MODELLING AND 3D-PRINTING OF BEVEL GEAR

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ABSTRACT

Bevel gear have teeth cut on conical blanks. The gear pair is used to connect non-parallel intersecting shafts for motor transmissions, differential drives and mechanical instruments. Bevel gears are used for transmission of power between axles in rear wheel of vehicle will be modelled by using solid works. Shaping, Casting and Grinding are the traditional methods of manufacturing of bevel gear which are time consuming, and increased in production cost.

To overcome this, new method such as rapid prototyping method of manufacturing is used which offers the potential for faster and more cost-effective manufacturing with ability to customize the design and improve performance.

In this project, the Bevel Gear is designed using solid works by ensuring that the gear's dimensions and tolerances are appropriate for the 3D printing process being used and then the Bevel Gear is printed using the 3D-Printer.

Keywords: Bevel Gear, 3D Printing,Rapid Prototyping, Design

I. INTRODUCTION

Gearing

Gears are most commonly used for power transmission in all the modern devices. These toothed wheels are used to change the speed or power between input and output. They have gained wide range of acceptance in all kinds of applications and have been used extensively in the high- speed marine engines.

In the present era of sophisticated technology, gear design has evolved to a high degree of perfection. The design and manufacture of precision cut gears, made from materials of high strength, have made it possible to produce gears which are capable of transmitting extremely large loads at extremely high circumferential speeds with very little noise, vibration and other undesirable aspects of gear drives.

II. LITERATURE SURVEY

Matthew D Brown etl. gives a detailed approach to spiral bevel gear design and analysis. Key design parameters are investigated in accord with industry standards and recommended practices for use in a medium class helicopter. A final gear design is proposed and analyzed to show that proper margins of safety have been included in the design. Upon completion of the design phase of the gear, analysis was conducted to ensure appropriate margins of safety had been implemented into the design. Calculated values of Hertz stress and bending stress are less than the allowable stresses as per AGMA.

Robert F Hand schuh etl. gives Experimental and analytical studies have been conducted with respect to the thermal behavior of spiral bevel gears. The experimental effort was conducted on aerospace quality spiral bevel gears at rotational speeds to 14400 rpm and 537 kW (720 hp). The experimental results indicated that load, jet location, flow rate, and oil inlet temperature all can affect the steady state operating temperature of the spiral bevel pinions that were instrumented. Also, an analytical modelling method was developed to analyze the thermal behavior via the finite element method.

SH Gowanda etl. gives mechanical design of crown wheel and pinion in differential gear box of MFWD (FWA) Axle (of TAFE MF 455) is done. Detailed modelling, assembly and analysis of tooth of crown gear and pinion is performed in Pro-E. Finite element analysis is performed to analyze the crown gear tooth for working load. Induced equivalent stress is less than allowable stress. From this it is concluded that design is safe.

A Bensely etl. gives failure investigation of crown wheel and pinion has been done. A fractured gear was subjected to detailed analysis using standard metallurgical techniques to identify the cause for failure. The study concludes that the failure is due to the compromise made in raw material composition by the manufacturer, which is evident by the 638 Int. J. Adv. Eng., 2015, 1(8), 637-643 presence of high manganese content and non-existence of nickel and molybdenum. This resulted in high core-hardness (458 HV) leading to premature failure of the pinion. The experimental results indicated that load, jet location, flow rate, and oil inlet temperature all can affect the steady state operating temperature of the spiral bevel pinions that were instrumented.

D. Lewicki etl. gives an experimental program to test the feasibility of using face gears in a high-speed and high-power environment was conducted. Four face gear sets were tested, two sets at a time, in a closed-loop test stand at pinion rotational speeds to 19,100 rpm and to 271 kW (364hp). The test gear sets were one-half scale of the helicopter design gear set. Testing the gears at one-eighth power, the test gear set many years of gear industry experience has led the design community to rely on carburized, case-hardened steel for bevel gears. Therefore, spiral bevel gear materials are limited to only those which are easily carburized and case- hardened of associated steel grades and their typical heat treatments displays the seven potential steel grades which are recognized to be well suited towards carburization in bevel gear applications.

Sweeney etl. (1995) carried out an investigation to study the effect of load and speed on noise and vibration. He stated that it was difficult to arrive at a conclusion about the relationship between vibration, noise and transmission error. It was emphasized that there is no physical source for an ideal correlation 19 between these parameters. However, some researchers have assumed that noise and vibration are the direct result of Transmission Error.

Maria & Zdzislaw (2001) modeled noise and vibration of a toothed gear. First, they detected the noise of gear box body at impact free vibration. In second step with two different working loads, noise of forcing vibration was observed. Digital tape recorder was used to observe the signals of vibration and noise of gear box.

Oswald et al (1998) have investigated the noise radiation based on the gear design. They state that, the contact ratio was the most important factor for reducing noise, by increasing the face of contact noise can be reduced. A final gear design is proposed and analyzed to show that proper margins of safety have been included in the design. Upon completion of the design phase of the gear, analysis was conducted to ensure appropriate margins of safety had been implemented into the design. They have also said that, involute spur gears produce 3 dB to 4 dB less noise than non-involute spur gears. Bueller (1968) investigated the gear teeth modifications and its influence on gearbox noise. He also related it with manufacturing errors. Especially, errors that occur after shaving and hardening 20 were discussed.

Karlis Paulins et al (2014) created winding incline gear with improved plan of rigging spaces with enhanced tooth closes. It is conceivable to advance rectangular-produced, winding incline pinion/gear sets with steady tooth stature and a typical pitch cone peak. The work effectively accomplished the recalculation of the apparatus spaces, with no adjustments in the flank geometry or tooth-cutting procedure.

Xiaofeng Shi and Cheuk-Ming Mak investigated wave propagation in microperforated tube mufflers through theoretical, numerical, and experimental approaches. They found that microperforated tube mufflers provide effective sound attenuation due to their high acoustic resistance and low mass reactance. Arranging multiple microperforated panel absorbers in parallel enhances absorption bandwidth compared to single absorbers. The periodic distance of perforation significantly influences sound attenuation within certain frequency ranges.

III. METHODOLGY

This methodology explains the step by step process which are carried out to accomplish the completion of entire modelling and 3D-printing of Bevel gear. Using Solid works, the computer model of Bevel gear will be designed. The 3D-model design is then printed by using the 3D printer. The 3D model of Bevel gear is printed by using Fused deposition Modelling technique. Acrylonitrile butadiene styrene(ABS) and Polylactic acid(PLA) are basically used material for preparing a model in 3D printing. The use of 3D printing technology allowed for the customization of the gear design and the creation of complex geometries that would be difficult or impossible to produce using traditional manufacturing methods.

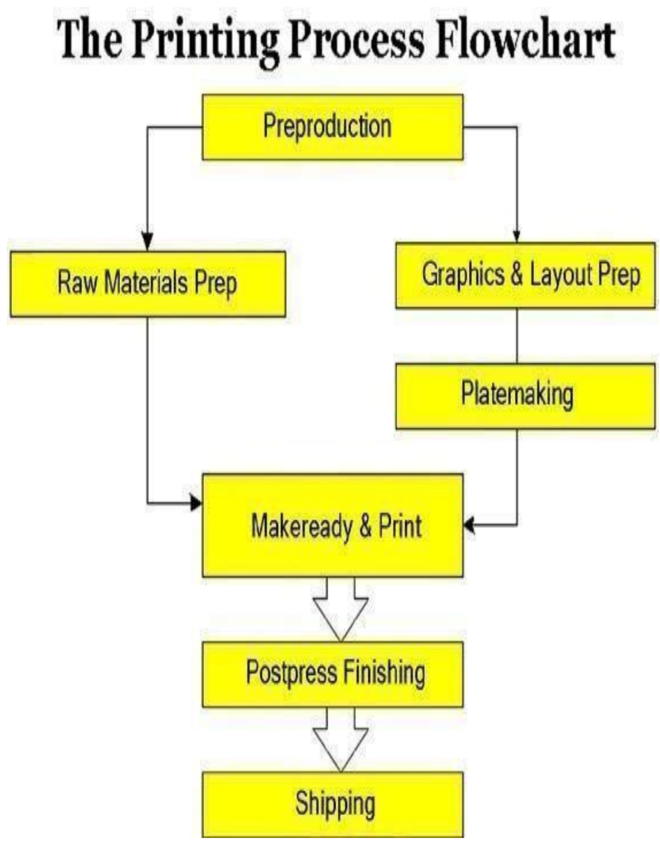

Fig-2: Printing process flow chart

MODELLING OF BEVEL GEAR

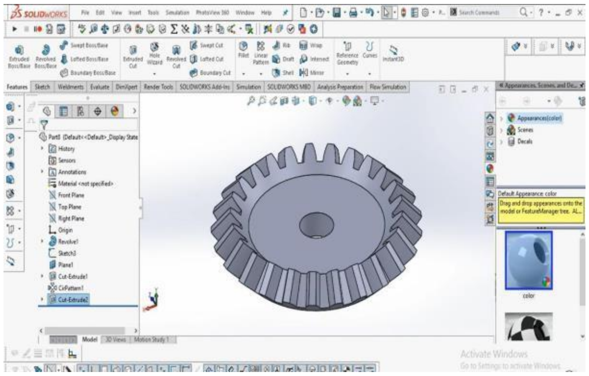

Fig-3: 3D Model of Bear Gear PRINTING OF BEVEL GEAR

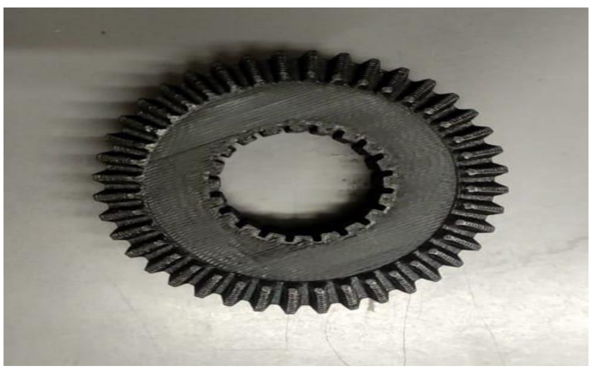

Fig:4: Final component of Bevel gear

CONCLUSION

In conclusion, this project successfully demonstrated the process of modeling a complex mechanical component, the bevel gear, using SolidWorks software. Through careful consideration of design parameters such as tooth profile, pitch diameter, and pressure angle, an accurate digital representation of the gear was achieved. The utilization of Stereolithography (SLA) 3D printing technology enabled the physical realization of the modeled bevel gear with high precision and surface finish.

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