An Investigation on Selection of Composite Bearing Material

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Abstract- *Rolling Element Bearings (REB) are the most common machine elements used in rotating machinery and their failure is the foremost cause of down time in plant machinery. Effectiveness of transient analysis of the finite element bearing model to simulate the vibration signal emanating from ball bearing with faults is presented in this work. Identification of ball bearing defect in frequency domain using FFT analyzer. The simulation results were validated with experimental results. In this study, vibration analysis of ball bearing for chrome steel and phosphors bronze material is carried out using FFT analyzer. The results of experimentation are validated with finite element analysis.*

Keywords- BALL Bearing, Finite Element Analysis, FFT analyzer,

I. INTRODUCTION

Vibration analysis is used to determine the operating and mechanical condition of equipment is very importance. A major advantage is that failure analysis can be identify developing problems before they become too serious and cause unscheduled downtime. The conducting regular monitoring of machine vibrations either on continuous basis or at scheduled intervals can be achieved. can be detect defective bearings with the help of vibration monitoring, mechanical looseness and worn or broken gears. Vibration analysis can also detect misalignment and unbalance before these conditions result in bearing or shaft deterioration. Reducing vibration levels can identify poor maintenance practices, such as obtain bearing installation and replacement for inaccurate shaft alignment or imprecise rotor balancing conditions. At high speeds the bearing loads are due in large part to dynamic forces-inertia and centrifugal forces[1] .

Rolling Element Bearings (REB) are the most used in the rotating machine most common machine elements and find out failure is the cause of down time in plant machinery. Commonly occurring REB defects are cracks and pits located at outer race, inner race and on the rolling element. These defects generate a sequence of impacts with each passage of rolling element over the defect due to the metal to metal contact. The ensuing vibration is distinguished by sharp peaks. It is not easy to identify the defect frequency in the spectrum as these impact vibrations disseminate their energy over broad range of frequencies, thus the bearing's defect frequency contains low energy and hence can be easily masked by noise and other low frequency effects.

To find out solution this problem for two methods time domain and frequency domain have been developed. Also indices that are sensitive to impulsive oscillations time domain methods usually involved, such as peak level, Root Mean Square (RMS) value, crest factor analysis, kurtosis and shock pulse counting Since it is difficult to identify incipient bearing defects in the frequency spectrum , many specialized techniques have been developed over the years the bearing fault diagnosis, such as, Bi-spectrum coherence, spectral entropy , autoregressive models , envelope spectrum wavelet transform and more Artificial Neural Network (ANN) to machinery fault diagnosis. In practice, it is quite difficult to obtain vibration signal from bearing having incipient defects; thus many researchers have attempted to simulate the vibration signal emanating from bearing having incipient fault.

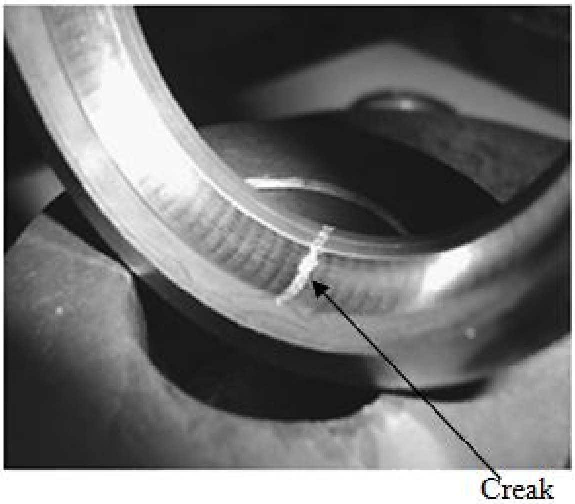

Fig .1, Outer race effect

In the present work, a method to simulate the ball bearing having an incipient crack on outer race has been presented. Transient analysis of the bearing was performed and nodal acceleration of a node on a region on outer race that was not constrained was recorded with respect to time. The results of transient analysis was compared with actual vibration signals emanating from ball bearing embedded with induced fault (crack) on outer race vibration data of a rotating shaft-line. It was shown that simulated signal matches with the actual vibration signal and it was also shown that identification of bearing faults at incipient stage is not very evident in time domain or in frequency domain. It was also shown that more accurate simulation is achieved when Finite Element (FE) model of full bearing assembly is done instead of making FE model of only outer-race or inner-race as done by various researchers.

II. LITERATURE REVIEW

Shelke et al. (2016)**,** presented adaptive spectral kurtosis (ASK) for multi-fault in single row ball bearing detection. A theoretical model of multiple bearing faults was developed. They showed that their method could more effectively extract a feature of multiple bearing faults in the presence of strong background noise compared with the kurtogram and preprogram techniques[1].

Patel et al. (2015**),** reported that local defects, such as spalls, pits and cracks on mating components of bearings are generated due to fatigue.[2]

Rajewari et al. (2014**),** developed a ball bearing fault model that is based on dynamic load analysis of the rotor bearing system. They investigated rotor bearing vibration model combined with both dynamic response and fault signal expression of ball bearing. The experimntal results verified with the signal model simulation results[3].

khanam et al. (2014**),**employed singular spectrum analysis for fault detection of single row ball bearings. The effects of operating parameters such as load and speed on the indicator are studied. Their results showed that the indicator defined is less sensitive than the RMS value, a traditional vibratory indicator[4].

Kankar et al. (2014)**,**used continuous wavelet transform (CWT) for a single row ball bearing fault diagnosis. They used ANN, SVM and self-organizing maps (SOM) for faults classifications and reported that the SVM gave a better diagnosis performance as compared to the ANN and SOM[5].

Abu-Zeid and Abdel-Rahman **(**2013) studied damaged bearings and reported they generated high amplitude of vibration at high frequencies and consumed higher energy. Bearing faults can increase vibration level up to 85%, increase power consumption 10- 14% and decrease pump efficiency up to 18%. Different researchers have used different parameters of vibration signal to study bearing fault [6].

Kankar et al. (2013)**,** used ANN and support vector machine (SVM) for fault diagnosis of a single row ball bearing; they showed that the SVM classified the fault better than ANN[7].

Rafsanjani et al. (2009), proposed the analytical model for single row ball bearing with local defects on the inner race, outer race and ball. They suggested that the analytical model can be used for design, predictive maintenance and also condition monitoring of machines. [8]

III. OBJECTIVES

- To identify different modes of failure in ball bearing.
- To identify the vibration analysis of bearing of cold draw bench.
- To identify the suitability of materials Phosphor bronze and chrome steel with the help of displacement, velocity and acceleration using FFT analyzer.
- To identify and comparing experimental result to finite element method

IV. METHODOLOGY

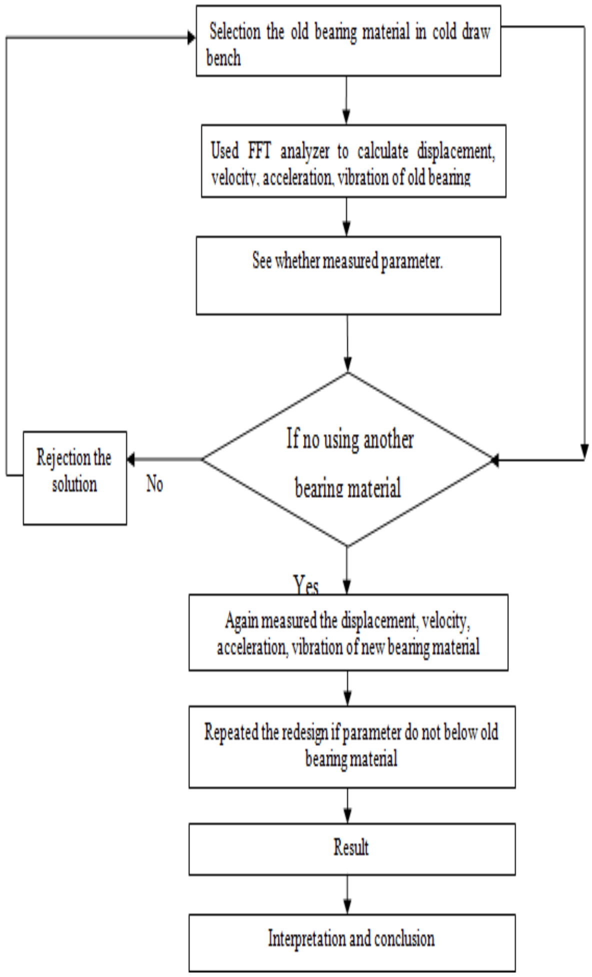

Fig.2, methodology description

V. EXPERIMENTATION AND DISCUSSION

A. Experimentation Of Old Bearing

Vibration response of old bearing (Material: Phosphor Bronze) with load

The graphs given below are of Phosphor bronze bearing in load condition-

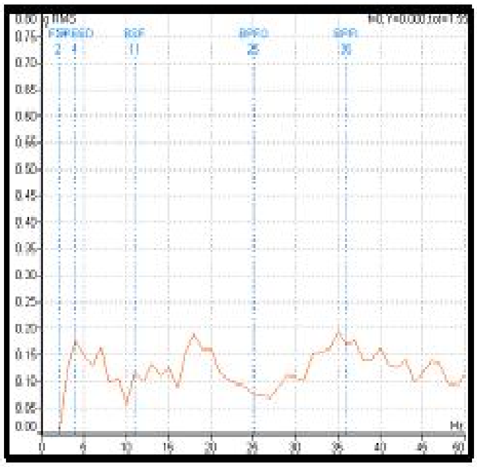

Fig.3, FFT of bearing with load in vertical direction

Fig.3, shows that envelope spectrum of phosphor bronze in vertical direction. In this fig., the values of FTF BSF, BPFO and BPFI are indicated clearly which are tabulated below in load condition. The overall acceleration – rms value for the vertical direction is 1.55.

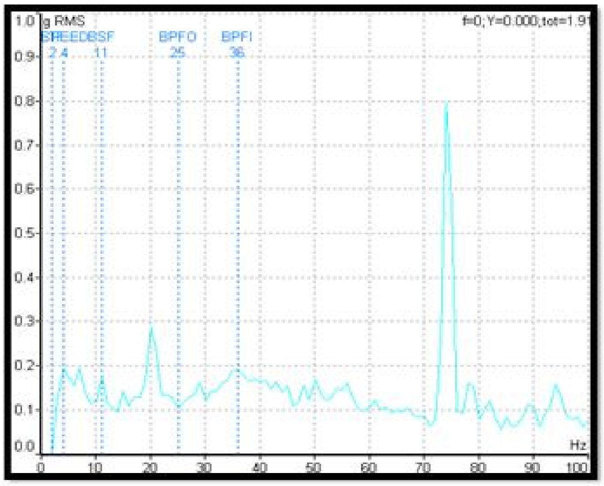

Fig.4, FFT of bearing with load in horizontal direction

fig.4, shows that envelope spectrum of phosphor bronze in Horizontal direction. In this fig., the values of FTF,BSF,BPFO and BPFI are indicated clearly which are tabulated below in with load condition. The overall acceleration – rms value for the vertical direction is1.91.

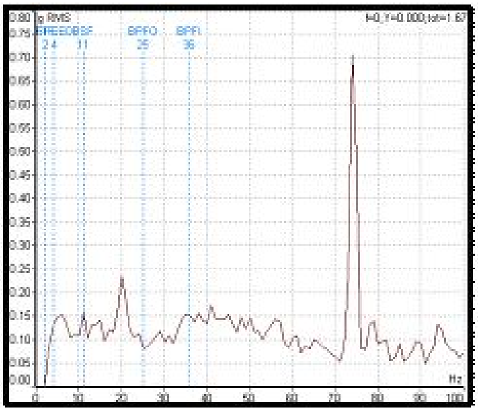

Fig.5, FFT of bearing with load in axial direction

Fig.5 shows that envelope spectrum of phosphor or bronze in axial direction .In this fig., the values of FTF, BSF, BPFO and BPFI are indicated clearly which are tabulated below in with load condition. The overall acceleration – rms value for the axial direction is1.67.From the above graphs, the values of the fault frequencies such FTF,BSF,BPFO, BPFI are tabulated below for the phosphor bronze bearing.

Fault frequency	Frequency
FTF	2
BSO	11
BPFO	25
BPFI	36

Fig.6, Fault frequency of ball bearing (SKF22308) at 4HZ

The overall-rms acceleration Level in vertical, horizontal and axial directionis1.55 g, 1.91 g and 1.67 g respectively for the Phosphor bronze bearing.

B.Experimentation of New Bearing

vibration response of new bearing (material: chrome steel) with load

Figs. 7, 8 and 9 shows envelope spectrum of new bearing with load in vertical, horizontal and axial direction respectively. The overall-rms acceleration level in vertical, horizontal and axial direction is 0.4g, 0.394 g and 0.258 g respectively.

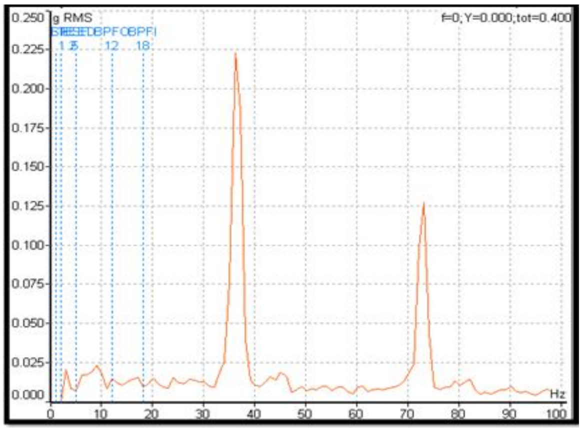

Fig.7, FFT of bearing with load in vertical direction

Fig.7 shows that envelope spectrum of Chrome steel in vertical direction. In this fig., the values of FTF, BSF, BPFO and BPFI are indicated clearly which are tabulate below in with load condition. The overall acceleration–rms value for the vertical direction is0.4

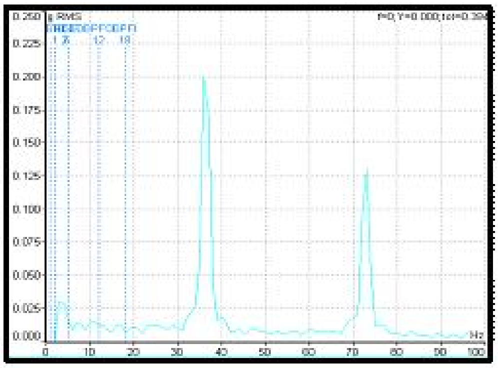

Fig.8, FFT of bearing with load in horizontal direction

fig.8, shows that envelope spectrum of Chrome steel in horizontal direction. In this fig., the values of FTF ,BSF ,BPFO and BPFI are indicated clearly which are tabulated below in with load condition. The overall acceleration – rms value for the horizontal direction is0.394

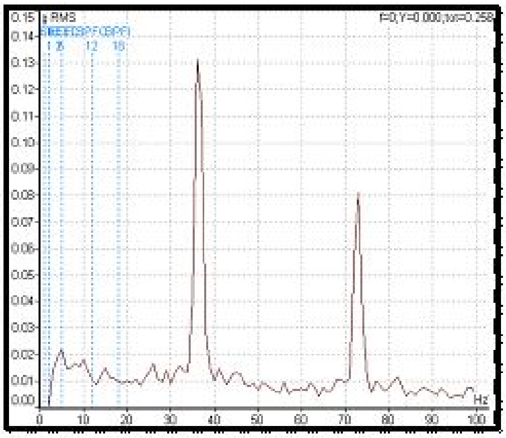

Fig.9, FFT of bearing with load in axial direction fig.9, shows that envelope spectrum of Chrome steel in axial direction.In this fig., the values of FTF ,BSF ,BPFO and BPFI are in dictated clearly which are tabulated below in with load condition. The overall acceleration–rms value for the vertical direction is 0.258.From the above graphs, the values of the fault frequencies such FTF,BSF,BPFO, BPFI are tabulated below for the chrome steel bearing

From the above graphs, the overall rms – acceleration values are as. For Phosphor bronze 1.55, 1.91 and 1.67 in vertical, horizontal and axial direction respectively. For chrome steel 0.4, 0.394, and 0.258 in vertical, horizontal and axial direction respectively. From the above values chrome steel is having less rms – acceleration. From the graphs, we tabulated the values of fault frequencies for both the bearings as in fig 6From the table, we say that the frequency of outer race(BPFO)and inner race (BPFI) is having high value of phosphor bronze as compared to the chrome steel.

From frequencies and acceleration – rms, it is clear that the chrome steel is better material than phosphor bronze for ball bearing of cold draw bench motor.

VI. CONCLUSION

In this experiment, failure analysis of ball bearing for chrome steel and silicon carbide material will be best carried out. The displacement, velocity, acceleration chrome steel material is better than phosphor bronze for ball bearing of cold draw bench motor are concluded with help of FFT analyzer.

Future plan

After experimentation will be used finite element method to design new bearing model and comparing result experimental to finite element method.

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