Dynamic Analysis of Single Row Deep Groove Ball Bearing with Surface Defects – A Review

Swapnil Kale[1], Sham Kulkarni[2], Atul Aradhye[3]

[1] PG Scholar, Department of Mechanical Engineering, SKN Sinhgad College of Engineering, Korti, Pandharpur-413304, Maharashtra, India.
[2,3] A P, Department of Mechanical Engineering, SKN Sinhgad College of Engineering, Korti, Pandharpur-413304, Maharashtra, India.

Abstract - *This paper provides review in understanding the vibration generated and transmitted through ball bearings once vibrations of rotating machinery are to be modeled and analyzed. Researchers have used several FE packages to understand the vibration response caused as a result of defect in a single row deep groove ball bearing.*

Key Words: **dynamic analysis, ball bearing, surface defects, FE, Vibration.**

1. INTRODUCTION

Rotating machines are essential in mechanical machinery that contains many elements. The condition monitoring of machinery has many economic benefits. A number of conventional vibration analysis techniques exist by which certain faults in rotating machinery can be identified. Ball bearings are key supporting elements used in machinery low or high speed e.g. machine tools, electric motor etc. The damage and failure of bearings are the major source of system breakdown. Vibration analysis is one among the foremost usual strategies used to evaluate the conditions of bearings in an operating machine. Such measurements could also be used for machines with bearings in new condition similarly as for machines whose bearings are failing and approaching the end of their useful lifespans. If a machine's vibration response to noted excitation forces has been determined through techniques like finite element analysis and modal analysis, then vibration measurements during service will determine the dynamic characteristics of the forces working on the automobile. Vibration information will likewise be used to understand forcing characteristics and also the condition of machine components, mainly single row deep groove ball bearings. Understanding the vibration generated and transmitted through ball bearings is a significant task when vibrations of rotating machinery are to be modeled and analyzed. Researchers have used many FE packages to understand the vibration response caused due to defect in a single row deep groove ball bearing.

2. LITERATURE RIVIEW

Amit Shrivastava et. al. [1] have worked on 6206 - ball bearing of three phase induction motor they used a methodology by considering an accelerometer used to measure the vibration level. The signals are then transformed into frequency domain using FFT and the obtained spectrum is analyzed to determine the condition of the motor. The defects were produced by the electron discharge method (EDM), have concluded that The distinct and different behavior of vibration signals from bearing with inner and outer race defect help in identifying the defects in roller bearings.

Abhay Utpat [2] have worked on single row deep groove ball bearing by using LS-DYNA solver for Modeling and meshing of test bearing and solution is obtained for number of defect sizes and at different speeds, when defect is on outer ring, Tetrahedron (Solid 168) free meshing is used for outer ring as well as balls.For inner ring without defect, mapped meshing Hexahedron (Solid 164) is preferred. But in case of inner ring defected bearings, inner ring is meshed with Solid 168. He had concluded that At constant speed and constant load with different defect sizes on outer ring, amplitudes of vibration varies with increase in defect size. Amplitudes of vibration are observed higher for outer ring defected bearings than inner ring defected bearings for same defect size.

Zahari Taha et. al. [3] have worked on SKF 1206 ETN9 single row deep groove ball bearing by using ABAQUS software they developed a Finite element model of a bearing and housing structure. Also, a dynamic loading distribution is developed to simulate the load distribution on the outer raceway due to load transfer from the shaft through the balls. The housing and outer raceway structures are discretized into 71846 and 14091 4-node linear tetrahedron elements, respectively. They have analyzed the models to obtain the vibration signal in the frequency domain and the vibration signal of defected bearing is compared with the one of healthy bearing for defect detection. Experiments were conducted to validate the simulation results of the software.

Arnaz S. Malhi [4] have worked on single row deep groove ball bearing by using an FEA package ANSYS which calculates stress distribution across the bearing element by doing static analysis of an angular contact ball bearing using

Finite Element Method. In order to find the deformation & maximum stress generated in static & dynamic condition.
H. Saruhan et. al. [5] have worked on single row deep groove ball bearing the vibration analysis technique is used for detecting defect in the bearing elements using simulation software in order to To increase operational reliability of rolling element bearing is to monitor defects in the REBs. One of the most effective techniques to use for condition monitoring of the rolling element bearing is vibration spectrum analysis.

Viramgama Parth D. [6] have studied 6316 - single row deep groove ball bearing using ANSYS Software for finite element analysis of single row deep groove ball bearing. ANSYS calculates stress distribution across the bearing element. static analysis of an angular contact ball bearing using Finite Element Method. We can find the deformation & maximum stress generated in static & dynamic condition.

Zeki Kiral et. al. [7] have studied and presented work on 6205 - single row deep groove ball bearing. . The vibration analysis of the bearing structure is performed using a standard finite element package I-DEAS. The solid model of the housing structure is discretized into 23,964 finite elements and the resulting node number is 37,894. The element type used in the discretization is a 10-node parabolic tetrahedron having 3 degrees of freedom at each node. The vibration analysis of the bearing structure is performed using a standard FE package under the action of these excitation functions simultaneously. The I-DEAS package uses the mode summation technique and 10 modes are used to calculate the dynamic response of the bearing structure. They have proposed a technique to simulate the vibration of bearing structures which houses a ball bearing with or without a defect. A computer program is developed to model the dynamic loading of the bearing structure, considering the bearing kinematics and load distribution.

Ritesh Fegade et. al. [8] have conferred an alternate procedure known as harmonic analysis to identify frequency of a system through critical speed, amplitude and phase angle plots using ANSYS. The unbalance that exists in any rotor due to eccentricity has been used as excitation to perform such an analysis. ANSYS parametric design language has been enforced to attain the results. In initial case, 2 undamped isotropic bearings were placed at positions four and 6. In second case, 2 symmetric orthotropic bearings were located at positions four and six, and in third case 2 identical fluid film bearings were located at positions four and 6. The result shows to finding a critical speed of rotor using completely different bearing. The accuracy of the model and also the solution technique has been demonstrated by comparison with results of previous publications.

Yimin SHAO et. al.[9] have presented, a simulation study conducted using the method of finite element analysis (FEA) to understand the vibration characteristics from the small impact. The vibration responses have been modelled based on a typical bearing assembly. Common faults including outer ring defect, inner ring defect and rolling ball defect are simulated and their vibration responses are compared between different faults and at different locations in the bearing housing. The results obtained have shown that under the same defect size, the vibration from the outer ring is the highest whereas that from the rolling ball is the smallest. In addition the vibration close to the mounting hole attenuates considerably compared to that close to outer ring. These findings provide fundamental information to place vibration sensors and to analyze vibration signals.

3. CONCLUSION

Through this literature review an attempt has been made to summarize the recent research and developments in the vibration analysis using finite element packages for the diagnosis of single row deep groove ball bearing with surface defects.

REFERENCES

[1] Amit Shrivastava, Dr. Sulochana Wadhwani, “Vibration signature analysis for Ball Bearing of Three Phase Induction Motor”, IOSR Journal of Electrical and Electronics Engineering (IOSRJEEE) 2012.

[2] Abhay Utpat, “Vibration Signature analysis of defective deep groove ball bearings by Numerical and Experimental approach”, International Journal of Scientific & Engineering Research, Volume 4, Issue 6, June-2013.

[3] Dr. Zahari Taha, Nguyen Trung Dung, “Rolling Element Bearing Fault Detection with a Single Point Defect on the Outer Raceway Using Finite Element Analysis”, Asia Pacific Industrial Engineering and Management Systems Conference,10 December 2010.

[4] Arnaz S. Malhi, “Finite Element Modeling of Vibrations Caused by a Defect in the Outer Ring of a Ball Bearing”, Project Report : Finite Element Method and Applications / MIE 605 Spring 2002

[5] H. Saruhan, S. Saridemir, A. Cicek, I. Uygur, “Vibration Analysis of Rolling Element Bearings Defects”, Journal of Applied Research and Technology Vol. 12, June 2014

[6] Viramgama Parth D., “Analysis of Single Row Deep Groove Ball Bearing”, International Journal of Engineering Research & Technology (IJERT) Vol. 3 Issue 5, May – 2014

[7] Zeki Kiral, Hira Karagulle, “Simulation and analysis of vibration signals generated by rolling lement bearing with defects”, Tribology International 36 (2003) 667–67

[8] Ritesh Fegade, Vimal Patel, R.S. Nehete, B.M. Bhandarkar, Unbalanced response of rotor using ansys parametric design for different bearings, International Journal of Engineering Sciences & Emerging Technologies, Aug. 2014. ISSN: 22316604 Volume 7, Issue 1, pp: 506-515

[9] Yimin SHAO, Wenbing Tu, Fengshou GU, A Simulation Study of Defects in a Rolling Element Bearing using FEA, International Conference on Control, Automation and Systems 2010, pp 596-599