A Review on Design, Modeling and Analysis of High Speed Helical Gear using FEA

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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 considered 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 different face width and helix angle. Contact stress and bending stress can also be calculated by Hertz, Lewis and AGMA equations. Bending stress can occur in the root of gear and contact stress can occur between meshing of two gears. Finally, these two methods bending and contact stress results both are compared with each other for different face width and helix angle.

Key word: bending stress, contact stress, face width, helix angle, model analysis, stress strain analysis and deformation.

I. Introduction

Gears are used 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 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.

II. Literature review

A) Tribhuwan Singh, Mohd. Parvez[1].

Face width and helix angle are important geometrical parameters in determining the state of stresses during the design of gears. Thus, in this work a parametric study is conducted by varying the face width and helix angle to study their effect on the bending stress of helical gear. The strength of the gear tooth is a crucial parameter to prevent failure. In this study, it is shown that the effective method to estimate the root bending stresses using three-dimensional model of the gear and to verify the accuracy of this method the results with different number of teeth are compared with the standard formula. 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 it is expected, in this work the maximum bending stress decreases with increasing face width and it will be higher on gear of lower face width with higher helix angle. As a result, based on this finding if the material strength value is criterion then a gear with any desired helix angle with relatively larger face width is preferred.


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 failure theory by which the design aspects are to no changed to reduce the contact stresses.

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.2 von misses stress (contact stress) of modified helical gear

C) Jerin sabu, Dr. Y. V. K. S. Rao, Alen John, Rajeev V. R.

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.
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 different number of teeth which are 18, 20 and 25 and different 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.

### III. 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.
IV. References


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