

Design and Development of Spur Gear by using Three Dimensional Printing

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ABSTRACT

Gears are power transmission devices in between input and output of machines, these power transmitting elements are very compact, and they transfer power with minimum loss. Due to the nature of their different speed ratios they are used for different applications like high speed marine engines, automobiles etc. Different materials are used for preparation or fabrication of gears like metals (steel or brass), plastics (nylon or polycarbonate). In this project spur gear is designed by CAD software and fabricated by using 3D printer, for 3D printing materials require like plastics or ceramics but for this project plastic material is used that is polylactic acid (PLA). By using 3D printer spur gear is produced within a small period with better dimensional accuracy than conventional method like milling etc.

KEYWORDS: Power Transmitting Elements, Speed Ratios, Steels or Brass, Nylon or Poly Carbonate, 3D Printer, Polylactic Acid (PLA) and Dimensional Accuracy.

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I. INTRODUCTION

In Each and every machine needs power transmission devices in order to transmit power from input devices of the machine to output devices. Chasis, gears and belts are three different power transmitting devices, they are having different considerations for their use in real time applications. For example, take the distance between input and output, if distance is very long then belt is used, for medium distance chains are used and for small centre distance gears are used. Gears are very compact and they're their central distance is very small compared to other power transmitting devices.

Gears are used where constant velocity ratio is required, and they provide low effect of forces on shafts on which gears are mounted. For power transmission purpose minimum two gears are required, the gear one which is in small diameter than other device is called pinion and other is called gear. When rotational speed applied between contacting gears, axis of rotation of two gears are different with respect to each other. Main disadvantage of gears is, which are not suitable for longer centre distance, noise generation problem is more, and they require more lubrication than other power transmission systems.

Different types of gears are used for power transmission like bevel gears, spur gears, helical gears, rack and pinion and

worm and worm wheel. For this project spur gear is selected for fabrication by using 3D printer by fused deposition method. Spur gear is used when both shafts on which gears are mounted must be parallel, in these gears teeth are straight and parallel to axis of shafts. These gears are easy to manufacture due to its simple construction and design. Because of these reasons only spur gears are having wide range of applications in industries.

Spur gears are having involute profile (path traced by the idealized string or wire wrapped around particular curve), this gear produces only radial forces on shafts not axial forces on circumference of shafts. Due to constant and continuous meshing of teeth of spur gears generation of noise is more in this type of gears, these gears having high transmission efficiency because of low slippage losses.

For high speed applications (ball mills and crushing equipment's) spur gears are used even though they are having high noise level. These gears are used for speed reduction and torque multiplication purpose. Before developing final product its prototype or replica of product is created and tested to know its properties and design considerations are correct or not and its dimensional accuracy is in proper condition or not. Three different

prototyping technologies are present like manual prototyping, soft prototyping and rapid prototyping.

Manual prototyping is oldest method of prototype production it requires more time for developing. Soft prototyping uses curves and surfaces in order to create prototype. Rapid prototyping is advanced process in this material is applied or added layer-by-layer this process is called additive manufacturing process. For this purpose 3D printer is used which reads the information in the form of G-codes and M-codes, after reading create slices of modelled product after that material is deposited on basis of codes as well as slicing of modelled product, material is added layer-by-layer manner in order to create complete product by using 3D printer.

Rapid tooling is produced directly or indirectly by fused deposition modelling process, it reduces product development life cycle and, it is costlier than other methods [1]. Operational characteristics of spur gear made up of polylactic acid (PLA) are better than acrylonitrile butadiene styrene (ABS) [2]. In order to know and increase the possibility of application of polymer gears in different fields. Analysis of spur gear with different materials conducted, it shows that if polymer is design optimized most of metallic gears are replaced with polymer gears with more benefits like less weight, easy to manufacture and low cost as well as less noise generation [3].

Computer aided design (CAD) reduces the time and cost by testing in the field because cad system includes drafting, modelling, analysis and testing. Elimination of errors are takes place in easy manner [4]. Finite element analysis (FEA) of spur gear made up of different materials like polylactic acid, acrylonitrile butadiene styrene, nylon12 and polycarbonate shows that nylon is strong when subjected to tensile and compressive loads [5]. In order to prevent failure of gear, strength of gear play an important role, as face width of gear increases maximum bending stress on gears becomes maximum stress [6].

II. Materials

Spur gear fabrication process done by using different materials like metals and plastics. Brass or steels and nylon or polycarbonate are commonly used materials. But for this project polylactic acid selected for spur gear production as filament material for 3D printer, this material is biodegradable produced from natural; materials like fermentation of starch like sugarcane etc.

PLA used in 3D printing because it is used as a moulded or pattern material for casting of products due to its less glass transition temperature, in casting it gets easily vaporized by forming mould cavity it allows molten metal to flow in to it.

III. Methodology

Every production process involves different stages of production like material collection, preparation, design, modelling, fabrication and inspection. Same like for plastic spur gear production different stages are involved as shown in Fig.1. like selection of materials, modelling of spur gear, conversion of modelling file to STL file, slicing of modelled spur gear and 3D printing of spur gear.

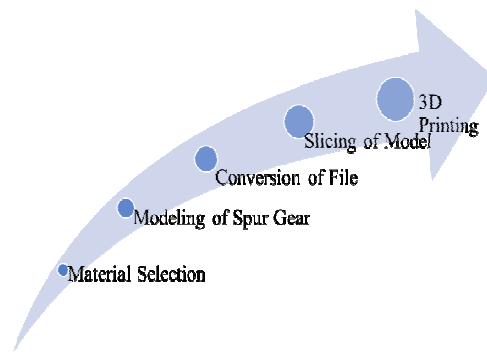


Fig.1. Stages of Plastic Spur Gear Production

In first stage material is selected on basis of their properties after that spur gear model is created by using CAD software and conversion this model into STL (Standard Tessellation Language) after that slicing is done to create 3D printed component.

IV. MODELING OF SPUR GEAR

Spur gear model is created by using CAD software CATIA V5R20, this is fully three-dimensional software and gives better description and design of any geometric shape and, it is double precision system due to this reason it has wide range of application in aerospace, automotive industries and shipbuilding etc.

1. Steps for 3D model Production

- Select the plane on which the design needs to be drawn.
- Select sketcher it is used to create 2D representation of part and create spur gear profile.
- After creating profile exit from sketcher and enter part design.
- By using padding option add material to profile of spur gear.
- Finally, by using slot option make slot inside hole created by pocket on spur gear face. Final modelled spur gear as shown in Fig.2.

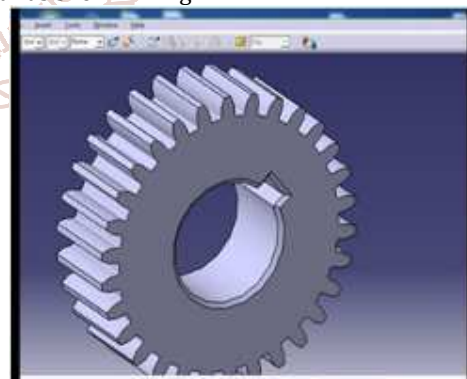


Fig.2. Spur Gear 3D Model

V. Fabrication of Spur Gear

Fabrication of plastic spur gear by using 3D printing technology includes different stages like after model creation the 3D model must be converted into standard tessellation language file in order to read information by 3D printer. 3D printer does not read information as it is, it requires geometry and machining codes in order to get better dimensional accuracy of modelled product.

Model is divided into number of layers this process is called slicing of model this provides better dimension for component and elimination of errors in production process.

By using fused deposition modelling process 3D printed spur gear is developed as shown in Fig.3. by the layer-by-layer adding of material from the 3D printer.



Fig.3. 3D Printed Spur Gear

VI. Conclusion

From this project it is concluded that the gear production process of conventional system is difficult and time-consuming process but gives good dimensional accuracy. These methods are only applicable for metals for better production, other materials also used but gives less production rate.

Due to this problem rapid prototyping is employed for production of spur gears in this project due to this process time taken for production of spur gear by using 3D printer is very less compared to conventional methods of production with benefits like better dimensional accuracy and perfect shape of modelled components are created. Products are created within short span of time with many advantages, but it has only one disadvantage is that it is costlier process than other conventional methods.

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