

Rapid Prototyping – A Review

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Abstract - 3D printer is the method of converting 3D design into the reality. This paper is on various types of 3D printing methods. Firstly define what is mean by 3D printing & what is significant of it. 3D printing technology is also called as rapid technology in which three dimensional objects are created. In this technology there are three steps follows for any 3D printing model viz. designing, printing & finishing. While adopting this technology we save the time & cost also it saves wastage of material. It is very ideal for give the demos of any product. We will study about the process of 3D printing & study about the materials used for 3D printing products. It is very helpful to those who have to build their creative ideas in to physical model. We select the best materials which are suitable for our 3D printing object. As well as, we compare the 3D printing with additive manufacturing technology.

A gear is an important element for mechanical power transmission system. The application of these gears field from wrist watches to huge machinery viz, gear box, aerospace industry, transmission system like. Spur gear has a unit area parallel to the axis of the wheel. In this project work the objective is to use the advance manufacturing process to produce complex designs using 3D printing method. The dimension of spur gear is taken from practical understanding gear used in gear box & is analyzed for different 3D printing materials using ANSYS software. Spur gear is manufactured using 3D printing FDM technique with different filaments i.e. ABS, PLY, Nylon. These types of gear can be used in any power transmission system & can be manufactured with required load carrying capacity with short time of production & complex design.

Keywords: 3D printing, Types, FDM, FEA

1. INTRODUCTION:

Gears are widely used in all transmission types of machineries. Science gear was known over 3500 years before; they become integral part of machines. They are used to transmit rotational motion from one part to another one. Pair of gear is used with lower speed cycle. The important difficulty by this system is when the loads & speed were raised the contact stress were generated at the tip of contact where materials could not withstand

with these stresses because of high wear & contact area. In the industry rapid use of gear such as automobile manufactures & office automation tools will require a refined application of gear technology. The gear box is the second element of the power train in automobile. Gears are used to change the torque & speed of vehicle according to load condition. By using the gear box in the vehicle its changes the engine speed into torque while climbing the hills or when required. Main functions of spur gear in gear box are as follows:

1. Providing the torque required moving the vehicle under the various load conditions.
2. Be shifted into reverse therefore the vehicle will move backward.
3. Be shifted gear into neutral for starting the engine.

Now days there are so many mechanisms those involve with load & requirement to understand the stress in component is increased. There is always strong relation between mechanism & stress. Spur gear is the simplest type of gear having at tooth cut parallel to the axis of the shaft on which gear is mounted.

Basically calculated stress in gear design formula are not necessary true stress, can make it difficult to calculate correct answer, because it may not be known whether load is uniformly distributed across the face width or whether properly shared by the two or more pairs of teeth that are in mesh at the same time.

The FEM method is capable to calculating the stresses on the gear tooth but it is time consuming, the time required to calculating these is more. In order to reduce the modeling software is used. One from that is ansys workbench.

2. Finite Element Method:

The finite element method is numerical analysis technical of an approximate solution to a wide verity of engineering problems. Because of its flexibility as an analysis tool , it is receiving much attention in engineering school and industries in more and more real situation today , It is necessary to obtain Similar solution to problems rather than exact close from solution it is

not possible to obtain analytical mathematical solutions are many engineering's problems. An analytical solution is a mathematical expression that gives value of the desire unknown quantity at any location in the model. For problem considering complex material properties and bounder condition, the engineer resource to numerical method that provide approximate solution.

3. Types of 3D Printing:

All 3D printing is not using similar technology. There are various ways to print the product so as to form the final product. Some of the technologies utilized now a days are as:[15] [16]

- 1) Fused deposition Modeling (FDM)
- 2) Stereolithography (SLA)
- 3) Selective Laser Sintering (SLS)
- 4) Laminated object manufacturing (LOM)

As shown in Figure below, the first step to 3D print is to make a model of the object using CAD software [7]. The model tells about the geometrical properties of the object. The CAD file is then saved to STL file format. This file format gives the external closed surfaces of the original CAD model. The STL file also includes the data for each single layer and can make the calculation for layers.

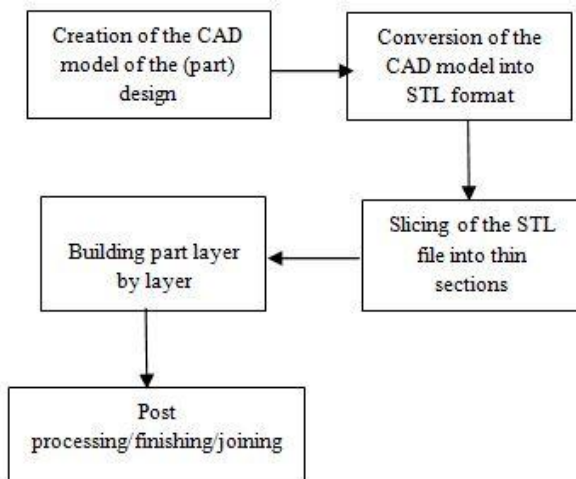


Figure1: 3D Printing approach [7]

Table-1: Comparisons of different types of 3D Printing technologies:

	FDM	SLA	SLS	LOM
Accuracy	Accurate & reliable	Most accurate	Not very accurate	Less accurate
Application	Home application & Prototypes	Form testing	Suitable for complex part	Ideal for complex shapes
Finishing	Std. finish	Excellent	Excellent	Good
Post processing	Requires	Requires	Not Requires	Requires

Comparisons of different types of 3D Printing technologies [11]

4. Literature Review:

Dilip Sahebrao,etal^[1]; The author used metal paint on surface of the FDM tool but it was seen that the metal paint cannot cope with wax pattern temperature above 80°C even though it has shown good thermal conductivity.

Omar M.F.M., etal^[2] The authors of this present study had used post processing technique i.e. to improve surface finish of FDM parts use optimized chemical treatment process technique

Yuhua Song, etal^[3] The author follow to study the dimensional accuracy for the rapid tool, the authors developed nonlinear coupled thermo-mechanical analysis for solidification process for transforming the ceramic mold to a metal die.

J.C. Ferreiraetal^[4] In the authors further automated the RT process by avoiding preparation of CAD model, instead of CAD model they have used direct 3D digitizing which a reverse engineering method. This point reverse engineering was used directly to prepare RP tool.

B.Praveen Kumaretal^[5] This study is about application of reverse engineering. Reverse engineering helps in obtaining the geometry of part which is not available otherwise. Its application makes it possible to redevelop the original component with its drawing and manufacturing process. In this paper author are going to manufacture spur gear used in automobile by Reverse Engineering. The procedure includes various stages

which will help understand the different phases of reverse engineering.

K. Aruna Prabha et al^[6] The paper is about design, analysis and manufacturing of planetary gear which explains the total process how easily the prototype can be manufactured using the technology of 3D printing.

Chandrashekhar Kalnad, et al^[7] Her work is about the FDM technique for 3D printing. An effort is made to carry out the study about 3D printing technique, Feature scope & different field application.

May Phyo Thu₁ New Lin Min₂, et al^[8] The work is on attempt to find out root bending stress distribution, maximum allowable stress and total deformation of spur gear tooth by rapid prototyping.

Pradeep Kumar Singh₁, Manwendra Gautam₂, Gangasagar₃, Shyam Bihari Lal₄, et al^[9] The research is based on Hertz theory is the basis of contact stress calculation and Lewis formula is use for calculating bending stress is a pair of gear. Analytically result obtained by Lewis formula and hertz equation and result found by comparable with finite element analysis of spur gear.

Alexandru Pîrjan₁ Dana-Mihaela Petroşanu₂ et al^[10] In this work is presented and analysed the impact of 3D printing technology on the society and economy. Also the study is about additive technology and the materials used in rapid prototyping.

5. Concluded remark:

The main purpose of authors work in above all research papers was to design a gear for various materials and use various types of 3D printing. For designing the gear, authors used finite element analysis and the modeling software's like Ansys, Catia, Solidworks, etc. The results obtained by these software's was compared with theoretical results. On this background, the main purpose of this dissertation is to propose the finding best 3D printing process as well as material for 3D printing for gear used in transmission system by comparing the various designs proposed by various methods and for different materials.

6. Conclusion:

Fused Deposition Modeling (FDM) is a less expensive process compared to all other 3D printing method. This makes it suitable for home use application. The level of accuracy and surface finish it provides are worth the manufacturing cost. However, the materials that FDM supports are limited mostly to thermoplastics.

3D printer is the method of converting 3D design into the reality. After the arrival of few years we can see 3D printer in every home if they want to make any toy or anything then they will buy the 3D file instead of the product. One day printer will make human organs for the need of peoples. Now days this technology is to be implemented in industries. Advantages of 3D printer are endless therefore it is most preferable technology.

References:

- [1] Dilip Sahebrao Ingole₁, Abhay Madhusudan₂, "Rapid prototyping - a technology transfer approach for development of rapid tooling" Rapid Prototyping Journal, 15/4 (2009) 280-290.
- [2] Omar M.F.M.₁, S. Sharif₂, M. Ibrahim₃ "Evaluation of Direct Rapid Prototyping Pattern for Investment Casting"
- [3] Yuhua Song₁, Yongnian Yan₂, "Three dimensional non-linear coupled thermo-mechanical FEM analysis of the dimensional accuracy for casting dies in rapid tooling"
- [4] J.C. Ferreira₁, N.F. Alves₂, "Integration of reverse engineering and rapid tooling in foundry technology", Journal of Materials Processing Technology.
- [5] B. Praveen Kumar₁, Mohammed Isran Shareef₂, "Spur gear development & analysis using rapid prototyping by reverse engineering"
- [6] K. Aruna Prabha K. Sambhavi, "Design, Analysis and Manufacturing of Planetary Gear Used in Clock Mechanism Using Rapid Prototype Technique"
- [7] Chandrashekhar Kalnad, "A review on 3D printing, International Journal of Advanced Research in Electronics and Communication Engineering" (IJARECE) Volume 5, Issue 7, July 2016
- [8] May Phyo Thu₁ New Lin Min₂ "Stress analysis on spur gears using ansys workbench 16.0" International Journal of Science and Engineering Applications Volume 7-Issue 08,208-213, 2018, ISSN:-2319-7560
- [9] Pradeep Kumar Singh₁, Manwendra Gautam₂, Gangasagar₃, Shyam Bihari Lal₄ "Stress Analysis Spur Gear Design By Using Ansys Workbench" International Journal of Scientific & Engineering Research, Volume 5, Issue 4, April-2014 1560 ISSN 2229-5518
- [10] Alexandru Pîrjan₁ Dana-Mihaela Petroşanu₂ "The impact of 3d printing technology on the society and economy".

[11] Shiwpursad Jasveer₁, Xue Jianbin₂ "Comparison of Different Types of 3D Printing Technologies" International Journal of Scientific and Research Publications, Volume 8, Issue 4, April 2018 1 ISSN 2250-3153

[12] Prof. D.V. Mahindru₁ & Prof. Priyanka Mahendru₂ "Review of Rapid Prototyping-Technology for the Future" Global Journal of Computer Science and Technology Graphics & Vision Volume 13 Issue 4 Versions 1.0 Year 2013.

[13] Lokesh k.₁ & Jain P. K.₂ "Selection of rapid prototyping technology" Advances in process engineering & management 5 (2010) 2, 75-84.

[14] Vaibhav S.Jadhav₁, Santosh R.Wankhade₂ "Review: Fused deposition modeling - a rapid prototyping process" International Research Journal of Engineering and Technology (IRJET). Volume: 04 Issue: 09 | Sep - 2017.

[15] Prof.N.U.Kakde₁, Prof.V.J.Deshbhratar₂ "Rapid Prototyping: A Review" International Journal of Engineering Research and General Science Volume 4, Issue 2, March-April, 2016. ISSN 2091-2730.

[16] Aman Kaushik₁, Suman kant₂, Parveen Kalra₃ "Rapid Prototyping Technologies and Applications in Modern Engineering -A Review". International Journal of Innovations & Advancement in Computer Science. Volume 4, special Issue, March 2015



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Biography:



Mr. Ganesh Sattyappa Kamble – B.E. Mechanical, research interest in design & analysis of solar dryer. Pursuing M. Tech. in Design Engineering from PVPIT, Budhgaon, Sangli, keen interest in rapid prototyping.



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