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REVIEW OF DESIGN AND ANALYSIS OF SPUR AND HELICAL GEAR

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Abstract: The theoretical basis and performance characteristics of helical gear design, this work is to coduct a comparative study on helical gear design and finite aliment as well as analytical approaches finite element approach in ANSYS one of the most critical in mechanical power transmission system the gear are generally used to transmit power or torque and the efficiency of transmission very high when compared to other kind of transmissions this application are explain the design the spur gear and dimension specification. Its have a ivolving morden design, specific character, specific materials, with consideration of analysis of force, and its mechanical properties. these approach for morden spur gear design developing the tooth profils with modified the shape and improving the diamention.

I. INTRODUCTION

The gear analysis is one of the most significant issues is in the machine elements theory particularly in the field of gear design and gear manufacturing. Many of the researchers have proposed several concepts for gear design optimization to enhance the performance of gear system .caviar et al. Has developed a loaded tooth contact analysis program to calculate all of the three-dimensional, thinc-rimmed gear structures with all of the gear parameters .kapelevich Has developed a surface wear for helical gear pairs to study the influence of tooth modifications on helical gear wear .the model uses a finite element based gear contact mechanics model to predict the contact pressures at a number of discrete rotational gear positions and a computational procedure for determining relative sliding distances of mating point son each gear for each rotational increment. In this method a simplified design formula was also proposed that links modification parameters directly to initial wear rates. fong it al. This gearcan be meshed together correctly only if they are fitted to parallel safts. The main reason for the popularity of spur gear is their simplicity in design and manufacturing. the two parameter i.e. tip radius and in tooth widths which play a key role gear design are studied. A gear is a rotating machine part having cut teeth. which is meshing the gear teeth to transmit the torque. A geared device can be change the speed, direction of power sources and magnitude. The tooth meshing on another gear of non roteting parts is called rack. when it a rotation it provide transmission in analogous to the wheels in pully. It is the cylindrical shaped its teeth are parallel in axis. its wide range of application most commonly used.

II. DESIGN OF SPUR GEAR

In order to design, build and discuss gear drive systems it is necessary to understand the terminology and concepts associated with gear systems.

Diametral pitch (DP): The gear tooth size is described by diametral Pitch larger gear have fewer teeth per inch of daimetral pitch, daimetral pitch is inversely gear teeth size.

Pitch diameter: The pitch diameter is indicatedthe diameter of the pitch circle.if the diameter of the gear pitch is known pitch diameter. We can mathamaticaly expression;

PD=N/P
PD=pitch diameter
N= number of teeth on the gear
P=diametral pitch (gear size)

Pitch circle: The pitch circle is the geometry. it is a imaginary circle through contact the circle of two pitch of the gear. the center of pitch circle meshing by center to center distance.

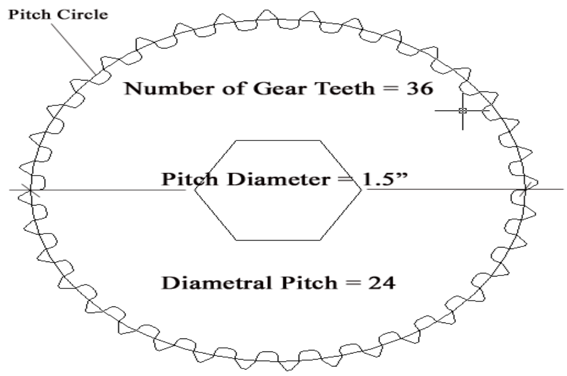


Fig.(a) pitch diameter

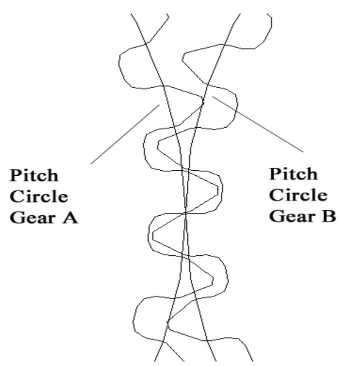


Fig (b)pitch circle

A. Some important defination parameter

Pitch diameter (D): the diameter of the pitch circle from which the gear is designe. An imaginary circle, which will contact the pitch circle of another gear when in mesh.

D=N/P

Diametral pitch (P): a ratio of the number of teeth per inch of pitch dimeter

P=N/D

Addendum (A): the radial distance from the pitch circle to the top of the gear tooth

A=1/P

Dedendum (B): the radial distance from the pitch circle to the bottom of the tooth

B=1.157/p

Outer diameter (OD): the overall diameter of the gear

OD= (N+2)/P

Root diameter (RD): the diameter at the bottom of the tooth

RD= (N-2)/P

Base circle (BC): the circle used to from the involute section of the gear tooth

BC=D*CosPA

Circle pitch (CP): the measured distance along the circumference of the pitch diameter from the point of one tooth to the corresponding point on an adjacent tooth.

CP=3.1416/P

Circuler thickness (T): thickness of a tooth measure along the circumference of the pitch circle

T=1.57/P

Clearance (C): refer to the radial distance between the top and bottom of gears in mesh some mechanism,. In other word the gap between two distances is known as clearance

Whole depth (WD): the distance from the top of the tooth to the bottom of the tooth.the whole defth is calculated by

WD =2.157/P

Pressure angle (PA): it refers to the angle through which forces are transmitted between meshing gears.

Center distance: the distance from the center shaft of one spur gear to the center shaft of the other spur gear.it is called center distance.

Gear ratio: the ratio of a given pair of spur gears is calculated by dividing the number of teeth on the driven gear, by the number of teeth on the drive gear

III. METHOD FOR CALCULATING THE APPLICATION FACTOR KA OF A COMPONENT UNDER VARIABLE LOADS

The method proposed in the present paper for determining the application factor KA in the case of variable amplitude loads aims to be a completion of the ISO Standard procedure when the gear has been already designed at least from the cinematic point of view. The heart of the method involves the use of a fatigue curve of the component instead of the Woehler-damage curve of the material.

So, being the pitch diameters of the engaging gears known, it is possible to calculate the tangential forces(involved in ISO Standard basis equations) corresponding to each torque level. The way of thinking that is the basis of this method allows also the specific calculation of the service life of gears, even if details about this procedure are here omitted for sake of brevity. It may also be utilised when the nominal torque value is unknown, as an example when experimental data are available about loading conditions of the transmission. As ISO Standard , this method utilises the Mine damage rule and the corresponding exponent p of Woehler damage curves (slope p) for both bending and pitting cases. The substantial difference is that the number of bins to be used in the Miner damage rule refers to the loading blocks that really are damaging the gears. In other words, being the amount of damage depending on the stress level, it is necessary to calculate the tangential force level FtD for which the damage entity can be considered as zero. This force limit FtD, belonging to the fatigue curve of the gear (slope p), simply corresponds to the endurance limit cycles NLref. The procedure will be described in detail in the following, referring only to the bending case for sake of brevity. Analogous relationships may be obtained for pitting. According to the tooth root stress σF is the maximum tensile stress at the surface in the root and it maybe calculated by the following equation:

$$\boldsymbol{\sigma_F}=\boldsymbol{\sigma_{F0}}\ \boldsymbol{K_A}\ \boldsymbol{K_V}\boldsymbol{K_{F\alpha}}\boldsymbol{K_{F\beta}}\ \mathrm{n}$$

Where K_A and Kv are respectively application and dynamic factors, $K_{F\beta}$ and $K_{F\alpha}$.

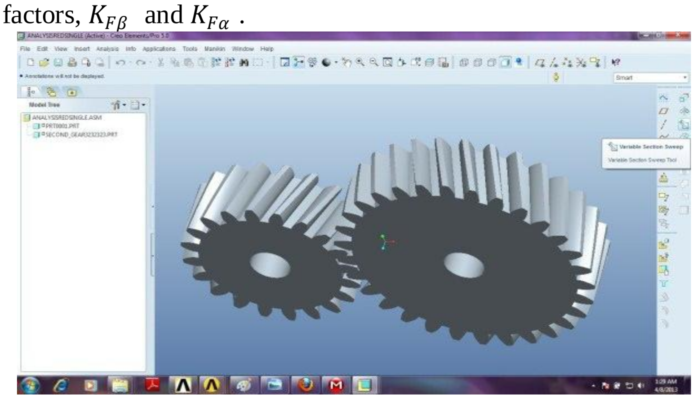
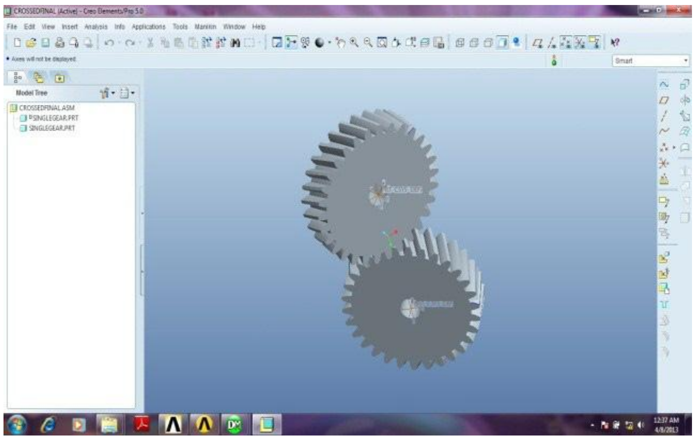


Fig.(b) Modeling of single helical gear model in Pro/E[6]



Fig(c): Modeling of double helical gear model in Pro/E[7]

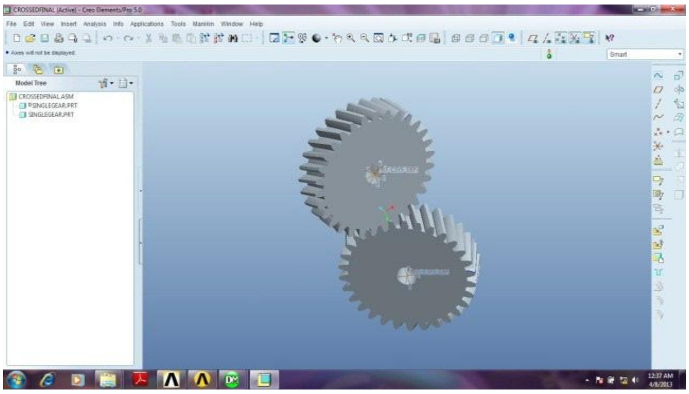


Fig.(d)Modeling of crossed helical gear model in pro/E[8]

IV. DESIGN METHODOLOGY

The design of helical gear is almost similar to spur gear design with slight modifications in lewis in Buckingham equation (venkatesh et 2010)due to helix angal According to lewis eqation ,the beam strength of helical gear tooth is given by

$$F_b = [\sigma_b].b.\pi m_n.y_v$$

Where

$[\sigma_b]$ = Allowable contact stress in kgf /cm^2

b = face width of gear bank =10m_n

m_n=Normal module which must be standardized.

y_v=Lewis form factor which depends on the virtual number of teeth

$$z_v=[z/\cos^3\beta]$$

Buckingham equation $FD=Ft+\frac{21(Cb\cos^2\beta+F_t)\cos\beta}{2lv+\sqrt{Cb\cos^2\beta+F_t}}$

Compressive stress is given by

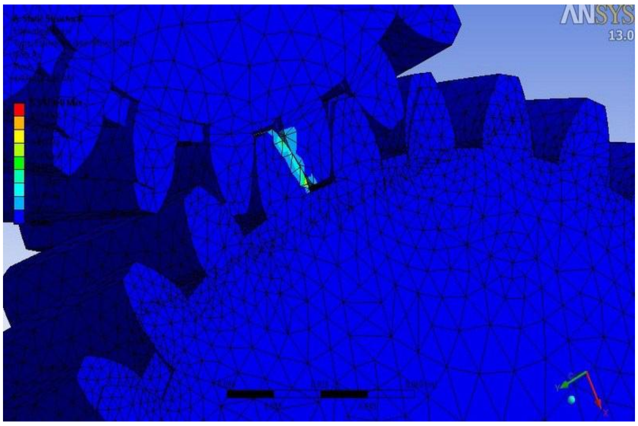
$$\sigma_c=0.7[(i+1)/a]\sqrt{(i+1)}E[MT]/(ib)]$$

Bending stress is given as

$$\sigma_b=0.7(i+1)[MT]/(ab\ mnYV)[9]$$

V. THE ANALYSIS OF HELICAL GEARS

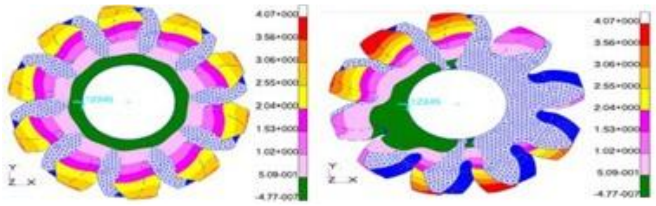
It deals with the development of finite element analysis that has been implemented for various gear systems that were dveloped in the previous chapter. The main objective of developing finite element analysis was in order to estimate bening, fatigue and contact stress distribution in the pinion and gear. Finite element analysis of the developed helical gear pair was executed in ANSYS. The first step is to perform structural analysis in order to calculate tooth bending stress and permible bending stress, bending fatigue strength of pinion.The second step in the finite element analysis approach is to perform contact stress analysis in order to calculate contact stress. The final step involved is to performed is fatigue stress analysis in order to calculate allowable surface fatigue stress, surface ftigue of pinion. Each of these step was executed and is dscribed below. The structural analysis of helical gear train was performed in six stages namely input of engineering data, definition of geometry development of model, step and generation of solution and results. Structural steel was use in this problem having material properties of elastic moduluas 207 GPa and poission's ratio 0.3. after input of these data, the model created in Pro/E was imported. after the model was imported, meshing operation was performed on the model to divide the model in to several elements or models. The type of node element considered was tetrahedron and the torque, angular velocity of required range as specified in table i were applied on the helical gear pair entities after the meshing operation. Two coordinate systems were taken for helical gear pair in one is global coordinate system for gear and another is normal coordinate system for pinion. Torque was applied on the pinion by considering normal coordinate system means torque will be applied on pinion about pinion central axis and angular velocity of pinion is considered by considering the coordinating system for pinion about pinion central axis. After completion of pre-processing step post processing steps were accomplished in ANSYS. In order to execute these several tools were imported such as fatigue tool, contact tool etc. In addition vomits' stresses, principal stress were also given for analysis in order to calculate the performance metrics of helical gear pair. Based on these input details, the solutions were generated by ANSYS. This structural analysis was executed for all the three helical gear listed earlier. The tooth bending stress distribution for various helical gears.



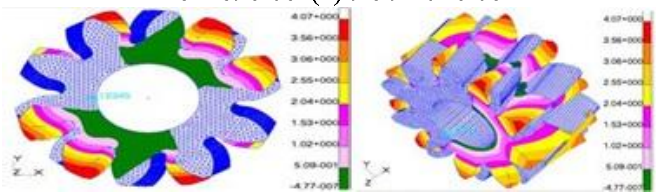
Fig(e): tooth bending stress distribution for single helical gear

VI. THE STUDAY ON TRANSMISSION EFFICIENCY

Generally speaking, the line speed of high speed, heavy-load gear transmission is higher, large dynamic load which influence the safety and stability will be caused. When the transmission is large, the tooth surface relative sliding speed is higher, leading to adhesion, wear .large loads corresponds large deformation. Therefore, gear especially large power gear transmission, transmission device has higher efficiency requirements. Gear transmission device for power consumption are two important sources, namely the gear loss, bearing and oil seal power loss .in the machinery industry in various fields, have attached great importance to study on transmission efficiency of gears, such as the gear transmission efficiency even by one percentage point but also has very important significance.



The first-order (2) the third- order



(3) The fifth -order (4) the sixth- order

The study on the powder metallurgy helical gear transmission efficiency characteristics of fire fighting vehicle power take-off have important significance for the analysis of the meshing process of dynamic performance, guiding the design of efficient gear drive, promoting the economic benefits. This paper intends to carry out 38CrMoAI alloy helical gear and powder metallurgy helical gear driving efficiency comparison test to find out the material factors in transmission efficiency effect

VII. CONCLUSION

This can lead to various benefits including reduction in redundancies, cost containment related to adjustment between manufacturers for missing part interchangeability and performance due to incompatibility of different standards. From this analysis , it was investigated that the effect of gear ratio, helix angle, face width and normal module on bending and compressive stress of high speed helical gear.

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