CONTACT STRESS ANALYSIS OF MODIFIED HELICAL GEAR USING CATIA AND ANSYS

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ABSTRACT

Gears are mainly used to transmit the power in mechanical power transmission systems. These gears play a most predominant role in many automobile and micro electro mechanical systems. One of the main reason of the failure in the gear is bending stresses and vibrations also to be taken into account. But the stresses are occurred due to the contact between two gears while power transmission process is started. Due to meshing between two gears contact stresses are evolved, which are determined by using analysing software called ANSYS. Finding stresses has become most popular in research on gears to minimize the vibrations, bending stresses and also reducing the mass percentage in gears. These stresses are used to find the optimum design in the gears which reduces the chances of failure. The model is generated by using CATIAV5 and ANSYS is used for numerical analysis. The analytical study is based on Hertz’s equation. Study is conducted by varying the geometrical profile of the teeth and to find the change in contact stresses between gears. It is therefore observed that more contact stresses are obtained in modified gears. Both the results calculated using ANSYS and compared according to the given moment of inertia.

I. INTRODUCTION

A gear is having cut teeth acts as rotating machine part meshes with driven gear, where as torque is transmitted and the provides more advantage through a gear ratio in a simple machine. By using gears magnitude, speed and direction of a power source can be changed. Contact stresses are produced in straight line due to involute profile used in gears. These helical gears are widely used for power transmission and due to their load carrying capacity, silent operation and also high operating speed. The gears which are to be used in power transmission is to be low level of vibrations and noise gives useful information on contact and bending stresses. The time required to generate this information using finite element method is large amount. CATIAV5 is used to generate the model geometry and the gear geometry is modelled according to the standard relationships. In CATIAV5 file is saved in IGES (INITIAL GRAPHICS EXCHANGE SPECIFICATION) format. This IGES format can be opened in any modelling software and it is dumped in ANSYS for analysis. Gear analysis is done by analytical method with number of assumptions, simplifications and complications in the problem, as the calculations related to tooth stresses are also multidisciplinary. Most of the scientists uses numerical methods to calculate the effect by developing theoretical models because they require very less number of assumptions. But the theoretical model and the solution are to be selected accordingly to ensure more acceptable finish and reasonable
computational time. Vijayaragan and Ganesan [2] presented a static analysis of composite helical gears system using three dimensional finite element methods to study the displacements and stresses at various points on a helical gear tooth. Huston et al [3] discussed a new approach to modeling gear tooth surfaces. The three dimensional geometrical model is generated using modelling software and analysed using ANSYS. Analysis is done by two methods which are APDL and workbench, as workbench is used for generating solution for contact stresses gives accurate results when fine meshing is done near the contact area. The solution is inversely proportional to the grain size of the mesh and stress regions occurred near the contact stresses are differentiated by colours.

II. HELICAL GEAR RELATIONS AND DIMENSIONS

The geometrical representation of helical gear is shown in the figure and the calculations are done with respect to the standard dimensions and relations

<table>
<thead>
<tr>
<th>Number of teeth</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Module (M)</td>
<td>6 mm</td>
</tr>
<tr>
<td>Normal pressure angle</td>
<td>20 degrees</td>
</tr>
<tr>
<td>Face width (mm)</td>
<td>0.015M</td>
</tr>
<tr>
<td>Addendum (mm)</td>
<td>1.00M</td>
</tr>
<tr>
<td>Dedendum (mm)</td>
<td>1.25M</td>
</tr>
<tr>
<td>Helix angle</td>
<td>12 degrees</td>
</tr>
</tbody>
</table>

Table I
III. RELATED WORK CATIA V5
(COMPUTER AIDED THREE DIMENSIONAL INTERACTIVE APPLICATION)

As the world’s one of the supplier of software, specifically intended to support a totally Integrated product development process. Dassault Systems (DDS) in recognized as a strategic partner. Catia Mechanical design solution will improve our design productivity. Catia is a suit of programs that are used in design, analysis and manufacturing of a virtually unlimited range of the product. As of this software some of the tools are used design the helical gear are PAD: which adds the material according to the profile created in the skinner 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. The following figures shows the standard gear and modified gear.

Fig. ISOMETRIC VIEW OF STANDARD HELICAL GEAR

Fig. ISOMETRIC VIEW OF MODIFIED HELICAL GEAR
IV. RESULTS OF CONTACT STRESS ANALYSIS OF MODIFIED HELICAL GEAR USING FEA

Fig. Meshing of Original Helical Gear

Fig. Meshing of modified Helical Gear

Fig. Von-Misses Stresses of Original Helical Gear
**Fig. Von-Misses Stresses of Modified Helical Gear**

**Comparison of Values of Modified Helical Gear and Normal Helical Gear**

<table>
<thead>
<tr>
<th>Gear Type</th>
<th>Von Misses Stresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Helical Gear</td>
<td>2.0051 Mpa</td>
</tr>
<tr>
<td>Modified Helical Gear</td>
<td>12.49 Mpa</td>
</tr>
</tbody>
</table>

**Table II: Comparison Of Von – Misses Stresses of Modified Gear and Normal Gear**

**V. CONCLUSION**

Gear analysis uses a number of assumptions, calculations and simplification which are intended to determine the maximum stress values in analytical method. In this paper parametric study is also made by varying the geometry of the teeth to investigate their effect of contact stresses in helical gears. 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 when compared to the standard helical so these paper pretends to be failure theory by which the design aspects are to no changed to reduce the contact stresses.

**Recommendation and Future work**

This thesis paper can be an interest for researchers, instructors and postgraduate students who have great enthusiasm to work more on gears. It may give enlightenment about the characteristics of involute helical gears and evoke previous works of various bodies that are involved in gears research and production. Furthermore this study contribute to a better gear design, assist technological institutions and all those who are interested in involute helical gears. More work can be done to improve this study and to obtain better output. Generally, the following areas are worthy for further research in the light of this thesis.

Further three dimensional numerical method of investigation and study can be conducted on the analysis of bending and contact stresses for all types of gears such as spur, bevel and other tooth forms. Further numerical method of investigation
and study can be conducted on the whole gearbox with all elements in the system including gear casing and bearing. Further numerical method of investigation and study can be conducted on gears in mesh under dynamic condition with and without cracked teeth, surface pitting or wear. The bending and contact stress analysis of gears made of composite materials using three-dimensional finite element analyses can be recommended as future work. The contact stress can be reanalyzed for a better result by simulating the real contact region between the two mating gears instead of using the equivalent cylinders by improving the solution in a high capacity computer.

REFERENCES

1. Yonatan, F., Variable Mesh Stiffness of Spur Gear Teeth Using FEM, M.sc thesis Department of mechanical Engineering, Addis Ababa University

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