A Review: Design, Modeling and Stress Analysis of high speed helical gear according to Bending strength and Contact strength using AGMA and ANSYS

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ABSTRACT

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.

Key word: bending stress, contact stress ,face width, helix angle

1. 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.

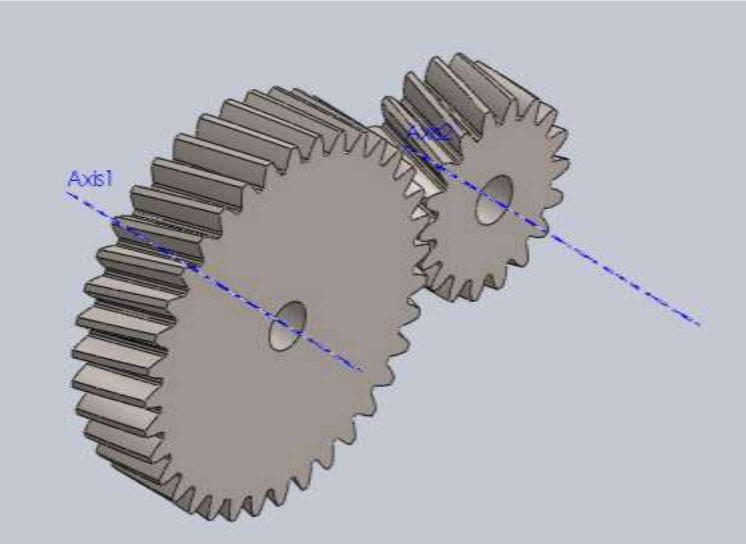

Fig. helical gear

2. LITERATURE REVIEW

A. Seok-Chul Hwang, Jin-Hwan Lee, Dong-Hyung Lee c, Seung-Ho Hana, Kwon-Hee Lee [1].

Contact stress analyses for spur and helical gears are performed between two gear teeth at different contact positions during rotation. Two examples of spur and helical gears are presented to investigate the respective variations of the contact stress in a pair of mating gears with the contact position. The variation of the contact stress during rotation is compared with the contact stress at the lowest point of single-tooth contact (LPSTC) and the AGMA (American Gear Manufacturers Association) equation for the contact stress. In this study, we can see that the gear design that considers the contact stress in a pair of mating gears is more severe than that of the AGMA standard.This study presents the change in the contact stress of spur and helical gears in relation to the contact position. Regarding changes in the contact stress, the maximum value measured at the lowest point single-tooth contact is compared with the contact stress calculated based on the AGMA standard. According to the analysis, the design that considers the contact stress is stricter than the AGMA standard. The values calculated by using finite element analysis are below the contact fatigue strength of the material; hence, they yield the appropriate strength and safety.

B. S.Jyothirmai,R. Ramesh,T. Swarnalatha, D. Renuka [2].

In this paper, an attempt has been made to compare the performance of various helical gear systems for a given set of specification through an analytical approach based on AGMA standards as well as a finite element analysis approach. Three different helical gear systems namely single, herringbone, crossed helical gear systems were evaluated. The developed FEA model was validated against the analytical approach and was found to be very close. Further stress analysis was carried out using FEA. The developed FEA model was validated against the analytical approach and was found to be very close. Further stress analysis was carried out using FEA. It was found that the overall performance of crossed helical gear was found to be the best in terms of stress as well as tooth strength at low speeds and low loads whereas herringbone and single helical gear systems are employed for optimum values of speeds and loads. The low stresses observed in case of single helical gear makes its use in case of high speeds and heavyloads

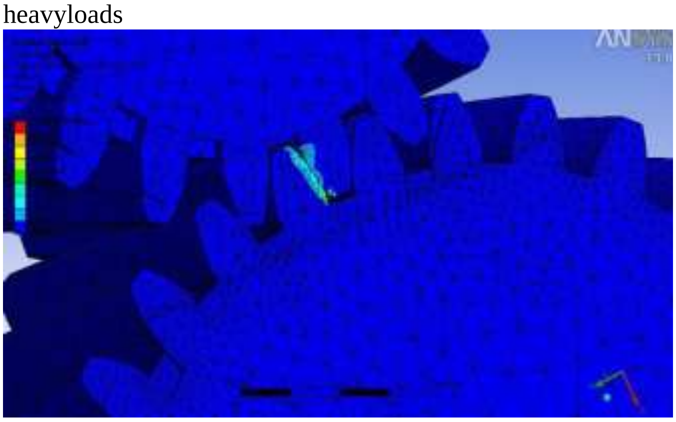

Fig. contact stress effect of helical gear

C. Faydor L. Litvin a, Alfonso Fuentes b, Ignacio Gonzalez-Perez a,Luca Carvenali a, Kazumasa Kawasaki a, Robert F. Handschuh [3].

The contents of the paper cover: (i) computerized design, (ii) methods for generation, (iii) simulation of meshing, and (iv) enhanced stress analysis of modified involute helical gears. The approaches proposed for modification of conventional involute helical gears are based on conjugation of double-crowned pinion with a conventional helical involute gear. Double-crowning of the pinion means deviation of cross-profile from an involute one and deviation in longitudinal direction from a helicoid surface. The pinion-gear tooth surfaces are in point contact, the bearing contact is localized and oriented longitudinally, edge contact is avoided, the influence of errors of alignment on the shift of bearing contact and vibration and noise are reduced substantially. The developed theory is illustrated with numerical examples that confirm the advantages of the gear drives of the modified geometry in comparison with conventional helical involute gears. The discussions above allow to draw the following conclusions:

1. A new geometry of modified involute helical gears, based on the following ideas, has been proposed:
   a. The pinion of the gear drive is double-crowned and therefore the pinion tooth surface is mismatched of an involute helicoid in profile and longitudinal directions.
   b. The gear tooth surface is designed as a conventional screw involute helicoid.
2. The pinion and gear tooth surfaces contact each other instantly at a point, the bearing contact is localized, and the function of transmission errors is a parabolic one of a low magnitude.
3. The parabolic function of transmission errors is able to absorb discontinuous linear functions of transmission errors caused by misalignment and therefore the noise and vibration are reduced.
4. The bearing contact is oriented longitudinally and this is in favor of the increase of contact ratio. The shift of bearing contact caused by misalignment is reduced.

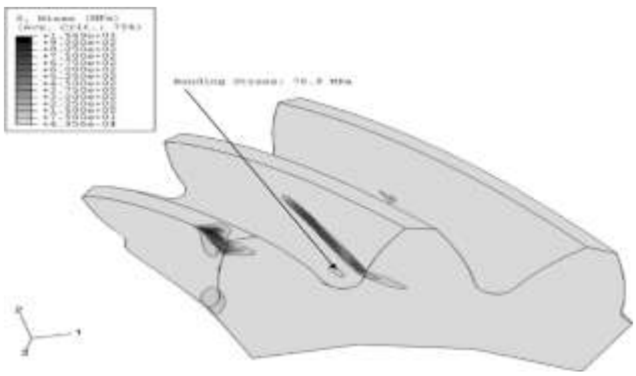

fig. bending stress effect

D. J. Venkatesh, Mr. P. B. G. S. N. Murthy [4].

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.

E. Faydor L. Litvin a, Alfonso Fuentes b, Ignacio Gonzalez-Perez a, Luca Carnevali a, Thomas M. Sep [5].

Anew version of Novikov–Wildhaber gear drive is considered. The contents of the paper cover design, generation, tooth contact analysis (TCA), and stress analysis of a new type of Novikov–Wildhaber helical gear drive. The great advantages of the developed gear drive in comparison with the previous ones are (i) reduction of noise and vibration caused by errors of alignment, (ii) the possibility of grinding and application of hardened materials, and (iii) reduction of stresses.

These achievements are obtained by application of (i) new geometry (based on application of parabolic rack cutters),(ii) double-crowning of pinion, and (iii) parabolic type of transmission errors. The manufacture of gears is based on application of grinding or cutting disks, and grinding or cutting worms. The advantages of the developed geardrive have been confirmed by simulation of meshing and contact, stress analysis, and investigation of formation of bearing contact. Computer programs that cover computerized design, TCA, and automatic development of finite element models of new version of Novikov–Wildhaber gear drives have been developed. A general purpose finite element analysis computer program has been used for stress analysis and investigation of formation of bearing contact. Helical gears of new geometry can be applied in high-speed transmissions

The discussions above allow drawing the following conclusions

(1) A new type of Novikov–Wildhaber gear drive of helical gears is considered

(2)Unlike the previous gear drive, the proposed one is based on application of two Mis matched rack-cutters of parabolic profiles being in internal tangency. One of the Rack-cutters generates the pinion; the other one generates the gear (3) The sensitivity of the gear drive to errors of alignment is reduced due to application of a pre designed parabolic function of transmission errors. Such a function is able to absorb linear discontinuous function of transmission errors caused by misalignment. The stress analysis has been performed for the proposed Novikov–Wildhaber gear drive and for a gear drive with modified involutes helical gears

F. B.Venkatesh,V.Kamala,A.M.K.Prasad [6].

In this work, structural analysis on a high speed helical gear used in marine engines, have been carried out. The dimensions of the model have been arrived at by theoretical methods. 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 are compared to check the correctness. A conclusion has been arrived on the material which is best suited for the marine engines based on the results. Basically the project involves the design, modelling and manufacturing of helical gears in marine applications. It is proposed to focus on reduction of weight and producing high accuracy gears.

G. Dr. M. S. Murthy, Pushpendra Kumar Mishra [7].

This paper presents a detailed study of different techniques proposed and used by various researchers to optimize and to calculate the stresses involved in the helical gear design. Several three dimensional solid models of gears of different specification have been developed by various researchers for analysis. They then used various analysis tools like Ansys, Computer aided FEM; Proe software etc for analysis. In this work various parameters that can affect the gear tooth, i.e. variation in face width, helix angle etc. for the complex design problems is also discussed.and they conclude A parametric study was also made to study the effect on the root stresses of helical gears by varying the face width and the helix angle. Many authors agree that if material strength is the criterion then a gear with any desired helix angle with a relatively larger face width is preferred

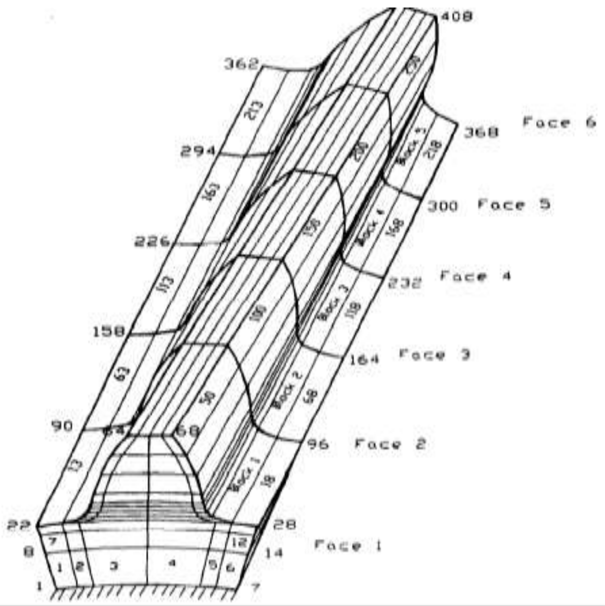

Fig. finite element method

H. B.Venkatesha, S.V.Prabhakar, Vattikutia, S.Deva Prasad [8].

The work is to focus on investigating the combined effect of gear ratio, helix angle, face width and normal module on bending and compressive stress of high speed helical gear Global market has brought increasing awareness to optimize gear design. Current trends in engineering globalization require results to comply with various normalized standards to determine their common fundamentals and those approaches needed to identify best practices in industries. This can lead to various benefits including reduction in redundancies, cost containment related to adjustments between manufacturers for missing partite changeability 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.

5. Conclusion

In this paper author have been presented a brief review of design and modelling and analysis of high speed helical gear using AGMA and ANSYS with various face width and helix angle and found their effect due to bending and contact stress and its value compared with ANSYS and AGMA

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