DESIGN AND CUSTOMIZATION OF SAREE GUARD USING 3D PRINTER

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ABSTRACT

Fused deposition modelling (FDM) is an additive manufacturing process that use heated nozzles to deposit semi-molten plastic onto a build platform in order to create components out of plastic materials such as Polycarbonate (PC), Polylactic acid (PLA), nylon, and polycarbonate. The major purpose of this research is to examine the best orientation for part-building of PC material treated using FDM technology. This research shows the creation and customization of a saree protection using 3D printing technology and polycarbonate material. The saree guard is a critical safety feature used on two-wheelers to prevent the saree from being entangled in the back tyre. Conventional saree guards are made of metal or plastic, limiting customization choices. Because of 3D printing technology and the use of polycarbonate material, it is now possible to design and manufacture customised saree guards with excellent durability and impact resistance. The paper describes the saree guard design process, which makes use of CAD software and 3D printing technologies using polycarbonate material. The 3D model of the saree guard was developed in SolidWorks software and then converted into a 3D printable file format. The saree protection was created using an FDM 3D printer and polycarbonate material. The finished product was post-processed to provide a smooth surface and high impact resistance. In addition, the paper emphasises the benefits of using polycarbonate material and 3D printing technology for saree guard design and customisation. Because of its exceptional durability, impact resistance, and flexibility, polycarbonate is an excellent material for safety equipment. In this research work, we have developed the analysis of pc using Tensile, Impact, Compression and Flexural .

Keywords: Fused Deposition Modelling, Polycarbonate (PC), ASTM standards, Saree guard Materials, Test Specimen.

I. INTRODUCTION

A saree guard is an important accessory that is attached to the wheels of a motorbike in order to prevent an accident. The saree is one of the most popular female clothes in India, but wearing one while riding one-sided on a bike, which is a major mode of transportation across the country, may be problematic. Winds can cause the saree to fly and become caught in the rear tyre, one of the leading causes of accidents in India. The same holds true for flying dupattas[1,2].

A saree guard is a steel grill-style component connected to the back wheel of a two-wheeler. This grill keeps the saree from becoming caught in the wheel while also acting as a footrest for the pillion rider. As a result, with a saree guard in place, the women's feet are entirely supported while also being prevented from becoming entangled in the wheel[3].

In our process for 3D printing PC (Polycarbonate) material, we employ Fused Deposition Modelling. It is a common material used in the production of OEM parts and 3D prints. This research investigates if PC material is appropriate for saree guards and whether it can endure various tests like as compression, flexural, tensile, and impact tests. PC stretches more readily than it breaks and is also resistant to corrosion. Because of its tensile strength, it is a perfect choice for anyone who intends to sand, polish, or glue the completed product. Because clients are constantly eager to invest in polymers, the typical system is injection moulding, which allows for polymer-based production[4,5].

Fused Deposition Modelling may quickly reach the intricacy of injection moulding (FDM). In the market, the most common Fused Deposition Modeling materials are industrial polymer Polycarbonate (PC) and medical polymer Poly Lactic Acid (PLA). To increase the characteristics of these polymers, the parameters of the moulding process by deposition of fused wire enable injection moulding performance. Several sorts of study have been undertaken to enhance the mechanical, structural, and thermal-based material qualities by varying the printing process settings[6,7].

The most commonly used materials for Saree Guard are steel, aluminum, and plastic. Steel is a cost-effective material that offers excellent strength and durability. Steel Saree Guards are heavy but provide good protection against accidents. Aluminum Saree Guards are lightweight and offer good corrosion resistance. However, they are more expensive than steel Saree Guards. Plastic Saree Guards are lightweight, inexpensive, and easy to manufacture. They offer good protection against accidents but are less durable than steel and aluminum Saree Guards.[8].

In addition to the selection of materials, it is also important to test the mechanical properties of the Saree Guard. Compression testing is one such method that can be used to evaluate the strength and stiffness of the Saree Guard. Deltaand is a popular 3D printing technology used for the manufacturing of Saree Guards. Compression testing of samples printed on Deltaand can provide valuable insights into the mechanical properties of the Saree Guard.Abstract: Fused Deposition Modeling (FDM) is a popular 3D printing technology used for the manufacturing of various products. The mechanical properties and production cost of FDM parts are critical factors in determining their suitability for different applications. In this study, we investigate the effect of process parameters on the mechanical properties and production cost of FDM parts. The process parameters considered in this study include layer height, infill density, and printing speed. Samples were printed using a Deltaand 3D printer, and their mechanical properties were evaluated using compression testing. The results show that the mechanical properties of FDM parts can be improved by optimizing the process parameters. Specifically, increasing the layer height and infill density can increase the compressive strength and modulus of the parts. However, increasing the printing speed can decrease the mechanical properties of the parts. Furthermore, we show that the production cost of FDM parts can be reduced by optimizing the process parameters. Specifically, increasing the layer height and infill density can reduce the material usage and printing time, thereby reducing the production cost of the parts. Overall, this study provides valuable insights into the optimization of FDM process parameters for improving the mechanical properties and production cost of FDM parts.[9,10].

Abstract: 3D printing has gained popularity in the manufacturing industry due to its ability to produce complex geometries with ease. However, the mechanical properties of 3D printed parts are still a concern, especially their hardness. In this study, we investigate the effect of processing parameters on the hardness of 3D printed parts using the Fused Deposition Modeling (FDM) technique. The processing parameters considered include layer height, infill density, and printing speed. Samples were printed using a MakerBot Replicator 2X printer, and their hardness was evaluated using a Shore D durometer. The results show that the hardness of 3D printed parts can be improved by optimizing the processing parameters. Specifically, increasing the layer height and infill density can increase the hardness of the parts. However, increasing the printing speed can decrease the hardness of the parts. Furthermore, we show that the production cost of 3D printed parts can be reduced by optimizing the processing parameters. Specifically, increasing the layer height and infill density can reduce the material usage and printing time, thereby reducing the production cost of the parts. Overall, this study provides valuable insights into the optimization of processing parameters for improving the hardness and production cost of 3D printed parts.[11].

In conclusion, this study demonstrates the significant impact of printing parameters on the mechanical behaviour of 3D printed PC parts. By optimizing these parameters, it is possible to improve the strength and stiffness of 3D printed PC parts while also considering their ductility. These findings provide valuable insights for manufacturers and designers looking to improve the performance of their 3D printed PC parts for various applications.[12].

Overall, the study highlights the importance of carefully selecting printing parameters and understanding their impact on the mechanical properties of 3D printed PC parts. This knowledge can help in the design and production of high-performance parts for various industries, including aerospace, automotive, and medical. Further research is needed to explore the effect of other printing parameters and to investigate the long-term durability of 3D printed PC parts.[13].

II. MATERIALS AND METHODOLOGY

2.1 MATERIAL

Polycarbonate (PC) is an industrial polymer that was employed in this research. It has the benefits of excellent impact resistance, structural strength, and chemical resistance. It performs admirably in both high and low temperatures.

Royalite R20-Thermoplastic sheet is a stiff PC product with a wide range of qualities, making it suitable for a wide range of applications. It possesses very high impact strength and stiffness, as well as outstanding high- and low-temperature performance and formability. The parameters of the PC material are described in Table 1.

Table1.Properties of PC.

Properties	**Value**
Density	1.20 g/cm3
Tensile strength	66 MPa
Tensile modulus	2.4 GPa
Flexural modulus	23 GPa
Flexural strength	93 MPa
Elongation-to-break	110%
Heat-deflection temperature	138^0C
Compressive strength	86 MPa
Notched impact strength	60-80 Kj/m^2

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Figure2.1 Sprintray printer

Specifications :

Printer Technology: DLP

Layer Thickness Option:50 microns, 100 microns, 170 microns

Print Size:up to 2 in/hour @ 100 microns

1 in/hour @ 50 microns

Printer Company : Rays 3D printers.

2.2 METHODOLOGY

Collect your resources, which should include a 3D printer, polycarbonate filament, a saree guard design or template, and sandpaper. Choose a 3D modelling software, such as Tinkercad or Fusion 360, then import or develop your own saree guard template. Modify the design to fit the necessary proportions, form, and other requirements. Preheat the 3D printer and load the polycarbonate filament after the design is finished. Adjust the printer bed to the desired temperature and begin printing. When the printing is finished, gently remove the saree guard from the printer bed, being sure to remove any support material as well. If required, use sandpaper to smooth off the surface of the saree protection and eliminate any rough edges.Attach the saree guard to the bike, ensuring that it fits securely and performs properly. After the installation, any extra adjustments, such as painting or adding decals, can be done. Make any required adjustments to the saree guard to ensure it meets all specified criteria.

Table 2. Process parameters

Process Parameters	Specimen 1	Specimen 2	Specimen 3
Layer thickness (micron)	600	400	200
Infill percentage (%)	50	75	100
Speed (mm/s)	20	30	40

III. RESULT AND DISCUSSION

3.1 IMPACT TEST

The impact test is also known as the crash testwhich is essential when it comes to vehicle safety. In the event ofan accident, the vehicle wheel may experience a sudden momentum caused by an external object. According to the standardization system, this test is performed from different angles.This part of ISO 6603 specifies a test method for the determination of puncture impact properties of rigid plastics, in the form of flat specimens.

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Figure 3.1 Printed Impact Specimens

IMPACT STRENGTH :(Test method – Customized)

Table 3 :Readings for Impact testing of test specimens

Sample ID	Value (Joule)
01	0.9
02	0.8
03	0.9

3.2 COMPRESSION TEST

A compression test can be used to measure the compressive strength of a 3D-printed object. To perform a compression test, you will need a testing machine with a load cell and a piston, as well as a sample of the 3D-printed object.
This experimental activity aims to determine the compressive properties of ABS specimens made from the FDM technique implemented in a home desktop Share bot NG printer with a single extruder. The reference standard for the determination of the compressive properties of plastic materials is the ASTM D695 standard. For isotropic materials, at least five specimens should be tested. For this reason, nine specimen samples were used in this test.

This standard offers two types of specimens, depending on the properties to be determined. When compressive strength is desired, the specimens must have the form of a right cylinder or prism. The first kind of specimen, with a cylindrical section, has been chosen for the present study of the compressive test. According to ASTM D 695 test method is taken.

Figure 3.2 Printed Compression Specimens

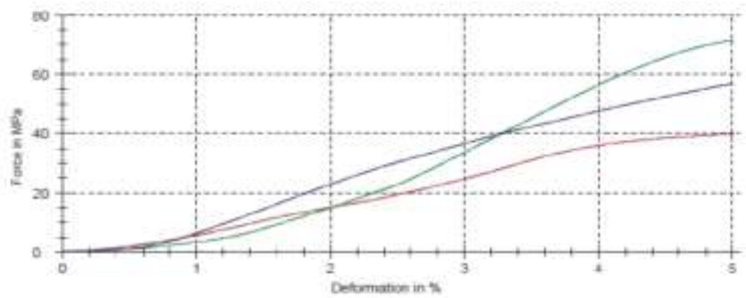
COMPRESSION STRENGTH :(Test method - ASTM D 695)

Test Speed: 3mm/min

Table 4 : Readings for Compression testing of test specimens

Sl.No.	Specimen	F_{max}MPa	dL at F_{max}
1	01	39.9	5.0
2	02	71.5	5.0
3	03	56.9	5.0

DEFORMATION GRAPH:



3.3 FLEXURAL TEST

The flexural strength of a material is defined as its ability to resist deformation under load. For materials that deform significantly but do not break, the load at yield, typically measured at 5% deformation/strain of the outer surface, is reported as the flexural strength or flexural yield strength. The test beam is under compressive stress at the concave surface and tensile stress at the convex surface.

Figure 3.3 Printed Flexural Specimens

FLEXURAL STRENGTH :(Test method - ASTM D 790)

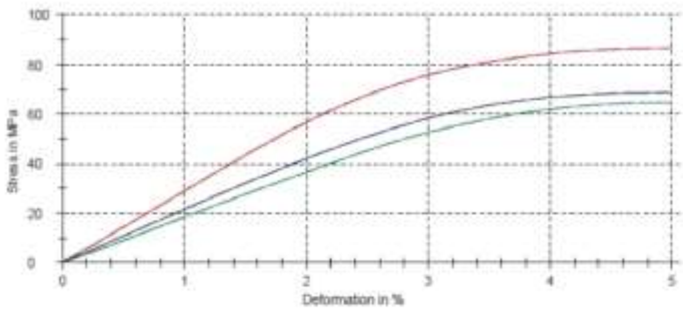
Test Speed : 1 %/min

Table 5 : Readings for Flexural testing of test specimens

No.	Specimen ID	S_MMPa	r_{max}%
1	01	86.5	5.0
2	02	64.8	5.0

3	03	68.6	5.0

DEFORMATION GRAPH:



3.4 TENSILE TEST

The test for 3D printing gives insight into the quality and mechanical behaviour of a 3D-printed material, determining how it will perform under stress. Tensile testing also assists producers in verifying that their processes are consistent and meet industry requirements.

ASTM D638 - 14 Standard Test Procedure for Tensile Properties of Plastics is the most widely used and approved standard for evaluating plastic products. This standard is used by Protolabs to evaluate plastic 3D-printed products. Build orientation influences mechanical property outputs in various 3D printing methods. The testers, or dog bones, for Protolabs' SLA materials are 3D printed and reported in the xy plane, indicating that the test pull direction is parallel to the layer lines. Dog bones are 3D printed using Protolabs' selective laser sintering materials, and values are presented in both the xy and z planes.

Figure 3.4 Printed Tensile Specimens

TENSILE STRENGTH ⊗Test method – ASTM D 638)

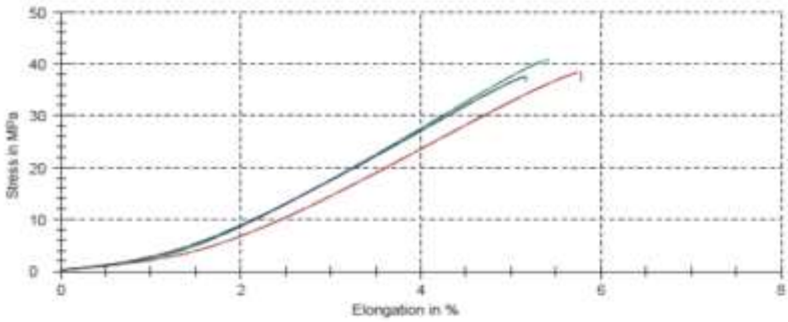
Test Speed : 5mm/min

Grip to grip separation at the start position : 90.00mm

Table 6 : Readings for Tensile testing of test specimens

No.	Specimen	M Mpa	
1	01	38.4	5.8
2	02	40.7	5.4
3	03	37.5	5.2

DEFORMATION GRAPH:



IV. CONCLUSION

From the above experimental result , We could conclude that the process parameters support the maximum properties of the material leads to improve their application in more fields.After Printing the material underwent different tests like Compression, Flexural, Tensile and Impact tests.

- From the Compression test, the Poly Carbonate material pocess a maximum tensile strength of 86 MPa. But As per the results when we have set the parameters of the layer thickness of 400 microns and the infill percentage of 75 with the speed of 30 mm/s. We have achieved the flexural strength of 71.5 MPa.
- From the Flexural test,the Poly Carbonate material pocess the maximum strength of 93 MPa. But As per the results when we have set the parameters of the layer thickness of 600 microns/ the infill percentage of 50 with the speed of 20 mm/s. We have achieved the flexural strength of 86.5 MPa.
- By observing the tensile test,the Poly Carbonate material contains the Standard strength of 66 MPa. But As per the results when we have set the parameters of the layer thickness of 400 microns/ the infill percentage of 75% & speed of 30 mm/s. We have achieved the tensile strength of 40.7 MPa.
- From the observbation of impact test, As per the results when we have set the parameters of the layer thickness of 600 microns/ the infill percentage of 50% & speed of 20 mm/s. We have achieved the value of 0.9 Joule.

Here by from the result , We could conclude that for printing a saree gaurd using Poly Carbonate is cost effective than the exisiting manufacturing process.As our research process helps to set a manfacturing standards for polymer production. And Also We can produce customized products for commercial applications.

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