INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK

DESIGN AND FINITE ELEMENT METHOD ANALYSIS OF GEAR MECHANISM FOR RAW MATERIAL CRUSHING IN PLASTIC INDUSTRY

PROF. AJITABH PATERIYA[1], DIPAK PARASARM KHARAT[2]

1. Associate Professor, Mechanical Department, Dr. V B Kolte College of engineering, Malkapur.
2. PG Student, Mechanical Department, Dr. V B Kolte College of engineering, Malkapur.

Accepted Date: 26/02/2015; Published Date: 01/03/2015

Abstract: This project deals with the finite element analysis of deformation on spur gear teeth by applying static load on teeth. The feasibility of the project is investigated and the results of the FEM analyses from ANSYS are presented. This investigates the characteristics of a gear system including bending stresses and the transmission errors of gears in mesh. Gear is one of the most critical components in mechanical power transmission systems. The bending stresses in the tooth root were examined using a 3-D FEM model. This paper also considers the variations of the whole gear body stiffness arising from the gear body rotation due to bending deflection and contact deformation. Many different positions within the meshing cycle were investigated. Investigation of contact and bending stress characteristic of spur gears continues to be of immense attention to both engineers and researchers in spite of many studies in the past. This is because of the advances in the engineering technology that demands for gears with ever increasing load capacities and speeds with high reliability, the designers need to be able to accurately predict the stresses experienced the stresses experienced by the loaded gears.

Keywords: Raw Material Crushing, Gear Mechanism

Corresponding Author: PROF. AJITABH PATERIYA

PAPER-QR CODE

Access Online On:

www.ijpret.com

How to Cite This Article:

Ajitabh Pateriya, IJPRET, 2015; Volume 3 (7): 48-55

INTRODUCTION

Gear is one of the most critical components in a mechanical power transmission system, and in most industrial rotating machinery. It is possible that gears will predominate as the most effective means of transmitting power in future machines due to their high degree of reliability and compactness. In addition, the rapid shift in the industry from heavy industries such as shipbuilding to industries such as automobile manufacture and office automation tools will necessitate a refined application of gear technology.

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 tooth leading to fracture at the root of a tooth under bending fatigue and surface failure, like pitting or flaking due to contact fatigue. In addition there may be surface damage associated seizure of surfaces due to poor lubrication and overloading. The seizure of surfaces leading to welding is usually prevented by proper lubrication so that there is always a very thin film of lubricant between a pair of teeth in motion. 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 tooth 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 tooth can be minimized.

Gears are usually used in the transmission system is also called a speed reducer, gear head, gear reducer etc., which consists of a set of gears, shafts and bearings that are factory mounted in an enclosed lubricated housing. Speed reducers are available in a broad range of sizes, capacities and speed ratios. Their job is to convert the input provided by a prime mover (usually an electric motor) into an output with lower speed and correspondingly higher torque. In this thesis, analysis of the characteristics of spur gears in a gearbox is studied using FEM. The increasing demand for quiet power transmission in machines, vehicles, elevators and generators, has created a growing demand for a more precise analysis of the characteristics of gear systems. In the automobile industry, the largest manufacturer of gears, higher reliability and lighter weight gears are necessary as lighter automobiles continue to be in demand. In addition, the success in engine noise reduction promotes the production of quieter gear pairs for further noise reduction. Noise reduction in gear pairs is especially critical in the rapidly

growing field of office-automation equipment as the office environment is adversely affected by noise, and machines are playing an ever widening role in that environment. Designing highly loaded spur gears for power transmission systems that are both strong and quiet requires analysis methods that can easily be implemented and also provide information on contact and bending stresses, along with transmission errors. The finite element method is capable of providing this information, but the time needed to create such a model is large. In order to reduce the modeling time, a preprocessor method that creates the geometry needed for a finite element analysis may be used, such as that provided by Pro-E.

Gears analyses in the past were performed using analytical methods, which required a number of assumptions and simplifications. In this thesis, static contact and bending stress analyses were performed, while trying to design spur gears to resist bending failure and pitting of the teeth, as both affect transmission error.

In this paper, first the finite element models and solution methods needed for the accurate calculation of two dimensional spur gear are created. Herewith bending stresses are determined analytically. Then, the bending stresses are calculated using ANSYS v-11 and compared to the results obtained from existing method. The purpose of this thesis is to develop a model and predict the bending stresses in the tooth root.

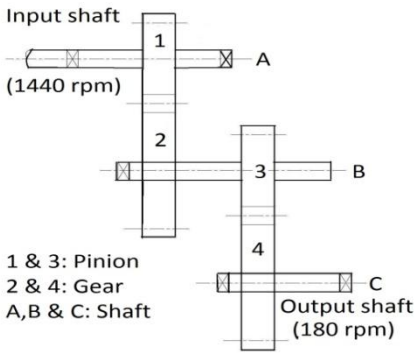

Figure1: Line diagram of spur gear drive

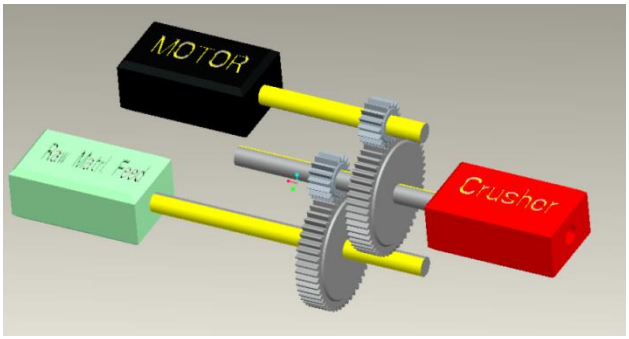

Figure2: Complete gear drive with feeder and crusher

PROBLEM DEFINITION:

SP Plastics, Pvt Ltd, Hingana MIDC, Nagpur is a small vendor company, manufacturer of plastics components such as Buckets, mugs, boxes etc. The company is small vendor company of Bajaj plastics. The company is operating on two Injection molding machines simultaneously to produce the parts.

Scrap material of the part is crushed by using crushing machine and reused as a raw material for molding machine. So there is requirement of designing the gear box which will take power from motor and transfer it to crushing machine as well as feeding mechanism of raw material.

SHOP FLOOR LAYOUT:

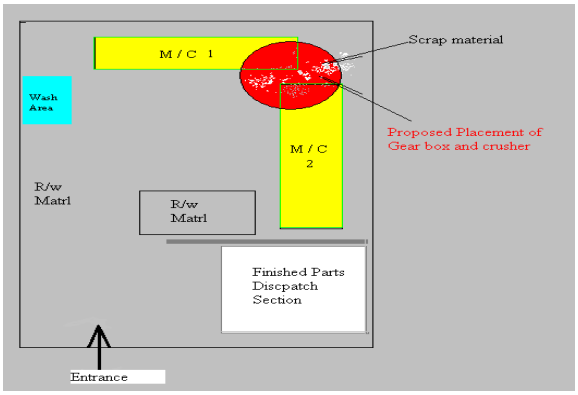

Figure3: Shop floor layout

The machine floor setup shown in diagram consists of two injection molding machines; finished parts dispatch section, space for raw material storage etc. Both machines are arranged in position perpendicular to each other and the gear box with crusher and feeder is placed at red spot shown in diagram.

After molding has been done, scrap from finished part has been separated manually and feed it to a hopper of crusher for making it in fine pieces for reusing as a raw material. Crusher is having hopper through which scrap is inserted. Blades are connected to shaft vertically and the axis of shaft is horizontal. As the shaft rotates at 540 rpm, scrap plastic gets converted into fine chips forward it to feeder.

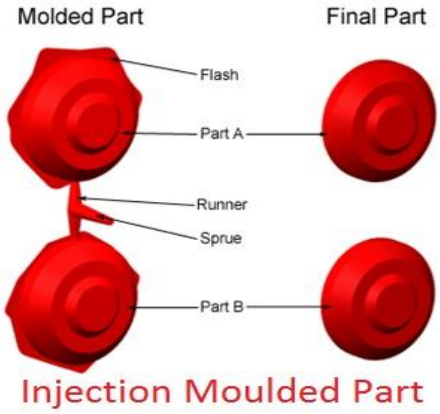

Fig4: End Product

LITERATURE REVIEW AND BACKGROUND:

There has been a great deal of research on gear analysis, and a large body of literature on gear modeling has been published. The gear stress analysis, the transmission errors, the prediction of gear dynamic loads, gear noise, and the optimal design for gear sets are always major concerns in gear design. Various research findings are described below on the field of spur gear and their terminology.

Ali Raad Hassan [1] developed a programme to plot a pair of teeth in contact. This programme was run for each 3° of pinion rotation from the first location of contact to the last location of contact to produce 10 cases. Also he has done the FEM analysis to find out the stresses developed in the spur gear body considering contact ratio, approach angle, recess angle, contact and length of contact. The stress was more than the correct value of contact stress obtaining from approximating tools.

Sunil Kumar et al. [2] have prepared CAD model of spur gear using Pro/Program toolkit of Pro-E and FEM analysis by ANSYS 10.0 to investigate validity of spur gear design. The results of FEM are compared with those obtained using Hertz's equations. Bending stresses have also been determined using three dimensional FEM analyses. It would be useful for achieving automation of gear design and analysis.

Ramalingam Gurumani and Subramaniam Shanmugam [3] studied the effect of crown radius in crowning it is observed that the area of contact of involute crowned gears is slightly lower than the circular crowned gears which show the existence of more point contact compared to circular crowned gears. Ramalingam also used CAD model to test the effect of crown.

Ishan Patel and Dr. M.S. Murthy [4], compare the bending stresses for different number of teeth of spur gear obtained by using various code like MATLAB Simulink and ANSYS. The result depicts that trend of results obtained from both ANSYS and Simulink are close to the results of AGMA. Hence, simulink is also an equivalent tool if modeled properly by using curve fitting.

Department of Applied Mechanics, IIT Delhi, [5] done the project on spur gear and its geometry. They have also used ANSYS as a tool for checking the different stresses induced in the gear pair. The study reveals that various application packages like ANSYS, simulink etc can replace the tedious work of analytical calculations which perhaps a time consuming task.

Mr. Bharat Gupta et al. [6], done the detail study on the contact region of spur gear. They have cross check the results of ANSYS with Hertzian theoretical equation. The deep investigation was carried out to measure various factor of spur gear contact region. Stress minimization was the primary concern and if the large power is to be transmitted then a Spur gear with higher module is preferred.

Ali Raad Hassan [7] is known as father of gear theory as he has done huge contribution to various studies of gear pair. He has been awarded 5 times for his researches and developments on gear manufacturing machines. The result shows that as the rotational speed of gear increases, the bending stress of dynamic stress also increases. For the moving load, the ratio of maximum dynamic bending root stress to maximum static bending root stress is increases.

Yogesh C. Hamand and Vilas Kalamkar [8], compared the theoretical results of planetary gear of stresses and deflection on real condition with the results obtained from ANSYS.

The investigation result infers that the deflection in trochoidal root fillet is also less comparing to the circular root fillet gear tooth.

CONCLUSION

As per mathematically calculated shear stress is coming to be near to 81 N/mm2 and the ANSYS stress value is 77.3 N/mm2. Only 4 to 5% error is present between two values.

Finite element method has been used to calculate the bending stress between two gears. It has been found that use of ANSYS gives results with enough close to accurate which in the acceptable limits.

REFERENCES:

1. Ali Raad Hassan, "Contact Stress Analysis of Spur Gear Teeth Pair", World Academy of Science, Engineering and Technology 34 2009.

2. Sunil Kumar, K. K. Mishra, Jatinder Madan**, "**Stress Analysis of Spur Gear Using FEM Method**".** National Conference on Advancements and Futuristic Trends in Mechanical and Materials Engineering (February 19-20, 2010)

3. Ramalingam Gurumani, Subramaniam Shanmugam, "Modeling and Contact Analysis Of Crowned Spur Gear Teeth". Engineering MECHANICS, Vol. 18, 2011, No. 1, p. 65–78

4. Department of Applied Mechanics, "Static Response of A Pair Of Spur Gear" by Indian Institute of Technology, Delhi.

5. Mr. Bharat Gupta1, Mr. Abhishek Choubey, Mr. Gautam V. Varde, "Contact Stress Analysis Of Spur Gear", International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 4, June - 2012 ISSN: 2278-0181

6. Ali Raad Hassan, "Transient Stress Analysis on Medium Modules Spur Gear by Using Mode Super Position Technique". International Journal of Aerospace and Mechanical Engineering 4:4 2010.

7. Yogesh C. Hamand, Vilas Kalamkar "Analysis of Stresses and Deflection of Sun Gear by Theoretical and ANSYS Method", Mechanical Modern Mechanical Engineering, 2011, 1, 56-68 doi:10.4236/mme.2011.12008 Published Online November 2011 (http://www.SciRP.org/journal/mme)

8. Vijay Bhaskar Sudarsi and T.B.S.Rao, "The Finite Element Analysis of Deformation on Spur Gear Teeth", Dept. of Mechanical Engg., Nimra Institute of Science and Technology, Vijayawada-520007

9. H. N. Ozguven and D. R. Houser, "The Mathematical Models Used in Gear Dynamics-A Review," Journal of Sound and Vibration, Vol. 121, No. 3, 1988, pp. 383-411. doi:10.1016/S0022-460X(88)80365-1

10. V.B. BHANDARI, “Hand Book of Design of machine element”, Tata McGraw Hill Publishing Company Limited, First edition, pages-(646-688)

11. R.S. KHURMI and J.K. GUPTA, “Text Book of Machine Design S. Chand publications, First edition, pages-(1021-1062).