DESIGN AND DEVELOPMENT OF EXPERIMENTAL SETUP FOR BALL BEARING NOISE TESTING

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Abstract : Bearings plays very important role in every kind of machines where sliding contact is to be replaced by point contact. In automobile sector, clutch release bearing in light and heavy duty vehicles plays a crucial role whose function is to engage and disengage the clutch plate and pressure plate. The whole idea of this project is to develop a testing setup for noise measurement of clutch release bearing. The clutch bearing is considered as ball bearing which is capable of taking axial load. This project deals with the design of components required for applying load to clutch release bearing and noise measurement using acoustic chamber. This project throws light on the noise parameter which shows the difference in sound level for varying speeds and load. In order to determine the usability of bearing, noise levels will help the user to discard the use or to continue with the bearing.

Index Terms: Clutch release bearing, axial load, acoustic chamber, noise, sound level

I. INTRODUCTION

Bearings are the crucial parts in any machine. It is because, bearings sustain the loads like radial load, axial load and thrust load too. This loads are induced in bearings due to various mechanisms present in the system. In order to reduce the friction between two mating components, bearings are used. These loads are not always constant which may give rise to fluctuating loads. Due to this fluctuation in loads, faults are generated in bearings which results into generation of noise in bearings. Noise is the main parameter which is observed firstly in case of bearings. These faults changes the behaviour of bearing in working circumstances.

Bagda and Patel has carried out the transient analysis of double row deep groove ball bearing used for clutch release. Authors investigated the parameters like natural frequency, von-misses stress, maximum shear stress and maximum deformation which affect the vibration analysis of bearing [1]. Joshi and Lodwal has carried out wavelet analysis on the fault signal obtained from the clutch release bearing. The signal is then given to MATLAB software in which wavelet analysis is carried for various faults made in the bearing like horizontal and vertical scratch on inner and outer race, one ball missing from the cage. The signal is studied using wavelet transform which is useful for fault detection [2]. Bargun et al. studied the effect of changing geometry in spinning operation of clutch release bearing on its tensile strength numerically as well as experimentally. The clutch bearing geometry is created by the CAD software and analyzed by analysis software. Using the generated data, authors have created a new clutch bearing model and prototypes are made. To validate the results experimentally, tests have been carried out which results in increase in axial tensile strength up to 40% [3].

Some researchers also investigated the rolling element bearings for various aspects of noise generation. Rho et al. investigated the source of acoustic noise in roller bearing which is due to the motion of the rollers in bearing under zero external load. Also, the effects of the radial clearance of the bearing, viscosity of the lubricant and the no. of rollers are examined which leads to the conclusion that all these above mentioned parameters affects the process of noise generation in roller bearing [4]. Rho et al. has provided a procedure of calculating the noise of oil lubricated journal bearings. In this paper, in order to obtain acoustical properties of journal bearing, a non-linear analysis including rotor imbalance is performed for a rotor-bearing system. Using transmission theory of plane waves, non-linear analysis gives the frequency analysis of pressure fluctuations for sound pressure levels of bearing. This paper shows us that sound pressure level of the journal bearing increases with increasing rotational speed of the rotor, although whirl amplitude of the rotor decreased at high speed [5]. Bucinskas et al. studied the fundamental aspects of bearing noise generation. This paper focuses on the problem of ball bearing and roller bearing noise generation. Authors investigated the effect of lubricant on vibration and noise generation. They have compared ceramic bearings with steel ones to evaluate influence of bearing lubricant with different properties [6].

Bearings generate noise which contribute to overall noise of the system. As far as bearings are taken into consideration, the very first thing that can be observed is loading condition. For heavy loading conditions, mainly the combination of radial and thrust loads are acting on the system. So for the defect created inside the bearing, only noise is the parameter that can be observed. But the noise cannot be distinguished when the bearing is operated in the working environment. In order to measure the noise of defective bearing, the bearing needs to be isolated from the surrounding. This can be done by providing a canopy system to the bearing under consideration. This project focuses on the development of test setup which will be useful for the testing of clutch release bearing.

II. DESIGN OF COMPONENTS

The main components required for the setup are spindle, spring, and acoustic chamber. Spindle is designed by considering the speed of motor which will give the bending load and torsional moment. On the other side there is an axial load which will be in line with axis of shaft. The axial load on the clutch bearing is given by the spring. The spindle is made in stepped manner having effective diameter of 40 mm. The axial load will be taken care by the thrust bearing. Spring is designed to give a desired load of 30 Kg which can be varied by pitch adjustment. This load is applied to the clutch bearing with the help of toggle clamp.

The clutch release bearing is placed on the coupling. One part of coupling is fitted on the spindle and other part is locked to the former with the help of bolts. The latter part is removable which facilitate the modification according to the size of bearing. Acoustic chamber is made to isolate the bearing from surrounding. A small opening is provided for insertion of microphone to record the noise generated by the bearing. Acoustic chamber is made of sheet metal of which inner side is coated with acoustic foam. The main part of setup are shown in fig.1. The position of acoustic chamber is also shown in fig.2.

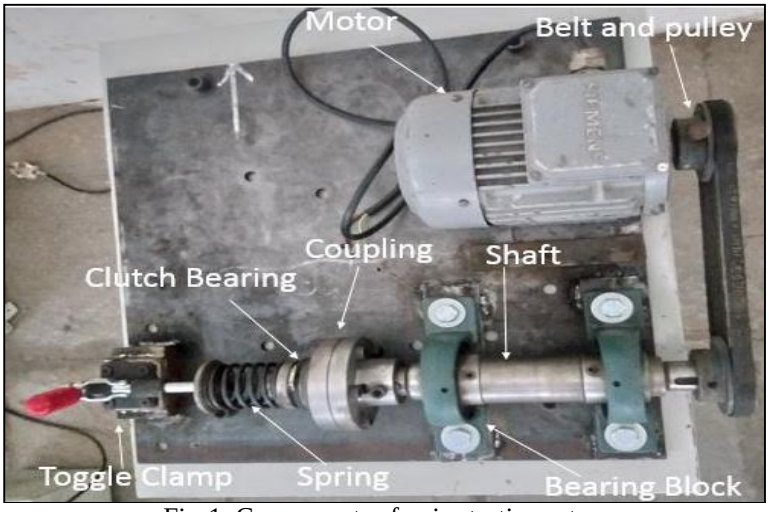

Fig-1: Components of noise testing setup

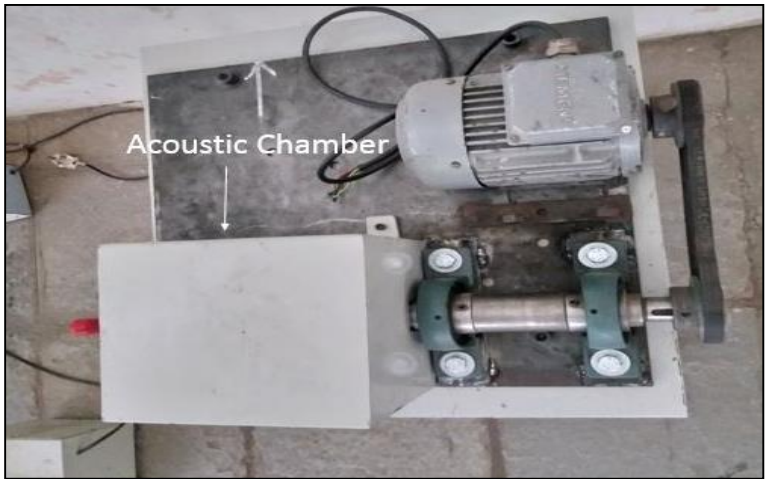

Fig-2: Position of acoustic chamber

III. WORKING OF SETUP

The motor is supplied by the power supply which is rotated at the rated speed. The speed can be varied using variable frequency drive (VFD). The intermediate speed of motor is obtained by changing the output if VFD. At different speeds, the background noise is recorded. Afterwards the noise generated by clutch bearing is recorded by varying the speeds. At the time of recording signal, clutch bearing is loaded by axial load by the spring with the help of the toggle clamp. In order to validate the noise generated by faulty bearing, sound signals for healthy bearing are recorded.

The whole interfacing of recoding noise signal is done with the help of Dewesoft X software which comes with DEWE43 data acquisition system (DAQ). The sound signal recorded by microphone are transferred to computer with the help of data cable. Fig.3 shows the measuring equipments along with the setup. A small cover is provided on the motor along with the partition between motor and acoustic chamber. This provision minimizes the noise induced in the acoustic chamber as the background noise cannot be fully eliminated.

Fig-3: Measuring equipments interfaced with DAQ

IV. RESULTS AND DISCUSSION

For the measurement of noise generated in the clutch bearing, a load of 30 Kg is applied to the bearing and the noise signal is recorded for different speeds of motor i.e. 1500, 2000, 2500, 3000 rpm. This results are then compared with the healthy bearing which shows that there is a significant rise in the noise level from healthy to faulty clutch bearing. The noise signal recorded for various speeds shows different sound pressure level which are recorded when bearing is operating which includes the background noise. In order to eliminate the background noise effect it is then subtracted from the original sound according to the following formula

Lpm = 10 *$\log_{10}(10^{faulty/10} - 10^{background/10})$

Where Lpm = Total sound pressure level

Thus we have a total sound pressure level. Similar formula is applicable for healthy bearing background noise elimination. As per above formula total sound pressure level is calculated for different speed for faulty and healthy bearing shown in table 1 and table 2.

Table-1: Total sound pressure level (dBA) for different speeds for faulty condition

Speed (RPM)	Faulty (dBA)	Background (dBA)	Lpm (dBA)
1500	93.37	72.11	93.34
2000	101.76	73.66	101.75
2500	103.04	75.50	103.03
3000	104.38	78.58	104.36

Table-2: Total sound pressure level (dBA) for different speeds for healthy condition

Speed (RPM)	Healthy (dBA)	Background (dBA)	Lpm (dBA)
1500	87.75	72.11	87.63
2000	90.61	73.66	90.52
2500	93.71	75.50	93.64
3000	94.10	78.58	93.97

V. CONCLUSION

The investigation of the noise generated by faulty bearing compared to healthy bearing shows that there is a significant rise in the noise ranging from 5 to 10 dBA which clearly indicates that the faulty bearing is not performing the intended function. In order to reduce noise from the system the bearing needs to be changed and must be replaced with the new one. The investigation leads to a point where clutch bearing during its working should be regularly checked for any noise. If there is a significant noise developed due to the prolonged working, it indicates that the bearing is damaged. At this point where the noise is heard significantly along with the background noise, the bearing needs to be replaced with the new bearing.

VI. REFERENCES

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