Review on Analysis of Spur Gear by FEA and ESA

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Abstract— As we know gear is one of the most critical components in a mechanical power transmission system, failure of one gear will affect on the whole transmission system. The contact stress in the mating gear is the key parameter in gear design. Contact stress refers to the localized stresses that develop as two curved surfaces come in contact and deform slightly under the imposed loads. Also due to contact stresses wear takes place at gear tooth. Consequently tooth thins down and gets weakened. Pitting is a surface fatigue failure of the gear tooth. The gears are generally fails when the working stress exceeds the maximum permissible stress and if we want to design a healthy system with defined performance efficiency through working life cycles, it is important to predict stresses developed & effectively reduce them. They develop high stress concentration at the root. Therefore it is necessary to find the root cause which result into failure of gear and try to eliminate these causes. Many of the researchers nationally and internationally found gear contact analysis as a field of interest with wide scope of research. This paper discuss on the review of different analysis of gear pair. In this study investigating and optimizing the root fillet of starter pinion by FEA and ESA.
Key words: Spur Gear by FEA, Spur Gear by ESA

I. INTRODUCTION

Gear is a rotating cylindrical wheel having teeth cut on it, which meshes with another teethed part to transmit the power, in most cases with teeth on the one gear being of identical shape, and often also with that shape on the other gear in mesh. There are different types of gears like Spur, Helical, Worm and Bevel. As the most common type, spur gears are often used because they are the simplest to design & manufacture, less costly, efficient with 98-99% operating efficiency. They are usually employed to achieve constant drive ratio. There are several stresses present in teeth of rotating gears but out of all the stresses, root bending stress and surface contact stress calculation is the basic of stress analysis

A pair of teeth in action is generally subjected to two types of cyclic stresses: bending stresses inducing bending fatigue and contact stress causing contact fatigue. Both these types of stresses may not attain their maximum values at the same point of contact. However, combined action of both of them is the reason of failure of gear teeth leading to fracture at the root of teeth under bending fatigue and surface failure, like pitting or flaking due to contact fatigue. However the fracture failure at the root due to bending stress and pitting and flaking of the surfaces due to contact stress cannot be fully avoided. These types of failures can be minimized by careful analysis of the problem during the design stage and creating proper teeth surface profile with proper manufacturing methods. In spite of all the cares, these stresses are sometimes very high either due to overloading or wear of surfaces with use and need proper investigation to accurately predict them under stabilized working conditioned so that unforeseen failure of gear teeth can be minimized.

II. OBJECTIVES

The main objectives behind this work are to check the behavior of unusual contact between flywheel ring gear and starter motor pinion. Following are major objectives of present work.

1) To find out the stress generated at the root of pinion because the probability of pinion failure is more than that of ring gear.
2) To predict stress & deformation generated on pinion in order expose the behavior of pinion when comes in contact with ring gear.
3) The tooth profile is modified at root and modified system is analyzed for predicting effect of tooth modification on stresses generated, deformation of tooth.
4) The photolastic experimentation analysis is also completed along with the finite elemental analysis. The Experimentation work is completed by using Transmission type Polariscope.

III. WORKING STEPS

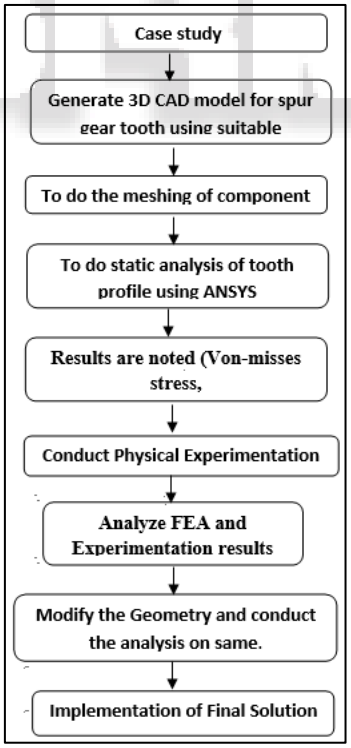

Fig. 1: Working steps

IV. LITERATURE REVIEW

Sankpal et al. [1] reported the recherché on contact stress refers to the localized stresses that develop as two curved surfaces come in contact and deform slightly under the

imposed loads. Also due to contact stresses wear takes place at gear tooth. Wear is nothing but progressive removal of metal from the surface. Consequently tooth thins down and gets weakened. Pitting is a surface fatigue failure of the gear tooth. It occurs due to misalignment; wrong viscosity selection of the lubricant used, and contact stress exceeding the surface fatigue strength of the material. Material in the fatigue region gets removed and a pit is formed. In work contact stresses find out by FEM method and experimental method by using the polariscope. And compare the FEM result with experimental result.

Rahate et al. [2] carried out contact stress analysis of steel gear and composite gear using Hertz equation and by Finite Element Analysis using Ansys 16.0 Workbench. Also experimental stresses are calculated using Photo-Stress Method. In this work, Aluminium Silicon Carbide is used as a gear material. When compared, the results of both theoretical method and FEA show a good degree of agreement with experimental results.

Naik et al. [3] analyzed the bending stresses occur on the gear tooth profile when subjected to loading condition with the help of FEM and Photo-elastic technique. Photo elastic stress analysis is a technique that provides stress distribution over an entire object/structural member of interest it is based on the property of some transparent material to exhibit colorful pattern when viewed with polarized light. These patterns occur as the result of alternation of the polarized light by the internal stresses into two waves travel at different velocities. In this work root radius are taken gear parameters, how stress redistribution are taken place by varying this parameter studied. The stresses are calculated with the help of the FEA this result are compared with the stresses calculated by Photo elastic technique. Parametric modeling is done using Pro-e WF 5.0 and for analysis ANSYS 12.0 workbench is used. For photo elastic validation optical polariscope is used .This work helpful to conclude effect of bending stress on gear tooth profile by variation of gear root radius it also give the comparison of FEM method with photo-elastic technique of stress analysis .

Rameshkumar et al. [4] carried out static finite element analysis for NCR & HCR gears with fixed module, center distance & gear ratio. Here the increasing contact ratio is obtained by increasing the addendum factor from 1.0 to 1.25 m. Hence a contact ratio of more than 2.0 was achieved for the same number of teeth. Two dimensional deformable body contact models for both HCR gear & NCR gears were created using the ANSYS-APDL loop program. Various parameters such as load sharing ratio, bending stress & contact stress were evaluated and compared over the path of contact. The maximum bending stress for a HCR gear is 18% less & contact stress is 19% less than of a NCR gear for the pair of same module & fixed center distance. Hence the load carrying capacity of the HCR gear is 18% more than the NCR gear designed for the same weight, fixed module & same centre distance of gear pair.

Patil et al. [5] reported the contact stresses among the Spur gear pair & helical gear pair, under static condition by using 3D finite element model. The Helical gear pair on which the analysis was carried out were 0°, 5°, 15°, 25° helical gear set. During analysis FE gear model was verified with Hertz/AGMA equation for zero coefficient of friction. The FE model of gear pair are compatible in evaluating the contact stresses & the results obtained are in good agreement with analytical calculations. For the spur gear pair the increase in contact stress with the increase in coefficient of friction was about 10%.

Karaveer et al. [6] investigated the stress analysis of mating teeth of spur gears to find maximum contact stress in the gear teeth. The results obtained from Finite Element Method are compared with theoretical Hertzian equation values. The spur gears are sketched, modeled & assembled in ANSYS 14.5 Design Moduler. The results show that the difference between maximum contact stresses obtained from Hertz equation & Finite Element Analysis is very less and it is acceptable also the deformation patterns of steel & cast iron gears depict that the difference in their deformation is negligible.

V. Conclusion

While working on this system it is observed that, there are lot of things that can be done over, the area of contact analysis quite interesting because of availability of effective analysis tools.

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