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Design and Stress Analysis of Helical Gear and Manufacturing through Rapid Prototyping Method

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Abstract *– Helical gears have been used for a wide range of engineering and technological applications especially in automobiles, shipbuilding, aircraft and marine applications. The rapid increasing demand for high speed ratio, highly efficient cum light weight engines with quite power transmission has led to the need for optimization of helical gears being used till today. They are used for a wide range of industrial applications. They are the most common means of transmitting power. They change the rate of rotation of machinery shaft and also the axis of rotation. Effective gear design contains Strength, durability, reliability, size, weight and cost. The gearbox is one of the inherent components in any automotive system and comprises approximately 30% cost of the total cost of the automobile. Plastic gears also open new opportunities for more efficient transmissions in many products along with reduced drive drive-cost, weight, noise and wear. Along with this the gearbox is a heavy component of the automobile. To reduce drive cost, noise and weight by replacing metallic gears by thermoplastic gears in the gearbox of identified low power moped is the objective of this work. Initially the material is identified among heavy engineering plastics for manufacturing of gear. The material selected is tested in test laboratory and gears are manufactured using hobing process with the same accuracy and specifications as that of metallic gears of the gearbox. It is found that a thermoplastic gear has less noise, vibrations than metallic gears.*

Keywords- Helical gear, gearbox, Plastic gear, Analysis

INTRODUCTION

Gearing is one of the most effective methods transmitting power and rotary motion from the source to its application with or without change of speed or direction. In automobile, highly reliable and lightweight gears are essential. Mechanical design can be defined as the selection of materials and geometry, which satisfies, specified and implied functional requirements. The method of design has to minimize the most significant undesirable effect and to maximize the most significant desirable effect. Gears are used for a wide range of industrial applications. They have varied application starting from textile looms to automobile industries. They are the most common means of transmitting power. They change the rate of rotation of machinery shaft and also the axis of rotation. For high speed machinery, such as an automobile transmission, they are the optimal medium for low energy loss and high accuracy. Their function is to convert input provided by prime mover into an output with lower speed and corresponding higher torque or vice-versa. Effective gear design contains Strength, durability, reliability, size, weight and cost. Designing highly loaded helical gears for power transmission systems that are good in strength and low level in noise necessitate suitable analysis methods that can easily be put into practice and also give useful information on contact and bending stresses one of the main reason of the failure in the helical gear is bending stresses and vibrations. But the stresses are occurred due to the contact between two gears while power transmission process is started. Due to meshing between two gears contact stresses are evolved, which are determined by using analyzing software called ANSYS. Finding stresses has become most popular in research on gears to minimize the vibrations, bending stresses.

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II-LITERATURE SURVEY

- B .Venkatesh et. al.: In their article, carried out the structural analysis of a high speed helical gear used for marine engines. These engines are continuously subjected to large stresses and deflections which are needed to be minimized. The dimensions of the model were obtained by theoretical techniques. These stresses generated and the deflections of the helical gear tooth had been analyzed for different materials and the final results obtained were compared to check the correctness by theoretical analysis and FEM. The project mainly concentrated on reduction of gear-weight and enhancing the accuracy of gears. The same authors, in 2014 came up with another research article "Investigate the Combined Effect of gear ratio, helix angle, face width and module on beam strength and Wear tooth load of Steel alloy Helical Gear" in which the effect of gear ratio, face width, helix angle, module to obtain the optimum beam strength and wear tooth load under variable circumstances was shown. Initially the helix angle, face width, speed and module were kept constant, when the gear ratio was increased; the corresponding beam strength remained constant. Secondly keeping the helix angles, gear ratios, speed, module except face width were kept constant and for variation of face width, the beam strength increased. Similarly for helix angles, gear ratio, face width and speed kept constant, with increase in module the beam strength increased accordingly
- Kailash Bhosale had done the Analysis of bending strength of helical gear by FEM. A helical gearbox with 2.2 kW power transmitting at 760 rpm and Number of Teeth = 30mm, Pitch circle Diameter = 60mm, Module = 2mm, Pressure Angle =20°, Helix Angle = 12054', Addendum = 64mm, Base circle Diameter = 56.38mm, Dedendum = 55mm. A solid modelling is done with CATIA and then by using the hyper mesh meshing is done. Analysis is done with ANSYS Workbench 12.1. The analysis of bending stress in gear tooth was done by Mr. Wilfred Lewis known as Lewis equation. In the Lewis analysis, the gear tooth was treated as a cantilever beam. The tangential component (Pt) causes the bending moment about the base of tooth. The Lewis analysis was based on the following assumptions: The effect of radial component (PR) was neglected. The effect of stress concentration was neglected. At any time only one pair of teeth was in contact and takes the total load.
- Tribhuvan Singh, Mohd. Parvez had carried out the analysis of helical gear using AGMA standards and FEM. In this work a parametric study was conducted by varying the face width and helix angle to study their effect on the bending stress of helical gear. This thesis investigates the characteristics of an involute helical gear system mainly focused on bending and contact stresses using analytical and finite element analysis. To estimate the bending stress, three- dimensional solid models for different number of teeth are generated by Pro/Engineer that is powerful and modern solid modelling software and the numerical solution is done by ANSYS, which is a finite element analysis package. The analytical investigation is based on Lewis stress formula. This thesis also considers the study of contact stresses induced between two gears. Present method of calculating gear contact stress uses Hertz's equation. To determine the contact stresses between two mating gears the analysis is carried out on the equivalent contacting cylinders. The results obtained from ANSYS are presented and compared with theoretical values.
- Raghava Krishna Sameer, B. V. Srikanth had worked on the Contact stress analysis of modified helical gear using catia & ansys In this paper parametric study was done by varying the geometry of the teeth to investigate their effect of contact stresses in helical gears. As the strength of the gear tooth was important parameter to resist failure. In this study, it was given that the effective method to estimate the contact stresses using three dimensional models of both the different gears and to verify the accuracy of this method. The two different result obtained by the ansys with different geometries are compared. Based on the result from the contact stress analysis the hardness of the gear tooth profile can be improved to resist pitting failure. The use of nylon plastics in the U.S. automotive industry has grown from tentative beginnings in a few years and knobs to a multi-million pound business which places highly specialized

engineered resins into virtually every area of a modern Vehicle. The keys to this spectacular growth have been nylon's basic properties which allowed replacement of metals and other materials with a substance that offered superior performance, and by nylon's ability to be adapted and modified to meet ever changing and increasing performance demands.

III- METHOLOGY

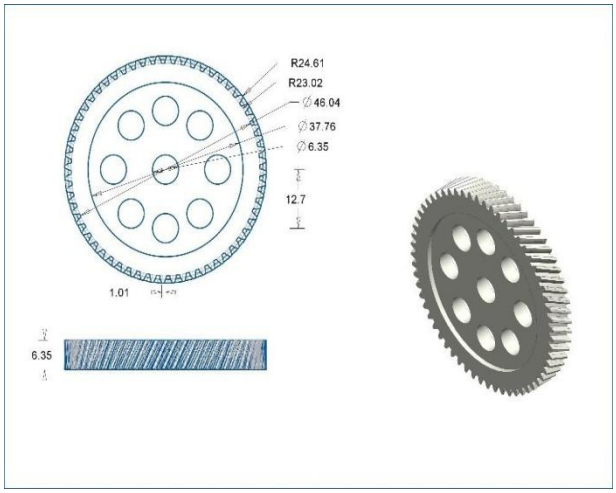
Initially Gears are design for same power transmission as that of present metallic Gears using same conventional design procedure.

Gears are modelled using CREO PARAMETRIC software and tested for displacement, strain and stress and are Simulated Using cad modelling and FEM, analysis of the plastic gear and its material will be done. In addition, it's an efficient design tool by which designers can perform parameter design studies by considering various design cases of loading, motion etc. can be analyzing and choosing the optimum design.

By taking into consideration the various methods of plastic Gears are manufactured using hobbing process by different thermoplastic materials viz. cast nylon, NylonMOS2 etc.

As per the objective of our project we will carried out the experimentation and testing of the replaced metal gear by plastic gear under different running condition and speed.

DESIGN OF HELICAL GEAR



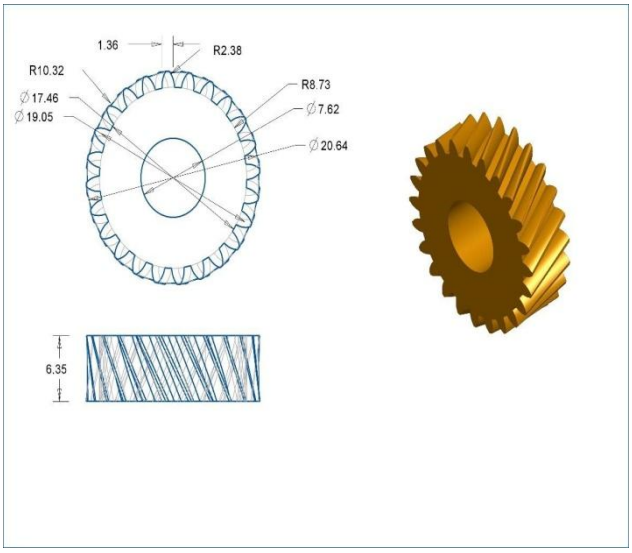


Fig.1.1 the Various Dimensions Over replaced Gear of Bajaj Sunny Indicated Above

IV- CONCLUSION

As the technological progress is happening the products are now extensively made using plastic material especially in robotics, industry, electrical instrument and automobile gear and in other mechanical working condition. This application needs to be light weight and modular in nature plastic components like gears. As per industry statistics we have found that gears are made up of plastic material of High-density polyethylene (HDPE) which is prone to various kinds of defects when manufacturing using image processing.

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