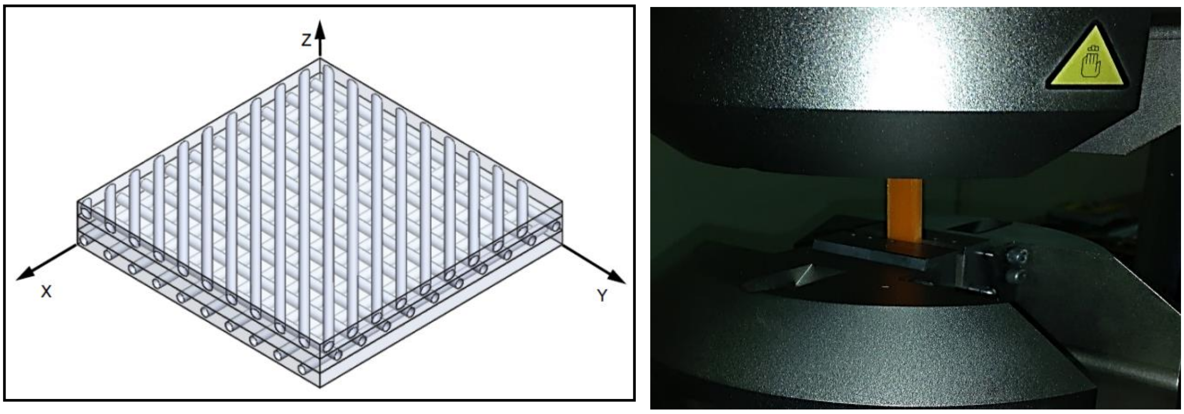
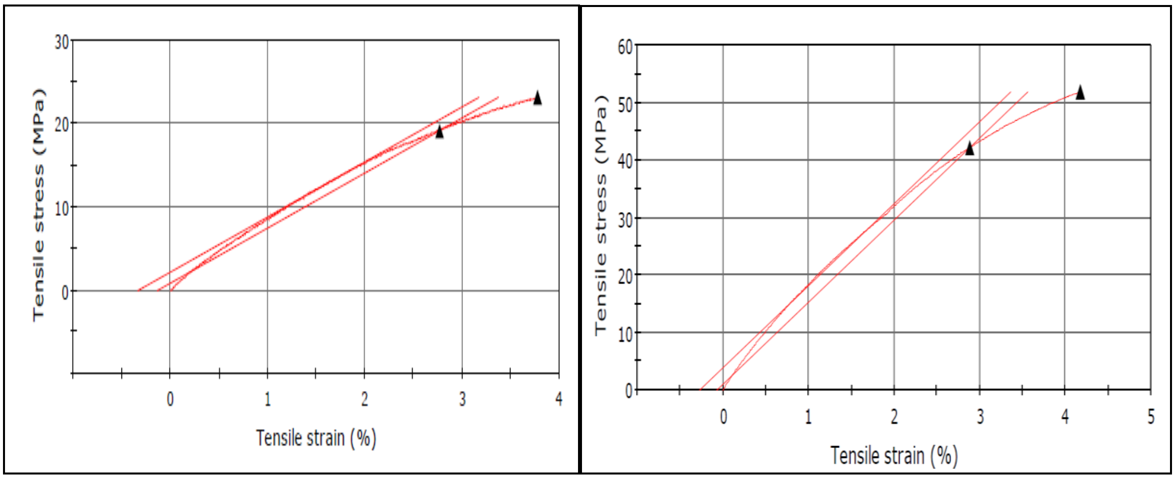


Fig 4**:** Laminate Structure and Flexure Testing PVC

V.RESULTS OF MODELLING



Graph 1: Stress-Strain Curve of PVCStress-Strain Curve of Polycarbonate

The stress strain curves are observed from the test which is as shown in the above figures. Which determines the maximum is observed for the value above 4 value and above 50 values.

Comparison between PVC and Polycarbonate:

When compared to that of PVC, Polycarbonate showed higher load baring capability which is as shown in the below figure. The PVC had maximum stress of 32.24 and 84.55 for Polycarbonate.The maximum flexure load for PVC was observed to be 201.315 and for Polycarbonate 88.67 which is said to be higher when compared to PVC. From the observations it was clearly observed that the Polycarbonate showed higher load baring capabilities than PVC.

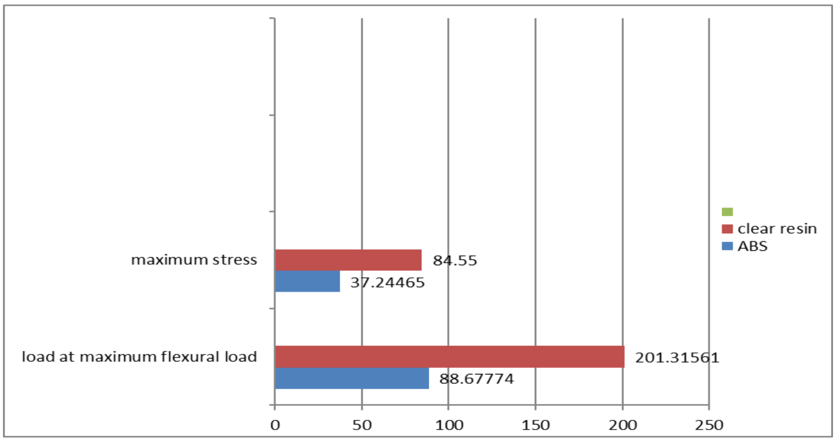


Fig 5: Comparison strength results of PVC and Polycarbonate.

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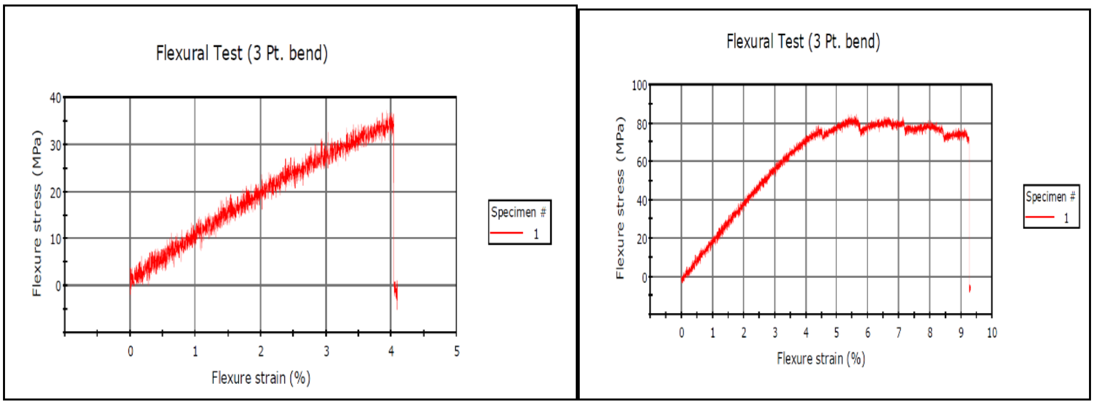
Under Flexural Test:



Graph 2: Flexural Test

Flexural strength of PVC resin

The flexure test for PVC and Polycarbonate was conducted which is as shown in the Figures. The plots were obtained for bott the specimen of PVC and Polycarbonate which determines the maximum stress is obtained at above 30 for PVC which is shown in the Figure. Similarly for the plots are obtained from the Polycarbonate at maximum flexure strain value above 9% with maximum of 80 MPa.

	Load at Maximum Flexure load (N)	Flexure stress at Maximum Flexure load (MPa)	Flexure load at Maximum Flexure stress (kN)	Flexure extension at Maximum Flexure load (mm)
1	-88.67774	37.24465	0.08868	6.40062
Mean	-88.67774	37.24465	0.08868	6.40062
Standard Deviation	-----	-----	-----	-----
Minimum	-88.67774	37.24465	0.08868	6.40062
Maximum	-88.67774	37.24465	0.08868	6.40062

Table 1: Results of Flexural Test

VI.CONCLUSION

From the results it was clearly observed that the Polycarbonate had higher load baring capability and strength when compared to PVC. The Young's modulus of the PVC is oCompared to most other bio-degradable and bio-based plastics, Polycarbonate is by far the most important and promising one for rigid applications. The leading position of Polycarbonate is demonstrated by the current scale of results. However, PVC exhibits poor stability and strengthening properties compared with some conventional thermoplastics. Tremendous efforts have been made to improve the performance of Polycarbonate via different modification methods which is observed to be 1424.2 which is higher whereas for PVC is 658.8. Therefore, the Tensile. Flexure, 3 point bending strength and young's modulus of the of Polycarbonate performed higher when compared to that of PVC.

VII.FUTURE SCOPE

The scope of the Resins i.e., PVC and Polycarbonate is very high on demand for the future uses they can be replaced or used in construction of houses, light bulbs, inner house equipment's, automobile interiors. There are wide ranges of applications of 3-D printing in all the engineering fields. Constant research has been going on to push the boundaries of application of rapid prototyping. Construction, automobile, aerospace, sports and medical are some of the major sectors where 3-D printing may play a major role in the future. There have been many examples of 3-D printed houses which were constructed in less than 24 hours.

They have already printed turbine blades for their engine. On the other hand, in the aerospace industry Unmanned Aerial Vehicles or UAVs have been manufactured using AM. Manufacturing the UAV with this process has increased the flight time of that UAV because of reduced weight, minimised volume and increased fuel efficiency

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