Study of Effectiveness of Abs-Pattern Compared To Wood-Pattern In Sand Casting

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Abstract- *The objective of this work is to compare the conventionally made wood pattern used in sand casting with the pattern made of ABS material through 3D-Printing technique of Rapid Prototyping. Two commercially available materials namely, wood and ABS are used to make patterns for sand casting The comparison is made from starting step of design concepts, technology used for manufacturing the patterns and the end effects of parts made from both the patterns. The established 3D-printing techniques are so effective on traditional casting process in terms of cost, time, surface quality and accuracy. The goal of the work is to make the casting process faster to deliver the products on time to the customer*

Keywords- 3D-Print, FDM, ABS, Sand Casting, Time and Cost Reduction

I. INTRODUCTION

A-Sand Casting

Sand casting is the old historical method used to shape the metal in to end use parts by applying some post process operations to achieve required surface quality and dimensional accuracy. The silica sand with some percentage of binders and additives are mixed in to it to strengthen and to increase the bonding properties of the sand the sand particles. The sand casting process contains the following components are: Pattern, Core and Drag setup, cores, risers, and gating system. To form complex metal parts that can be made of nearly any alloy. The metal heat at its melting temperature and then poured using ladle to the mold cavity and then solidification takes place.

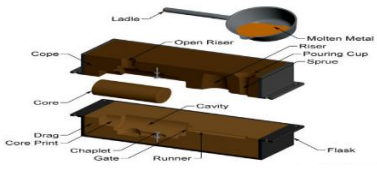


Fig 1. Sand Casting

Wood is the most common material used in pattern making. Wood is easy to shape by using hand tools. The pattern made from wood can be used in sand casting to produce metal cast parts in a range between 40-50 casts per pattern. These patterns are takes much longer time as the complexity increases from the customer end. The types of wood patterns are: split patterns, loose patterns, single piece pattern and match plate pattern. Complex shapes which are difficult to shape in wood; can be made by metal using CNC operations. But in machining the pattern making cost get increased.

Fig. 2. Wood Pattern Making

B. Fused Deposition Modeling (FDM):

For Fused Deposition Modeling (FDM) technique, it has been reported that it provides a low-cost 3D printing alternative than other RPs and traditional methods. This is, perhaps, the reason for its adoption for pattern making in sand casting. There are different process parameters are needed to be considering to get the part with required quality, properties and dimensions of the final part. Parameters are:

1. Raster angle
2. Layer height
3. Interior fill
4. Print speeds.
5. Build orientation

Some process parameter values of FDM that influence the mechanical properties. The ABS filament is semi melted inside the liquefier at a suitable temperature and pushes it through the nozzle tip on the build tray with respect to the tool path generated by the software

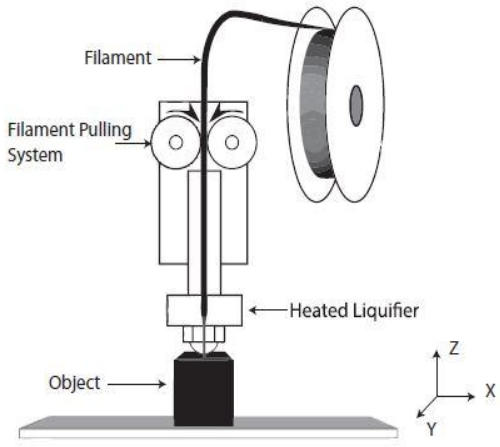


Fig. 3. Fused Deposition Modeling

The extrusion head moves along the liquefier the material lay down and start to laying down the layers one upon the previous built layer. The part of the object which is over hanging must be supported by the support structure provided in the FDM machine. The supportive structure maybe soft or water soluble which does not need any high force tools to separate it from modeler structure. The process is most suitable for the low investment and material cost requirements. The FDM process provides different materials with different colors for building the part. Similar to other 3D techniques the FDM also works on STL file conversion process.

Firstly the required object which developed in CAD software must convert into STL binary date by using suitable software. The software defines the strength, resolution and look of the object. The influence of feed rate, linear movement, and speed on extrusion head for a given layer thickness as shown in Fig.4. An increase in the feeding rate results in an increase of the extrusion width, and if the speed slow down immediately extrusion width decreases.

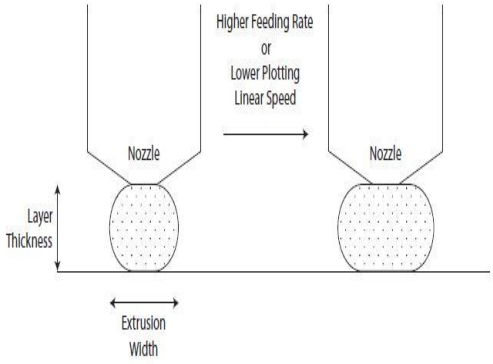


Fig. 4. FDM extrusion width parameter

II. RESEARCH OBJECTIVES

The implementation of 3D printing in sad casting provides a tool less pattern making process which results in huge cost and time saving to the company. Therefore, a pattern that lasts longer will reduce tooling costs.

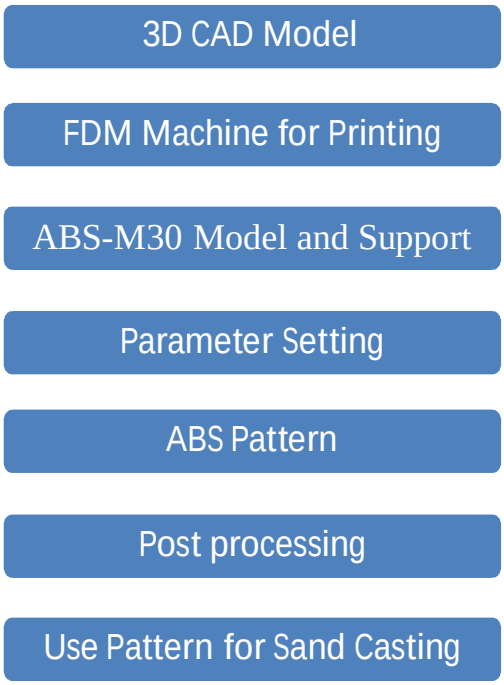
ABS (Acrylonitrile Butadiene Styrene): This composite material is taken for experimentation to carry out the research work.

Material Brief:

ABS-M30- thermoplastic (15 TO 20 % stronger than standard material)

- Greater Mechanical Properties Like: tensile, impact, and flexural strength.
- The bond between the layers is very much stronger than other materials within range.
- Versatile Material: Good for functional applications.

III. METHODOLOGY



IV. RESULTS AND DISCUSSION

A wooden pattern by itself will deform too quickly, and it can be used instead to make a mold for a stronger pattern that will be less likely to warp over time. Fiber

reinforced resins or cast metal patterns can be made from the original wood pattern. Metal patterns can also be made through machining. These processes are more expensive, and casting size can be constrained, so they are only used in some situations. Comparisons made between traditional and conventional casting technique provides an insight on various parameters of consideration such as time, cost etc.

Process time

Process :FDM
Pre-processing time
(Creation of tool path and Support structure)
:2min
Setting up the machine
(adding the build plate, purging the nozzle) :10min

Printing time
Build time
:1hr 30mins
Post processing time
Removal of support structure
:20min

Casting

Preparation of sand mold and pouring the molten metal
:3hrs

Total time to build the component : 5 hrs. 2 min

V. CONCLUSION

Lead time and cost of tooling is saved 50% by FDM based rapid tooling for sand casting. Geometries such as thin walls are suitable for FDM based rapid casting. The pattern made by FDM process is able to solve the problem faced in conventional wood pattern making process and results in better surface quality and dimensional accuracy.

Comparison conversion data

Process Requirements	**Wood Pattern**	**ABS pattern**
3D CAD software	No	Yes
Repeatability od use	No	Yes
Skill labor required	Yes	Not
Dependency on manpower	Yes	No
Pattern-making time	12hrs	4hrs
Equipment and process costs	Low	High

The tooling cost: in casting the tooling cost must be divided in to two components; one is pattern and another one flask. The pattern cost is mainly depending upon its size and complexity. The quantity of cast also impacts the tooling cost. A larger production quantity will require the use of a tooling material, for both the pattern and core-boxes.

VI. FUTURE SCOPE OF WORK:

The factors like environment, health and safety issues are taken into account; the toxicity of the resin must be addressed. The new material must be developed for sand casting process. And also it is important to establish SOP's and standards for pattern making.

REFERENCES

[1] Peters F et al (2008) Effect of mould expansion on pattern allowances in sand casting of steel. Int J Cast Metal Res 20(5):275–287

[2] Philip Mark Hackney Richard Wooldridge, 2017, Characterization of direct 3D sand printing process for the production of sand cast mold tools, Rapid Prototyping Journal, Vol. 23.

[3] Rosochowski, Matuszak, Rapid tooling: the state of the art, Journal of Materials Processing Technology 106 (2000) 191-198.

[4] Elena Bassoli, Andrea Gatto,3D printing technique applied to rapid casting, Rapid Prototyping Journal,13/3 (2007) 148–155.

[5] Alain Bernard, Jean-Charles Delplace, Nicolas Perry, Serge Gabriel,Integration of CAD and rapid manufacturing for sand casting optimisation ,Rapid Prototyping Journal, Vol. 9.

[6] M. Too, K. Leong, C. Chua, Z. Du, S.F. Yang, C.M. Cheah, S.L. Ho, Investigation of 3D non-random porous structures by fused deposition modelling, Int. J. Adv. Manuf. Technol. 19 (2002) 217–223.

[7] O.A. Abdelaal, S.M. Darwish, Review of rapid prototyping techniques for tissue engineering scaffolds fabrication, in: A. Öchsner, L.F. Silva, H. Altenbach (Eds.), Characterization and Development of Biosystems and Biomaterials, Springer Berlin Heidelberg, Berlin, 2013, pp. 33–54

[8] P. Dudek, FDM 3D printing technology in manufacturing composite elements, Arch. Metall. Mater. 58 (2013) 12–15.

[9] S.H. Masood, W. Rattanawong, P. Iovenitti, Part build orientations based on volumetric error in fused deposition modelling, Int. J. Adv. Manuf. Technol. 16 (2000) 162–168.

[10] T. Grimm, Fused Deposition Modeling: A Technology Evaluation, T.A. Grimm & Associates, Inc., Atlanta, 2002

[11] Wohlers Terry, Future potential of rapid prototyping and manufacturing around the world, Rapid Prototyping Journal, Vol. 1(1995), 4–10.

[12] Dotchev K., and Soe S.,Rapid manufacturing of patterns for investment casting: improvement of quality and success rate, Rapid Prototyping Journal. Vol. 12(2006),156-164.

[13] Sulaiman, S. & Hamouda, A.M.S. (2004). Modelling and experimental investigation of solidification process in sand casting. J. Mater. Process. Technol. 155–156(1–3), 1723-1726.

[14] Alafaghani, A., Qattawi, A., Alrawi, B. & Guzman, A. (2017). Experimental optimization of fused deposition modelling processing parameters: a design-for-manufacturing approach. Procedia Manuf. 10, 791-803

[15] Dul, S.; Fambri, L.; Pegoretti, A. Fused deposition modelling with ABS-graphene nanocomposites. Compos. Part A Appl. Sci. Manuf. 2016, 85, 181–191.