Study the Design and Analysis of Helical Gear Using ANSYS

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ABSTRACT *Gears are one of the most important parts in mechanical power transmission system. Gears have wide variety of application. Gears generally fail when the tooth stress exceeds the maximum stress. The bending and Surface stresses of the gear tooth are main causes for the failure of the gear. Thus, analysis of stresses has become popular as an part of research on gears to reduce he failures and for best possible design of gears. Wear of gear flanks is an observed and always present phenomenon in gearboxes. To this point, few investigations addressing the problem of quantifying the amount of wear as well as its distribution have been carried out. In this thesis the amount and distribution of mild wear is predicted using several existing wear models and numerical methods. Both helical gears are treated.*
Since minor changes of the shape of a surface can lead to significantly increased surface pressures, even mild wear on a gear flank can lead to surface pressures above fatigue limits. In order to simulate and predict the wear of spur gears it is necessary to find the contact forces and the conditions under which the contact take place.
The study in this paper show that the characteristics of an involute helical gear system mainly concentrate on bending stresses .in this thesis we modeled a helical gear on solid work .The FEM simulation is carried out using standard commercial available software that is ANSYS 15.0 is used.
Face width and helix angle are important geometrical parameters in determining the state of stresses. In this Simulation is conducted by varying the face width and helix angle and stress distribution pattern has been observed.

Keywords: *Gears, failures,Flank , specimen*

1. Introduction

A gear may be defined rotating mechanical device used in transmission system that allows rotational force to be transmitted or received to another toothed member or device. Motion through helical gears might be transmitted between parallel shafts and non crossing shafts. Geared devices are utilized to change the speed or control power between two stages (input and output). Depending on their configuration and arrangement, forces are often transmitted at completely different speeds, torques and even in a very completely different direction, from the power source.

Gear manufacturers have so far been occupied with failures due to high root stresses, high surface pressures and hardening cracks; they have neglected investigations of mild wear and its connection to more severe types of damages. Surface fatigue is a known problem and the cure for it has been better and purer materials, smoother surfaces, heat treatments etc.

If it were possible to calculate the wear distribution already in the design phase, much would be gained since indications as to the performance and service life of the designed product will be obtained. Several researchers have treated the wear of gears, but few have made comparative analyses of wear simulation compared to real tests. Wear is normally treated rather casually using blunt approximations and without reflecting on the effects of wear on the working behaviour of the gears. Wear analysis of tested gears is generally carried out using a scale to indicate the degree of wear. As the gears rotate, the number of teeth in contact varies, and as a consequence, the effective length of the line of contact is changing, causing variations in mesh stiffness. For low contact ratio spur gears, these variations are largely due to the load transfer occurring over a single tooth and a double tooth pair.. Throughout the mechanical industry, diverse sorts of gears exist with every kind of gear possessing specific benefits for its supposed applications. A comparison of bending stress and contact stress of helical gear as calculated by FEA. In this paper, bending stress at the root of the helical gear tooth and surface contact stresses are computed by using theoretical method as well as FEA. To estimate the bending stress at the tooth root Lewis beam strength method was applied. NX CAD 8.5 modeling software package was used to create the 3D solid model of helical gear pairs. NX Nastran 8.5 software package was used to analyze the gear tooth root bending stress.

2.Literture Review

There are great deal of researches and number literatures on gear analysis that has been published. Generally their major concerns are on the analysis of gear stresses, transmission errors, dynamic loads, noise, and failure of gear tooth, which are very useful for optimal design of gear set. They have used various approaches and means to attain their main intention. The first systematic studies in gear dynamics started in the 1920s by A.A Ross and E.Buckingham . The basic concern in their studies was the prediction of tooth dynamic loads for designing gears at higher speeds. This research attempts to review literatures, which are relevance to analysis gear of stresses.

As the strength of the gear tooth was important parameter to resist failure. 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.

In 1998, a method namely the normal stiffness matrix along contact line (NSMCL) for analyzing cylindrical gears was proposed by Jianfeng et al . The method established three dimensional finite element models for spur and helical gears; external and internal hobbling and slotting, different parameters and materials can be analyzed using these models. Results such as load distribution along the contact lines, deformations and stiffness at any position, and contact stresses are presented. The calculated results show that the trend of gear tooth deformation coincides with the tested ones using the dynamic speckle photography method.

The involute profile of helical gear has been modeled and the simulation is carried out for the bending and contact stresses by finite element method and result obtained in analysis were compared with AGMA standard. It can be concluded that the helix angle is critical for contact stress as increasing helix angle increases contact stresses because it increases length of contact in the area. The stresses generated and the deflections of the tooth have been analyzed for different materials. Finally the results obtained by theoretical analysis and Finite Element Analysis were compared to check the correctness. A conclusion has been arrived on the material which was best suited for the marine engines based on the results. Basically the project involves the design, modeling and manufacturing of helical gears in marine applications. The objective of their work is to conduct a comparative study on helical gear design and its performance based on various performance metrics through finite element as well as analytical approaches.

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3.Designining of Gear

A. General Consideration

The proper design of gears for power transmission for aparticular application is a function of (a) the expected transmitted power, (b) the driving gear's speed, (c) the drivengear's speed or speed ratio and (d) the centre distance (Khurmi and Gupta 2009). In this paper we designed thehelical according bending strength condition and the tooth bending stress equation for helical gear teeth.

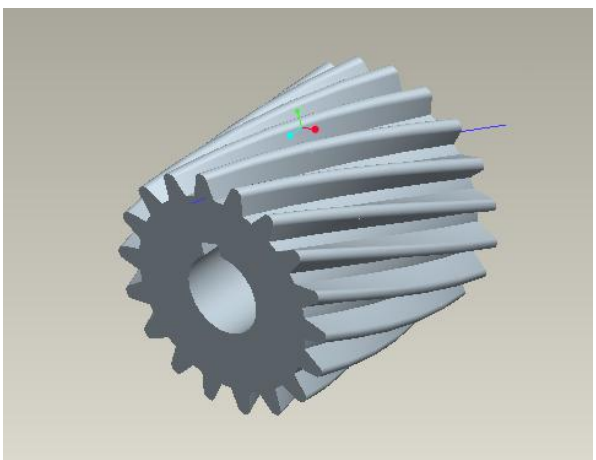
B. Tangential Force Calculation

In order to design the gear according to bendingstrength condition the following parameters were assumed:

Power (P) = 30 kW
Speed = 1200 R.P.M

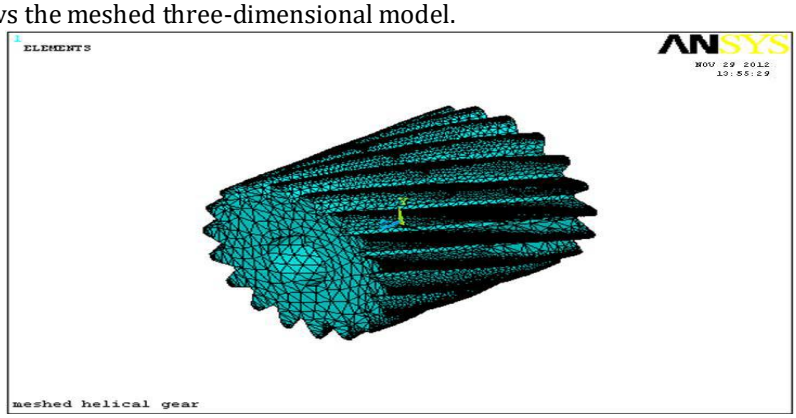
4.,MODELING OF GEAR

The procedure to model the gear of 20 number of teeth with the combination of the all above mentioned parameters in the Pro/ENGINEER Wildfire, other set of gears are modeled in the similar way. Part parameters are the basic parameters defining the gear. These part parameters determine all the other parameters that define the gear tooth profile using the Tools/Relation menu. Figure showing the helical gear generated by Pro/Engineer



5. FEM Analysis

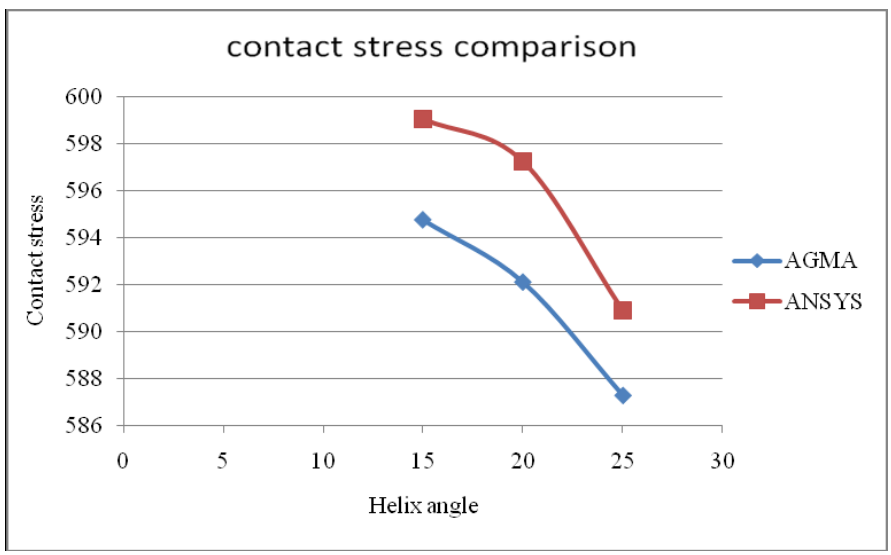
In this, the teeth bending stress and contact stresses of helical gear are calculated by using ANSYS. For this purpose the modeled gear in Pro/Engineer is exported to ANSYS and then an automatic mesh is generated. Figure 2and 3 shows the meshed three-dimensional model.



6. RESULT AND DISCUSSION

Face width and helix angle are important geometrical parameters in determining the state of stresses during the
design of gears. Thus, the objective of this work is to conduct a parametric study by varying the face width to study their effect on the bending stress of helical gear. In order to determine the stresses variation with the face width five different models of helical were created by keeping other parameters (i.e. module, pitch circle diameter, number of teeth, helix angle etc) constant. Table II below shows the results of bending stress with the variation in the face width of the helical gear tooth.

The face width is increasing there is a corresponding decrease in the value of the tooth bending stresses of a helical gear calculated from the AGMA as well as that obtained from ANSYS analysis. Therefore, from the results obtained we can say that for any constant load and speed, the gear with higher face width is suitable. Fig. shows the Graph of Bending Stress [MPa]
against Face width [mm].



7. CONCLUSION

The results obtained from ANSYS when shows that there is a little variation with a higher difference in percentage of 4.70%. From the results we can conclude that ANSYS can also be used for predicting the values of bending stress at any required face width which is much easier to use to solve complex design problems like gears.

1) In theory of helical gear we are considering that load is acting at one point and the stress is calculated. But, in case of FEM a continuous load is considered. So a pressure will act along the teeth of helical gear.

2) Helix angle is critical for contact stress as increasing helix angle increases contact stresses because of increase in the area of contact.

3) It is observed that the bending & compressive stresses of Al-Alloy are less than the of the other material like steel

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