"A REVIEW ON THE BENEFITS OF VIBRATION MONITORING AND ANALYSIS"

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Abstract : The main cause of failure or breakdown of rotating machine is the rolling element bearing faults. Therefore it is necessary to detect and diagnosis of various faults in rolling element bearing for smooth and reliable operation. The application of rolling element bearing in various areas like domestic and industrial application. Bearing defects unless detected in time may lead to malfunctioning of the equipment. Different methods are used for detection and diagnosis of the bearing defects. This paper reviews the benefits of vibration monitoring and analysis. Also this paper attempts to summarize the recent research and developments in rolling bearing vibration analysis techniques.

Index Terms: Vibration response, Rolling element bearing, Bearing fault, Vibration analysis.

I. INTRODUCTION

Some of the companies still running with a "run to failure" maintenance strategy. In this method, actions will be taken after failure or disaster happen before that no action is taken. This will increase the maintenance costs and also higher the production losses. Some industries prefer preventive or calendar based maintenance. Irrespective of the actual condition of the machine calendar based maintenance action schedule on time, in this method or approach fault free equipment can be repaired unnecessarily. This involves excessive costs or leads to higher maintenance costs. Over the past few years some companies prefer condition-based maintenance over preventive maintenance. On the other hand in condition based maintenance strategy, equipment or component are examine with different methods such as vibration analysis, and the vibration analysis don't require tearing a machine down to find out its actual condition. When an equipment condition fault or defect comes in observation, a repair or maintenance is scheduled when it's needed—not before and not too late.

Early prediction of machine health

There are many techniques which is useful for measuring the machine health and also diagnosis of machine health. In view of machine health there are two most important method these are infrared thermography and vibration testing. The graph of above these method shows that we can detect changes first with testing of bearing or machine vibration and then use infrared thermography. After then shortly before failure of bearing or machine we can hear different type of audible noise and also observed heat generation.

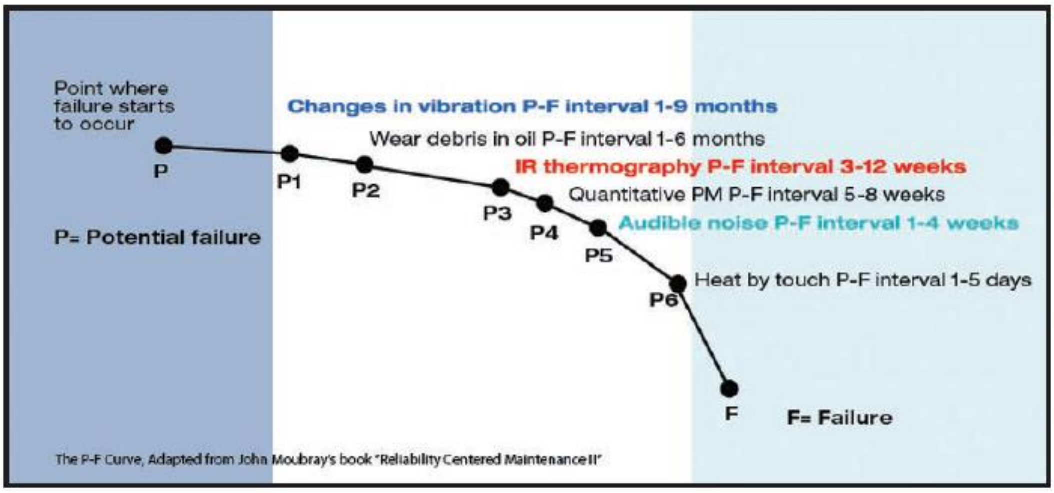


Figure 1.1: prediction of machine health

Benefits of early vibration testing include:

• Predictability. The ability to be predicted machine fault for schedule required repairs or maintenance

• Safety. Take faulty machine shutdown before a failure condition occurs.

• Revenue. Unexpected failure of machine can be repair, helping to prevent production shut down due to equipment failure this will cut into the bottom line.

• Increased maintenance intervals. Vibration testing result the long life or extended machine life.

• Reliable.

• Free of worries. Develop confidence level in condition based maintenance strategy, their productivity estimation and budgeting.

Mechanics of vibration testing

In vibration testing a transducer as shown in figure is a device that converts variations in a physical quantity, such as Vibration, into an electrical signal from different bearing location and send to a data collection device. The main important things about the mechanics of vibration testing as shown in figure 1.2 are:

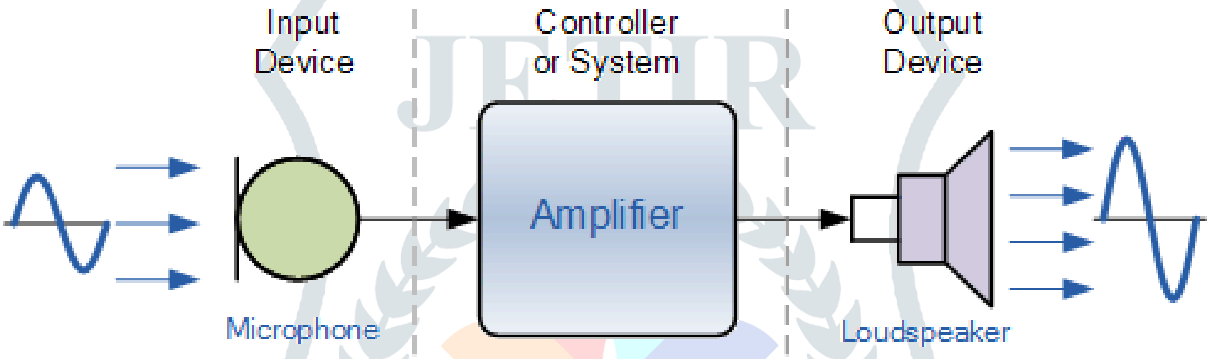


Figure 1.2 : Simple Input/output System using Sound Transducers

• Collecting or receiving vibration signature or signal by all rotating equipment.

• All these unique signature are often recorded in series, with the help of signal's amplitude which is on y-axis depicted over time which is on x-axis as shown in figure 1.3. This representation is called a *time waveform*.

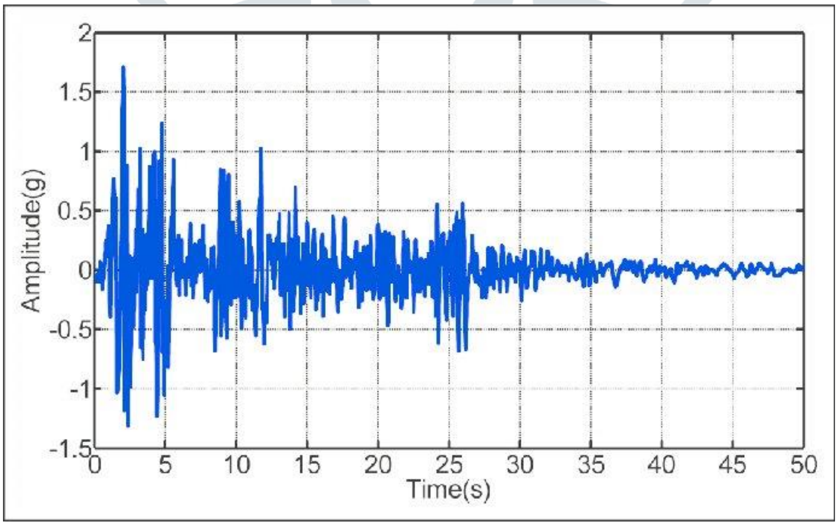


FIGURE1.3 : TIME WAVEFORM OF AMPLITUDE

• Waveform contains information about the condition of machine, fault etc. Vibration succeed in achieving from the rotating machine component, adjacent equipment, machine foundation, noise, structural resonances.

• But, the vibration signals repeat in a predictable manner of different occurrence are overlapped and however, the patterns of different occurrence are overlapped and mix up in a confused or untidy way together. This will create a complex situation for deducting, extracting and isolating one vibration signal from another.

• A mathematical algorithm called **fast Fourier transform** (**FFT**) performed by the vibration testing tool, the function of FFT is that piece of a vibration signal over a time interval (or space) and split it into its frequency components. These split frequency components are individual sinusoidal oscillations at definite frequencies each of them having their own amplitude and own phase. This frequency transformation is represented in figure 1.4. Over the time interval calculated in the diagram, the vibration signal contains three well defined dominant frequencies.

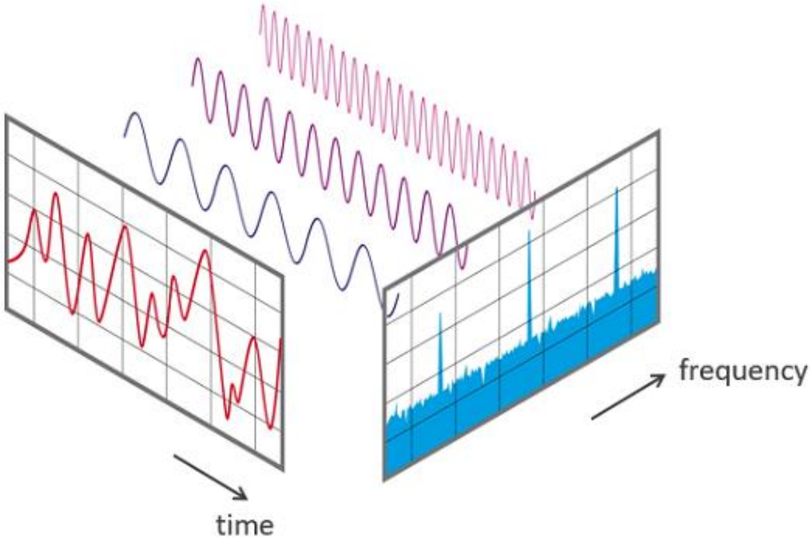


Figure 1.4: fast Fourier transform (FFT)

• *Spectrum: It is the plot of individual signal between amplitude* (y axis) *against frequency* (x axis).

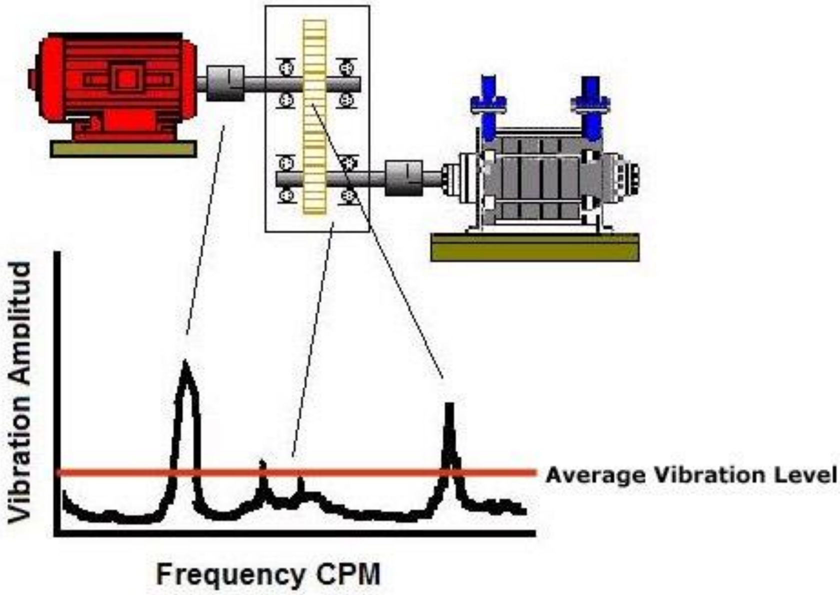


Figure 1.5: Spectrum Analysis

Bearing defects and failures

SKF bearing conducting a case study of few similar bearings element and they have observed a bearing life. This prevent the use of an effective calendar-based maintenance program. Alternative study found that bearing defect can account for over sixty percent of mechanical defect. Although rolling element bearings are a main benefactor to mechanical related problems, sometimes bearing defect are the result of an individual underlying case, like unballast. Many clients change bearings every few interval until they understand to balance and proper alignment of the machine— then bearings life will increase for years.

Bearings failure occurs due to the following, these are
• Poor installation of machine, machine component or Bearing
• Cheapish lubrication
• Defilement or degradation
• Wear/fatigue
• Other defects
A roller bearing—also called a rolling-element bearing—carries a load by placing round elements between the two pieces. Most machines today have roller Bearings

Analyzing roller bearing faults

Bearing frequencies are nonsynchronous. The geometry of the balls, cage, and races show up at different speeds; these speeds are not a multiple of shaft speed. In most cases, non-synchronous peaks are roller bearings. Most vibration programs use the following bearing frequencies:

• Inner race
• Outer race
• Cage
• Ball spin

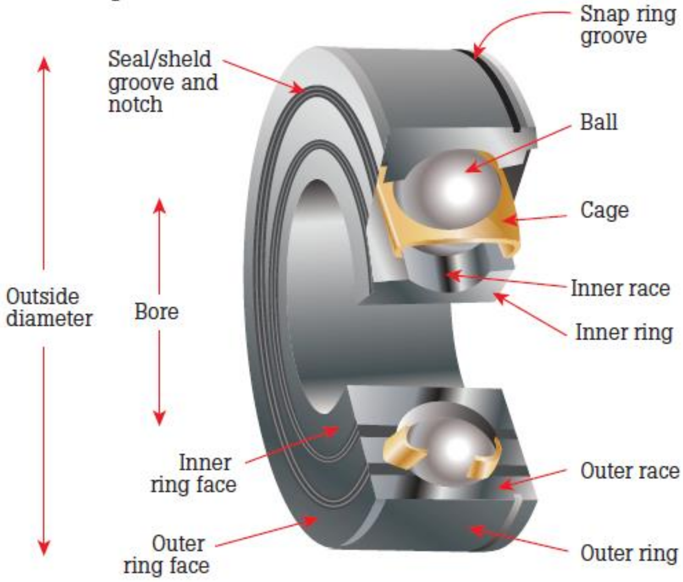


Figure1.6 : roller bearing

The graph shows an example of data with a bearing fault. Notice that the vibration peak from the shaft is at 1 times the shaft speed (1,775 RPM). Four pump impeller vanes and seven motor cooling fan blades are within the system. A large vibration peak occurs at 3.56 times shaft speed. It cannot have 3.56 fan blades or 3.56 pump vanes.

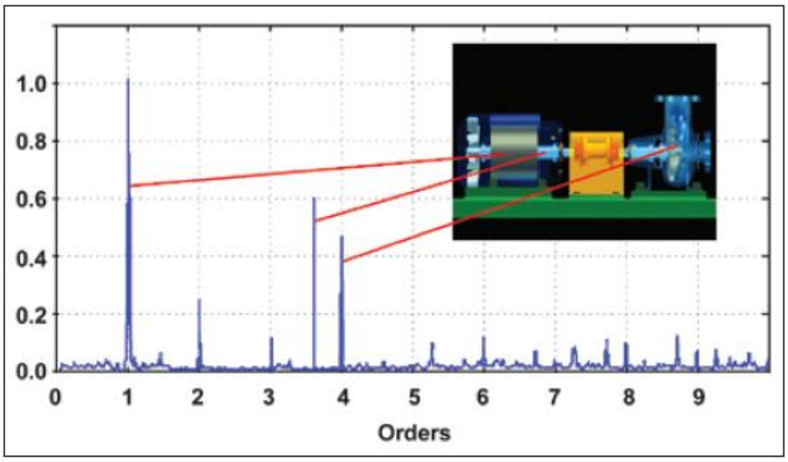
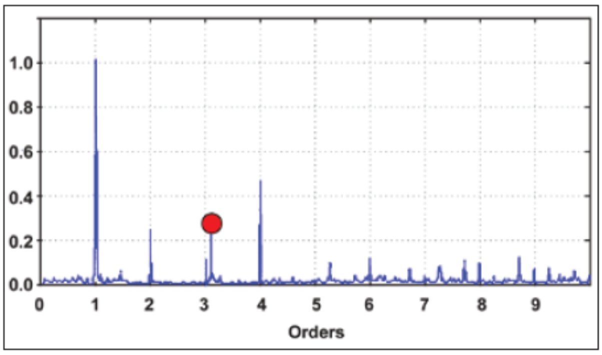


Figure1.7 data with a bearing fault

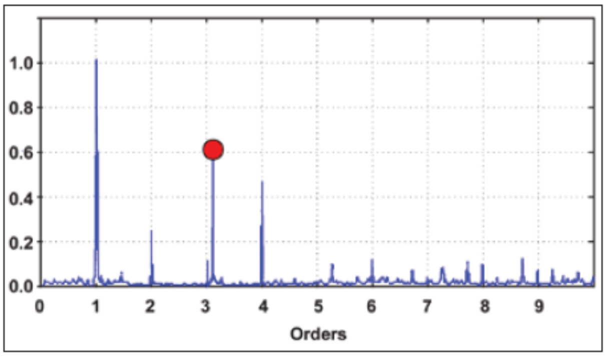
The nine stages of bearing wear

More than 4700 rules exist for machine faults. These rules are based on analyzing patterns seen in rotating machinery, and are built into the diagnostic engine in the Fluke 810 Vibration Tester. The most common faults are unbalance, misalignment, looseness, and bearing failures. The nine stages below show pattern changes as bearing wear progresses as shown in figure 1 to 9.

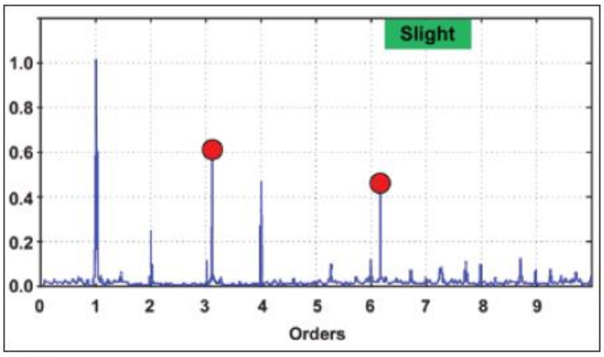
1. Early bearing wear in the high range only.



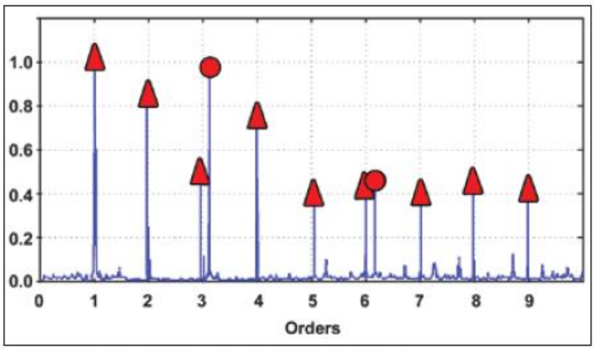
2. Non-synchronous peaks in the low range.



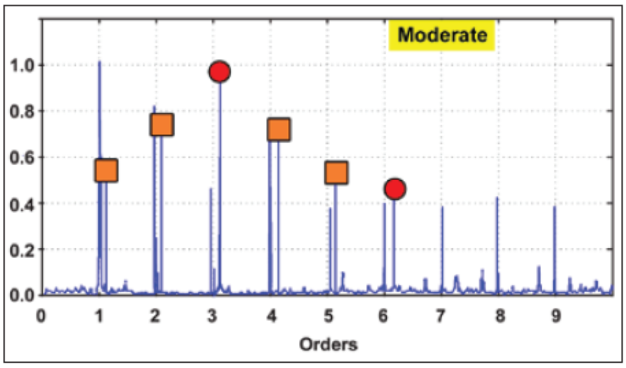
3. Increased non-synchronous peak.



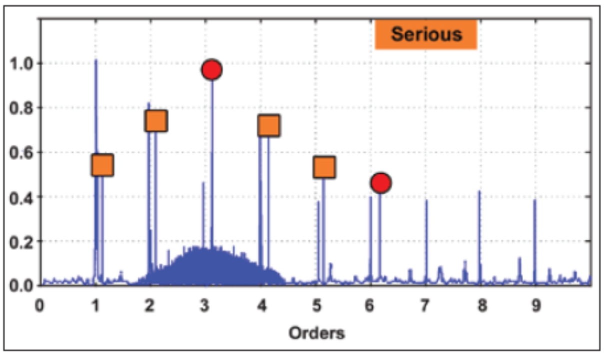
4. Harmonic of bearing tone.



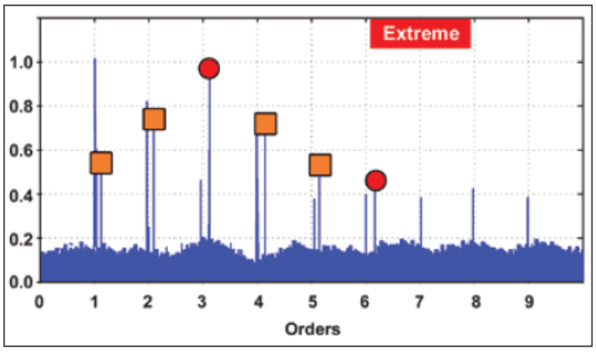
5. Looseness—harmonics of motor shaft.



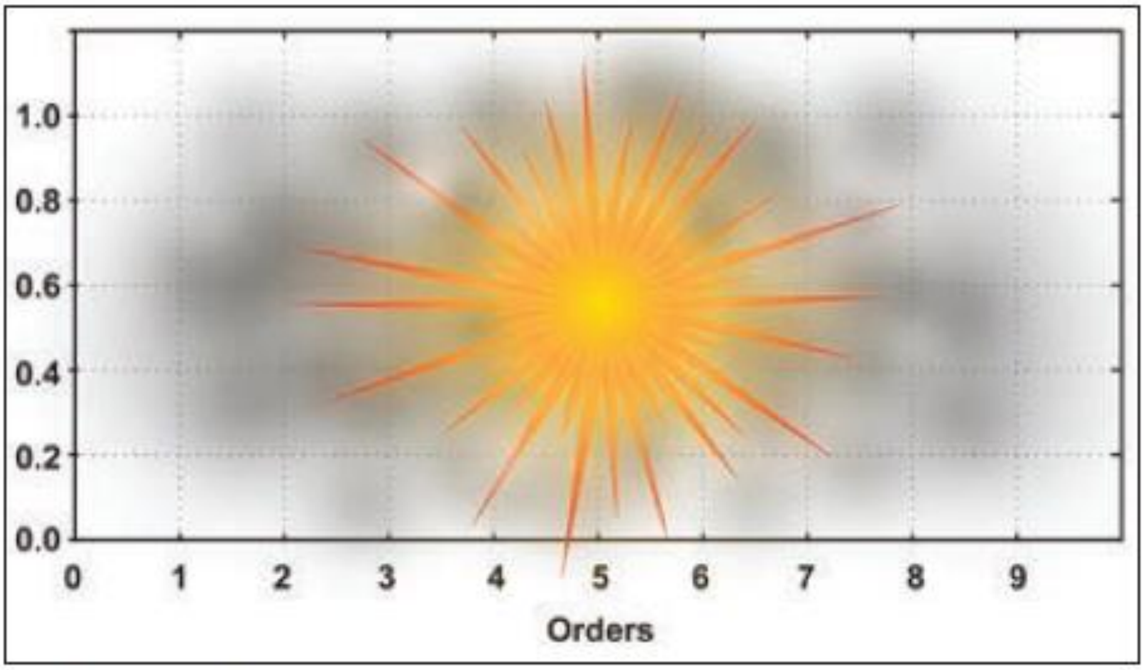
6. Bearing tone and motor shaft sidebands.



7. Noise hump near bearing tone.



8. Increase of entire noise floor.



9. Bearing failure.

Traditional bearing analysis

How does a vibration analyst find bad bearings? The analyst first looks at the complex waveforms.

It takes years of training in waveform analysis and years of experience to do this. Another technique exists, but it is time consuming: Contact the bearing manufacturer and get a table of the bearing frequencies. Then you can overlay the frequencies to see whether they line up with the non-synchronous peaks that you find in the data. If they line up, then you have found the bearing fault. If they don't line up, you probably have a different bearing than expected. If that is the case, determine whether someone replaced the bearing with one from another vendor without updating the maintenance records.

Vibration pens, meters, and testers

The most basic tool for checking vibration is the vibration pen. With a vibration pen, you can measure specific variables such as bearing condition and temperature.

Figure1.8 : Vibration pens, meters, and testers

When you move up to a vibration meter, you have the capability to measure overall vibration in addition to specific variables. The Vibration Meter has a combination vibration and force sensor tip that compensates for user variance (force or angle), which result exact, repeatable vibration signature. These sensors can understand a large range of vibration frequencies, covering most of the machine and machine component types.

CONCLUSION

In this review paper, an attempt to brief on the benefits of vibration monitoring and analysis and the recent research and developments in the vibration signature analysis techniques for diagnosis of machine component rolling element bearing defect has been made. Vibration peaks in vibration spectrum at the bearing characteristics frequencies shows that which bearing element is defected. Also, it has been seen that the amplitude of vibration of the defective bearing are more liken to the healthy bearing. Moreover, the presence of bearing defect (local or distributed) and its location of these defects can be identified through the time and frequency domain analysis of the vibration signature. The accuracy of the dynamic model depends on the various factors like shaft mass, rolling element bearing, bearing housing, stiffness of bearing (linear or nonlinear), oil or lubrication, rotating speed, damping, defect, friction and presence of noise level.

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