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STUDY AND ANALYSIS OF 3D PRINTED MOULD DESIGN WITH COMMERCIAL MOULD CAST

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Abstract

The purpose of this study is to identify and compare the quality of industrial and 3D Printed Mould specimens produced by injection moulding and 3D printing. This is to test if new cutting-edge technologies used in 3D printing can replace traditional manufacturing techniques like injection moulding. Both 3D printing and injection moulding are ways for producing plastic parts and components, yet each has benefits and drawbacks. 3D printing is an additive printing technique that creates products by layering material, whereas plastic injection moulding creates parts and components by filling a mould with molten material that cools and solidifies. Although both injection moulding and 3D printing may be used to create prototypes, there are several key differences between the two processes.

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1. INTRODUCTION

Designers consider a wide range of factors while creating products or components that will eventually impact the performance and mechanical features of any given product. Because technology is always being developed and improved, there is a diverse spectrum of manufacturing techniques that may all produce identical-looking objects with distinct attributes. It is vital for an engineer to be able to distinguish between several techniques and select an appropriate path to provide the greatest performance for the planned application.

Many businesses now use tried-and-true technology with a high success rate to assess the variations in specimens generated by both techniques of manufacturing and to run various tests to decide which strategy is best.

1.1 Objective of the Paper

1) To Make an 3D Printed Mould by using any 3D printer.
2) Inspect the quality between Injection molded cast and 3D printed Mould cast.

2. LITERATURE REVIEW

2.1 Background

1) Chen-Yu Liu's original thesis was a direct evaluation of several fast prototyping technologies and their impact on mechanical characteristics. SLS was compared to other technologies such as FDM and Polyjet. Liu's thesis delved into considerable detail by comparing several construction orientations (Horizontal, Vertical, and Side) on various materials and studying the influence each has on the mechanical characteristics of said component. Numerous experiments, including tensile testing, water absorption testing, shore hardness testing, and microscopy, were carried out for the objective of the inquiry. According to the findings of Chen-Yu Liu's detailed investigation, the horizontal construction orientation surpassed the others in terms of dimensional accuracy, meaning that the actual dimensions of the specimens made were as near to the required measurements as feasible. Other areas of investigation revealed that Polyjet RP had the best tensile and hardness qualities, beating all other alternatives. Because the build orientation and kind of RP employed are determined by the intended application, there is no conclusive conclusion as to which is the best method/direction to use; rather, the data can be used as a reference for individuals interested in this area of manufacturing (Liu, 2013).

2) Joseph Ahlbrandt's Following on from Liu's work, Ahlbrandt's thesis gave a better understanding of 3D printing, as well as parallels to a typical manufacturing process, injection moulding. Ahlbrandt proceeded to employ the same RP procedures and a range of materials in each, which were then directly compared to specimens made by plastic injection moulding (PIM). The testing protocols used in this comparison were similar to those used in Liu's research, with the exception that PIM was also examined.

3) Sivaramakrishna, Ashokgundeti, According to the comparison research of 3D printing with injection molding, the dimensional accuracy of 3D printing with PLA material is better than injection molding with ABS, which is better than 3D printing with ABS. The average variations recorded are 0.066mm, 0.068mm, and 0.13mm, respectively. 3D printing and injection molding using ABS material are 0.198mm and 0.165mm for the beginning box, respectively. In terms of surface roughness, injection molding has a smoother surface with an average surface roughness value of 0.45 microns, followed by 3D printing using PLA material at 2.34 microns. In the case of 3D printing using ABS material, a somewhat rough surface is found at 3.53 microns.When manufactured in large quantities, the manufacturing cost of electronic casing and starter box per piece in injection molding is determined to be Rs. 15.86/- and Rs. 148/-, respectively. However, as compared to 3D printing, the initial expenditure in acquiring the injection molding equipment, machine die, and operational costs is relatively high. Injection molding component manufacturing time includes mould fabrication as well as set up time. Mold creation and setup

will take 3-4 months. After setup, the fabrication time for four pieces of electronic casing and one piece of starting box was discovered to be 68 seconds and 76 seconds, respectively. Total fabrication time in 3D printing comprises part loading and printing time.Because it is a long process due to the layering of one layer over another, the time taken to produce one portion of electronic casing and starting box was 42 minutes and 6 hours 15 minutes, respectively. Chong Tan, a and Chengcheng Li, Today's society will be an era of enormous developments in science and technology, with discoveries continuing to be made; it is also an era in which sophisticated manufacturing technologies are fast emerging and being extensively employed. 3D printing technology will have an impact on practically every element of future industrial design. Industrial design is primarily dependent on inventive design, and the arrival of three-dimensional printing technology has given the sector a boost. 3D printing technology has offered significant chances for industrial design via study in the field of 3D printing in the field of industrial design. Industrial designers may radically disrupt the traditional production process and build more fresh and individualized goods, which are extensively employed in all sectors of industrial design.At the moment, many manufacturing industries are embracing 3D printing technology for product creation, which not only improves firm production efficiency but also generates a large profit. Simultaneously, designers will turn more good ideas into reality from a variety of perspectives in order to suit the demands of customers and help humanity.

4) Lay et al

This research analyses three distinct materials and delves into their physical and mechanical qualities. Once again, both production procedures are thoroughly investigated, and the effects of each on the materials are compared. This test includes procedures such as density, viscosity, water absorption, impact, and tensile testing, among others. Only the last three tests described are relevant for the purposes of this inquiry (Lay, et al., 2019).

The injection moulded samples performed to a higher level where the tensile strength of the specimens was significantly stronger and therefore the Young's Modulus and elongation % was lot bigger, according to the findings analysis. Because this has been a repeating theme in all of the research described, it is anticipated that this hypothesis will hold true if the experimental methods are carried out. A similar result can be seen in the impact test, where injection moulding outperforms 3D printing significantly and the impact strength is substantially greater for all materials. In the water absorption test, the author discovered that the 3D printed samples absorbed significantly more water, as seen by the rise in mass. Overall, the authors found that injection moulding was considerably superior in terms of mechanical qualities, and for engineers who want maximum performance from components, injection moulding provides expanded possibilities (Lay, et al., 2019).

The goal of this paper is to expand on Ahlbrandt and Lay et alwork .'s by comparing other critical mechanical parameters and determining the influence of the production technique. The content has been maintained consistent throughout for the sake of this study, and only FDM is considered.

3. METHODOLOGY

3.1 Methods used For this Study is as Follows:

1) Choosing a Minimal Design for a 3D-printed Mold.
2) The design in this case is a 3.5 Audio Jack Connector Mold.
6) Contrast its qualities with those of the industrial casted design.

3.2 Chosen 3D Printer in This Project:

a) Creality 3D Ender-3 3D Printer

Enders 3 is a 3D printer for basic and simple designs. It has a manual adjustable X,Y,Z axis printer with a printing size of 220*220*250mm (x- 22cm,y- 22cm,z- 25cm). Is the printer SD card based? This programme reads.stl files from an SD card and prints the model. To create models, Filament material is required.

Figure 1. 3D Printer Filling element or filament PLA Material

Figure.2. Creality Enders 3 3D printer

3.3 Software Used:

UlimakerCura:

Cura is a 3D printer slicing application that is open source. It was created by David Braam, who was later employed by Ultimaker, a 3D printer manufacturing company, to maintain the software. Cura is released under the LGPLv3 licence. Cura was originally distributed under the open source Affero General Public License version 3, however on September 28, 2017, the licence was changed to LGPLv3. This change improved compatibility with third-party CAD applications. The development is hosted on GitHub. UltimakerCura has over one million users worldwide and prints 1.4 million pages per week. Although it is compatible with other printers, it is the primary 3D printing software for Ultimaker 3D printers.

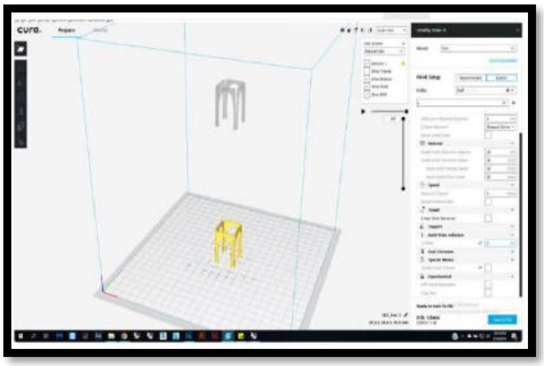

Figure 3. UltimakerCura Software

By splitting the user's model file into layers, UltimakerCura creates printer-specific g-code. When finished, the g-code may be sent to the printer for physical object manufacturing.

UltimakerCura generates printer-specific g-code by dividing the user's model file into layers. When completed, the g-code may be transferred to the printer for physical item fabrication.

3.4 Design Selected 3.5 Audio jack Connector:

Design selected for the 3D printed Mould testing is an 3.5 Jack Audio Connector ,whose Dimesnions are 62.4x33.7x8.4 mm.Small Size Mould is choosen because Large moulds take to much time.Thismould design takes approx 1 hour.Bigger Design take 8-12 hours of time**.**

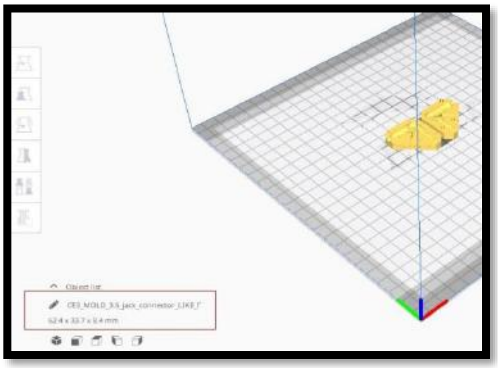

Figure 4. Shows the dimension of Mould are 62.4x33.7x8.4 mm

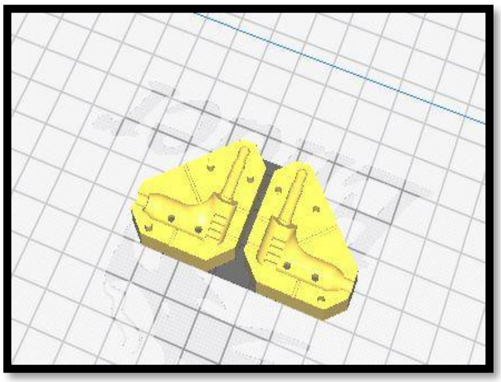

Figure 5. Design Mold Closeup View

The Ultimaker cura 3D view illustrates the design positioning. On the bed or base of the 3D printer. It may be placed anywhere beneath the edges of the 3D printer's rectangular bed frame.

3.6Mould:

A mould or a die is a tool used in the production of plastic parts in moulding.

Because moulds are costly to construct, they were frequently used primarily in mass production when thousands of parts were produced. Molds are frequently constructed from hardened steel, pre-hardened steel, aluminium, and/or a beryllium-copper alloy. The material used to make a mould is mostly a question of economics; in general, steel moulds are more expensive to construct, but their longer lifespan more than compensates for the higher initial cost over a greater number of components manufactured before wearing out.

Pre-hardened steel moulds are less wear-resistant and used for lower volume requirements or larger components; their usual Rockwell-C hardness varies from 38-35. Hardened steel moulds are heat treated after they have been machined; these are much superior in terms of wear resistance and lifetime. The normal hardness is between 50 and 60 Rockwell-C.

(HRC). Aluminium moulds are far less expensive, and when developed and manufactured using modern computerised technology, they may be cost viable for moulding tens of thousands or even hundreds of thousands of parts. Beryllium copper is used in mould components that demand quick heat removal or generate the most shear heat. Molds can be created using CNC machining or electrical discharge machining processes.

Figure 7. Standard two plates tooling – core and cavity are inserts in a mould base

4. RESULT AND CONCLUSION

4.1 3.5 Jack Mould Design In Enders 3 3D Printer

Figure 8. Mould making in 3D printer with Software Ultimaker Cura

As in making process First a design is maked in the 3D Printer software,in this project Ultimaker Cura is used and converted that design into .stl file format,and given to the hardware for Printing.

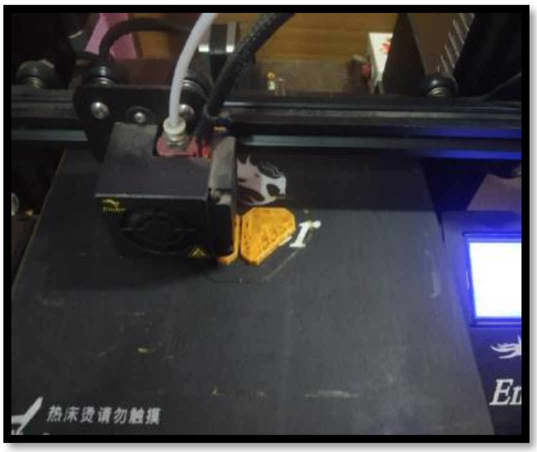

Figure 9. Mould Design Making In 3D Printer

Figure 10. 3D printed Mould Compared To the Industrial Commercial Specimen

Comparing The size of Mould with Industrial Mould cast.

4.2 3D Printed Mould casting:

Figure 11. Inserted Audio jack for outer covering and casting

To start the casting process audio jack metal piece is inserted on the mould.Place Jack on one side of mould and Close the mould by another Mould Part.

Because Mould has very low resistivity to heat ,high temperature Polymer paste cant be used.

That’s why low Temperature flexible Polymer is used.

Figure 12. Opening The 3D printed Mould after 5 minutes of cooling

After Cooling Down open the mould,Some times due to Poor adhesiveness Casting material cant able to bind with each other properly,that’s why cast breakes some times.

Figure 13. Taking Out The cast From 3D printed Mould

After Proper casting, casting jack cover can be seen in the above image.Which is flexible and Low heat Resistance.

4.3 Industrial Mold cast:

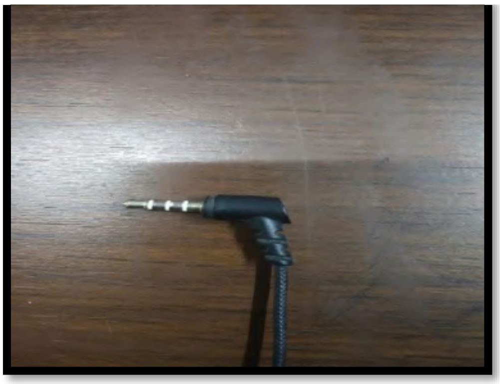

Figure 14. Industrial Mold cast

4.4 Compare Industrial Mould

cast with 3D Printed Mould Cast

Figure 15. Observation Comparison Between 3D Printed Mould cast and Industrial Mould Cast

Figure 16. Closeup View Of 3D printed cast and Industrial Printed Cast

4.5 Result Points to be Considered:

Following are the Comparison Points for the 3D printed mouldcast and Industrial Mould Cast:-

1) If you produce your own components, one of the first things you should consider is the cost of investing in die casting vs 3D printing. The cost of the die in die casting requires a significant upfront investment, whereas 3D printing has zero upfront expenditures. Printing, on the other hand, has a significantly higher unit cost than die casting. You will have to clean and repair parts on a regular basis with either, which will involve additional expenditures.
2) The difference is in how these processes work. Die casting is comparable to sculpting. It involves injecting liquid metal into a mould or die, which produces a shorter cycle time (30-45 seconds) than printing. 3D printing layers on the material (common materials include metals and polymers such as thermoplastic polymer, polylactic acid, and acrylonitrile butadiene styrene) is used to produce your item, which is why it is also referred to as additive manufacturing. Small layers of heated material are placed on top of each other to construct the 3D item, a process called as deposition.
3) Because die casting creates extra waste, you must pay to have it removed. On the other hand, because a single die lasts for 80,000 shots, you don't need to build a new die every time you make a new part. If you

need a large quantity of the same part, die casting is also much faster. It becomes more cost-effective when the cost of the mold/die is amortised over the whole quantity.

4) When producing several components of the same kind from the same material, die casting is significantly faster, hence huge quantities are frequently more cost-effective.

5. CONCLUSION

Plastic components are typically 3D printed since they are generally accurate items that may require the accuracy supplied by a 3D printer. Furthermore, while plastic is not as well suited to die casting as metal, high-quality plastic parts may be injection-molded. For small batches of specialty objects, 3D printing may be the best alternative. However, if several duplicates of a particular kind and size of item must be created quickly, die casting is without a doubt the best solution. Several firms are merging die casting and 3D printing for their industrial purposes. There's no reason why die casting can't be used to mass-produce the strong aluminium or zinc pieces that serve as the cornerstone of any business.

References

[1] Kauffer, P.H., Injection Molding: Process, Design, and Applications. 2011: Nova Science Publishers.

[2] Wu, T., et al., A framework for optimizing the design of injection molds with conformal cooling for additive manufacturing. 2015. 1: p. 404-415.

[3] Wu, T., et al., Design optimization of plastic injection tooling for additive manufacturing. 2017. 10: p. 923-934.

[4] Jahan, S.A., et al., Implementation of conformal cooling & topology optimization in 3D printed stainless steel porous structure injection molds. 2016. 5: p. 901-915.

[5] Jahan, S.A. and H.J.P.M. El-Mounayri, Optimal Conformal Cooling Channels in 3D Printed Dies for Plastic Injection Molding. 2016. 5: p. 888-900.

[6] Jahan, S.A., Optimization of conformal cooling channels in 3D printed plastic injection molds. 2016.

[7] Jahan, S.A., et al., Thermo-mechanical design optimization of conformal cooling channels using design of experiments approach. 2017. 10: p. 898-911.

[8] Jahan, S. and H.J.A.S. El-Mounayri, A Thermomechanical Analysis of Conformal Cooling Channels in 3D Printed Plastic Injection Molds. 2018. 8(12): p. 2567.

[9] Jahan, S.A., et al., Effect of Porosity on Thermal Performance of Plastic Injection Molds Based on Experimental and Numerically Derived Material Properties, in Mechanics of Additive and Advanced Manufacturing, Volume 9. 2018, Springer. p. 55-63.

[10] Jahan, S., et al., A Framework for Estimating Mold Performance Using Experimental and Numerical Analysis of Injection Mold Tooling Prototypes, in Mechanics of Additive and Advanced Manufacturing, Volume 8. 2019, Springer. p. 71-76.