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A REVIEW ON DESIGN, ANLYSIS AND MATERIAL OPTIMIZATION OF HIGH SPEED HELICAL GEAR BY CHANGING DEFFERENT DESIGN PERAMETERS USING FEA APPROACH

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ABSTRACT

Gears are one of the most critical components in mechanical power transmission systems. The bending and surface strength of the gear tooth are consider to be one of the main contributors for the failure of the gear in gear set. The three dimensional solid model can be generated in pro E. This model is imported in ansys and then contact stress and bending stress can be calculated in ansys for deferent face width and helix angle. Contact stress and bending stress can also be calculated by hertz, lewis and AGMA equation. Bending stress can be occur in the root of gear and contact stress can be occur between meshing of two gear. Finally these two methods bending and contact stress results both are compared with each other for deferent face width and helix angle Different material can also be tried for wight and cost optimization. And also to increase corrosion resistance which might be cause of failure.

KEYWORDS: Stress Analysis, Face Width, Naylon, Glass Filled Polyamide, Fiber, Epoxy.

INTRODUCTION

Gears are use to transmit power and motion from one shaft to another. Helical gears are currently being used increasingly as a power transmitting gear owing to their relatively smooth and silent operation, large load carrying capacity and higher operating speed. Helical gears have a smoother operation than the spur gears because of a large helix angle that increases the length of the contact lines. 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 .Gears are used to change the speed, magnitude, and direction of a power source. Gears are being most widely used as the mechanical elements of power transmission.

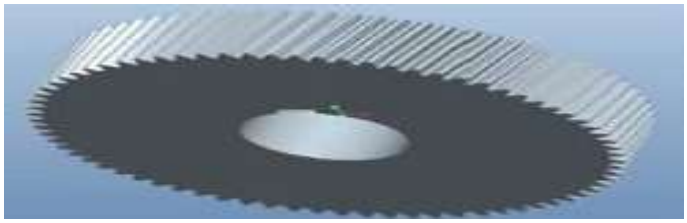

Fig.1 .helical gear

LITERATURE REVIEW

Nitin Kapoor, Virender Upneja, Ram Bhool and Puneet Katyal [1].

The main objective of this paper is to developed parametric model of differential Gearbox by using CATIA-V5 under various design stages. It is observed that Glass filled polyamide composite material is selected as best material for differential gearbox and is found to suitable for different revolutions (2500 rpm, 5000 rpm and 7500 rpm) under static loading conditions. Comparisons of various stress and strain results using ANSYS-12 with Glass filled polyamide composite and metallic materials (Aluminum alloy, Alloy Steel and Cast Iron) are also being performed and found to be lower for composite material.

Glass filled polyamide composite material is used for gears and are analyzed using ANSYS for equivalent (Von-Misses) stress, displacement (total deformation) and maximum shear elastic strain for different revolutions (2500 rpm, 5000 rpm and 7500 rpm) under static conditions. Comparisons of various stress and strain results with Glass filled polyamide composite and metallic materials (Aluminium alloy, Alloy Steel and Cast Iron) are also being performed and found to be lower for composite material. By observing these analysis results, Glass Filled Polyamide composite material is selected as a best material for Differential gear box which in turn increases the overall mechanical efficiency of the system.

Utkarsh.M.Desai, Prof.Dhaval.A.Patel [2].
In this work, A metallic gear of Alloy Steel is replaced by the composite gear of 30% Glass filled Poly-ether-ether-Ketone (PEEK). Such Composites material provides much improved mechanical properties such as better strength to weight ratio, more hardness, and hence less chances of failure. In this work, an analysis is made with replacing metallic gear with composite material such as PEEK so as to increase the working life of the gears to improve overall performance of machine. Finally the Modeling of spur gear is carried out using SOLID WORK and bending stress analysis of spur gear is carried out using ANSYS V14.Von mises stress for alloy steel is to be found as 6.50 Mpa and for composite material it is to be found as 5.96 Mpa as shown in the figure.

For that, analytical and finite element method are applied for determining bending stress of gear tooth. The obtained FEA result is compared with the analytical result and found that both result are comparable. Result shows that by stress analysis the strength of the GF 30 PEEK spur gear is more when compared with alloy steel spur gear.

Also the density of the GF 30 PEEK is very less when compared with alloy steel. So we can conclude that the alloy steel spur gear can be replaced by GF 30 PEEK(composite) spur gear due to its high strength, low weight and damping characteristics.

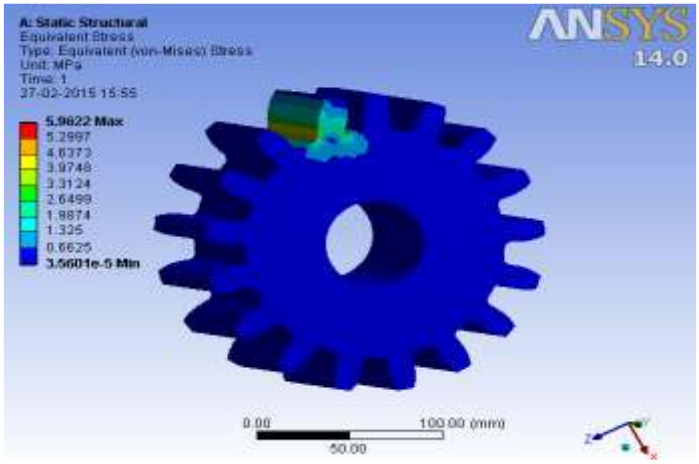

Fig 2. von mises stress for GF 30 PEEK material spur gear.

S.Mahendran, K.M.Eazhil, L.Senthil Kumar [3].
In this paper the analysis of spur gear with cast steel and composite material like fiber and epoxy is done by using fea. Their value for weight and stress has been compared and found that composite materials are more better than cast steel.

Fibers produce high-strength composites because of their small diameter; they contain far fewer defects (normally surface defects) compared to the material produced in bulk. As a general rule, the smaller the diameter of the fiber, the higher its strength, but often the cost increases as the diameter becomes smaller. In addition, smaller-diameter high-strength fibers have greater flexibility and are more amenable to fabrication processes such as weaving or forming over radii.

Epoxy resins are widely used in filament-wound composites and are suitable for molding prepress. They are reasonably stable to chemical attacks and are excellent adherent shaving slow shrinkage during curing and no emission of volatile gases. These advantages, however, make the use of epoxies rather expensive. Also, they cannot be expected

beyond a temperature of 140ºC. Their use in high technology areas where service temperatures are higher, as a result, is ruled out.

Epoxy resins are easily and quickly cured at any temperature from 5°C to 150°C, depending on the choice of curing agent. One of the most advantageous properties of epoxies is their low shrinkage during cure which minimizes fabric print-through and internal stresses. High adhesive strength and high mechanical properties are also enhanced by high electrical insulation and good chemical resistance. Epoxies find uses as adhesives, caulking compounds, casting compounds, sealants, varnishes and paints, as well as laminating resins for a variety of industrial applications.

From these analysis we got the stress values for composite materials is less as compared to the cast steel spur gear. Composite materials are capable of using in automobile vehicle gear boxes up to 1.5KN in the application of Tata super ace model instead of existing cast steel gears with better results.

V. Siva Prasad, Syed Altaf Hussain, V.Pandurangadu, K.PalaniKumar[4].
This paper describes design and analysis of Spur gear. In the present work, it is proposed to substitute the metallic gear of sugarcane juice machine with plastic gears to reduce the weight and noise. For the purpose of two different types of plastic materials were considered namely Nylon and Polycarbonate and their viability are checked with their counterpart metallic gear (Cast iron). Based on the static analysis, the best plastic material is recommended for the purpose. Static analysis of a 3-D model has been performed using ANSYS 10.0. Compared to Cast iron spur gears Nylon gears are suitable for the application of sugarcane juice machine application under limited load conditions.

The majorities of nylons tends to be semi-crystalline and are generally very tough materials with good thermal and chemical resistance. The different types give a wide range of properties with specific gravity, melting point and moisture content tending to reduce as the nylon number increases. Nylons can be used in high temperature environments. Heat stabilized systems allow sustained performance at temperatures up to 185oC.

Polycarbonates received their name because they are polymers containing carbonate groups (–O–(C=O)–O–). Most polycarbonates of commercial interest are derived from rigid monomers. A balance of useful features including temperature resistance, impact resistance and optical properties position polycarbonates between commodity plastics and engineering plastics.

To find the suitable design gears with less weight and less cost, corrosion resistance, frictionless also. To design and manufacture a sugarcane juice for a common people including women. With less cost, self lubricating neat and clean hygienic juice. With more material removal of deflection and stress are increased. So for safe operation of this design is more appropriate under limited load conditions for Nylon gear.

Raghava Krishna Sameer.B, V.Srikanth[5].
In this paper parametric study is also made by varying the geometry of the teeth by using catiav5 In catiav5 this tools are manly used design the helical gear are PAD: which adds the material according to the profile created in the sketcher module CIRCULAR PATTERN : this option is used to rotate the teeth with respect to the gear axis which generates total number of teeth on complete crown of the gear TRITANGENT FILLET: this tool is used to create the fillet along the teeth, which creates tangential fillet to investigate their effect of contact stresses in helical gears. Analysis is done in Ansys 14.0.As the strength of the gear tooth is important parameter to resist failure. In this study, it is shown that the effective method to estimate the contact stresses using three dimensional model 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: a phenomena in which a small particle are removed from the surface of the tooth that is because of the high contact stresses that are present between mating teeth, as of the obtained data the contact stresses which are acting on the modified helical gears are more which is 12.49Mpa as shown below when compared to the standard helical which is 2.0051Mpa so these paper pretends to be failure theory by which the design aspects are to no changed to reduce the contact stresses.

Jerin sabu,Dr.Y.V.K.S.Rao, Alen John,Rajeev V.R[6].
This paper proposes the development of the finite element model for the helical gear pair for monitoring the deformation and stress state of teeth flanks, teeth fillets and parts of helical gears during the tooth pair meshing period. Here in the case of nonlinear contact type, contact element used is ‘Rough’. For the teeth contact ‘pure penalty’ method

is chosen. Penalty method uses a contact "spring" to establish a relationship between two contact surfaces. Another important one in the connection type is the Interface Treatment'. Interface Treatment indicates how the contact interface for the pair is treated. For nonlinear contact types (frictionless, rough, and frictional), Interface Treatment is displayed. In this paper 'Adjust to Touch' interface treatment is used. So any initial gaps are closed and any initial penetration is ignored creating an initial stress free state. Here the proper choice of the contact stiffness is critical. For the investigation of contact problems with finite element method, the stiffness relationship between the two contact areas is usually established through a spring placed between the two contacting areas. This can be achieved by inserting a contact element placed in between the two areas where contact occurs. Initially helical gear pairs are modelled in SolidWorks and then import the IGS file to the ANSYS Workbench 11 environment. Thereafter in ANSYS Workbench, nonlinear contact analysis is done. The stresses generated on gear teeth flanks, teeth fillets and parts of helical gears during the tooth pair meshing period are obtained.

Analysis of stresses on gears is very much necessary to minimize or to reduce the failures and for optimal design of gears. Analytical methods of gear analysis uses a number of assumptions and simplifications and it is intended to determine the maximum stress values. One of the main gear tooth failure is pitting which is a surface fatigue failure due to many repetition of high contact stresses occurring in the gear tooth surface while a pair of teeth is transmitting power. Proper contact element in teeth contact region is very much necessary for the simulation of nonlinear contact problem In this paper two cases were discussed in first case the gear has fixed support and pinion has frictionless support which has contact stress value 42Mpa as shown in the figure. In second case the gear has frictionless and pinion has fixed support which has contact stress value 70Mpa.The 3-D diagrams obtained during the work showing the maximum stresses on the gear tooth is very helpful for the detailed analyses. Here maximum von-mises stress state of teeth flanks, teeth fillets and parts of helical gears during the teeth pair meshing period and deformation is obtained The total deformation of gear teeth was also found to be very less and which is acceptable.

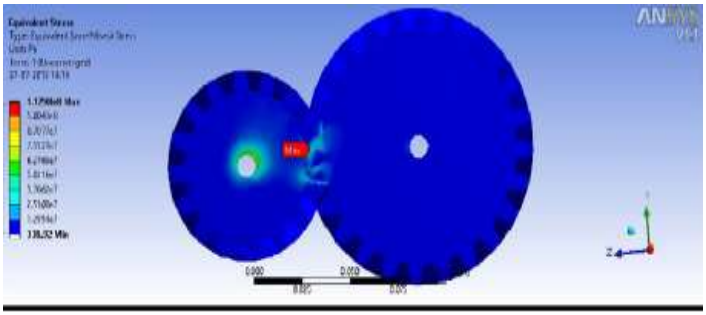

Fig. 3 Equivalent stress (non-linear contact stress) for helical gear pair when gear has fixed support and pinon has frictionless support.

J. Venkatesh, Mr. P. B. G. S. N. Murthy[7].
In the gear design the bending stress and surface strength of the gear tooth are considered to be one of the main contributors for the failure of the gear in a gear set. Thus, the analysis of stresses has become popular as an area of research on gears to minimize or to reduce the failures and for optimal design of gears In this paper bending and contact stresses are calculated by using analytical method as well as Finite element analysis. To estimate bending stress modified Lewis beam strength method is used. Pro-e solid modeling software is used to generate the 3-D solid model of helical gear. Ansys software package is used to analyze the bending stress. Contact stresses are calculated by using modified AGMA contact stress method. In this also Pro-e solid modeling software is used to generate contact gear tooth model. Ansys software package is used to analyze the contact stress. Finally these two methods bending and contact stress results are compared with each other In this work analytical and Finite Element Analysis methods were used to predicting the Bending and contact stresses of involute helical gear. Bending stresses are calculated by using modified Lewis beam strength equation and Ansys software package. Contact stresses are calculated by using AGMA contact stress equation and Ansys software package. Analysis is carried out for deferent number of teeth which are 18,20 and 25 and deferent helix angle and different bending stress is found out as shown in the figure. Induced bending stress is a major function of number of teeth and helix angle influence is less on contact stresses. As a result, based on this finding if the material strength value is criterion then a gear with minimum number of teeth with any maximum helix angle of more face width is preferred.

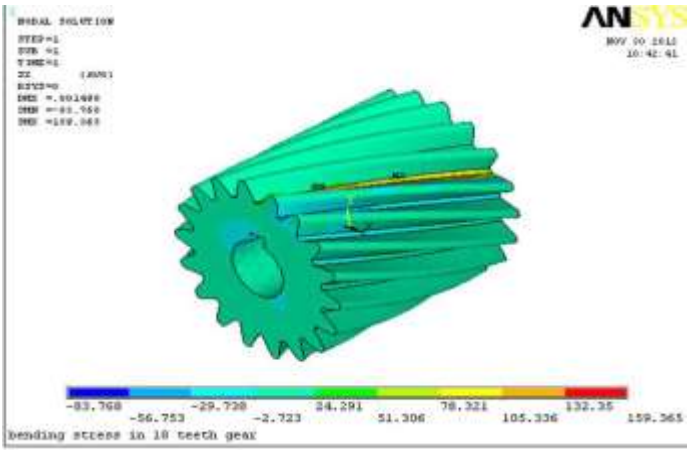

Fig. 4 bending stress in helical gear

Pradeepkumar Singh,Manwendra gautam ,Gangasagar and Shyam Bihari Lal[8].
In this paper using ansys work bench software, bending stress, contact stress and Static load on the tooth of spur gear drive is found. The finite element method is most widely for find a real model of the geared set using the stress analysis in the pair of gears. The development off finite element analysis model of the spur gear assembly to simulate the contact stress calculation and bending stress calculation is play more significant role in the design of gears. The study is show that Hertz theory is the basis of contact stress calculation and Lewis formula is use for calculating bending stress is a pair of gear. Theoretically result obtained by Lewis formula and hertz equation and result found by comparable with finite element analysis of spur gear. As a result, based on this finding if the contact stress minimization in the primary concern and if the large power is to be transmitted then spur gears with higher model is preferred. Hence we conclude that analysis software can be used for other analyzing purpose.

CONCLUSION

In this paper author have been presented a brief review of design and modelling and analysis of high speed helical gear for contact and bending stress using hertz, lewis and AGMA equations and ANSYS with various face width and helix angle and found their effect due to bending and contact stress and its value compared. And also deferent material is tried for weight reduction and cost optimization.

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