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Condition Monitoring and Vibrational Analysis of Proposed Shaft through Experimental and FEA Approach – A Review

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Abstract
Condition Monitoring is an advanced and very useful tool of predictive maintenance techniques.When a machine fails or break down, the consequences can range from annoyance to the financial disaster or personal injury and possible loose of life. For this reason early detection, identification and correction of machinery problems is paramount to anyone involved in the maintenance of industrial machinery to insure continued, safe and productive operation. In order to run the machines efficiently condition monitoring of machines is important.Vibrations are found almost everywhere in rotating shaft. shaft vibrates due to unbalances, misalignments and imperfect bearings. .Here in this project condition monitoring of rotating shaft is done using vibration analysis and also crack detection analysis, accelerometeris used along with a device called as Fast Fourier Transform (F.F.T.) Analyzer.
Keywords: Condition monitoring, FFT Analyser, Vibration Analysis.

I. Introduction

Condition monitoring is process of monitoring a parameter of condition in machinery. Out of various condition monitoring vibration analysis is used in general way for fault diagnosis of mechanical component.

1.1 Study of present condition monitoring techniques

There are only seven main techniques of condition monitoring.
They are:
a. Visual monitoring
b. Contaminant or debris monitoring
c. Performance and behavior monitoring
d. Corrosion monitoring thermograph
e. Sound monitoring.
e. Shock pulse monitoring.
f. Vibration monitoring

1.2 Vibration Monitoring

Vibration monitoring is a well established method for determining the physical Movements of the machine or structure due to imbalance mounting an alignment this method can be obtained as simple. Easy to use and understand or sophisticated real time analysis, vibration monitoring usually involves the attachment of a transducer to a machine to record its vibration level special equipments is also available for using the output from sensor to indicate nature vibration problem and even its precise cost. Shafts are components subjected to difficult operating conditions in high-performance rotating equipment such as compressors, steam and gas turbines, generators, pumps, and engines that are used in process and utility plants. Rotating machines are being designed to operate at higher mechanical efficiencies by decreasing the weight and dimensional tolerances leading to greater operating speeds, power transfer, loads, and stresses. As a consequence, many rotordynamic systems contain shafts that are susceptible to fatigue failure due to transverse cross-sectional cracks. The wide variations in temperature and environment during operation also contribute to conditions conducive to fatigue failure. The fracture of a turbine shaft due to cracking is a rare event; however, if a cracked shaft is not detected and bursts, the consequences are dire. Several power plants around the world have experienced accidents due to burst shafts. Personal safety, operating costs, and increasing overhaul-time intervals motivate research in cracked shaft detection. Vibration monitoring is one approach for detecting cracks that could be implemented in an automated manner to help alleviate cost and safety issues. The appearance of transverse cracks in overhanging shafts having propellers carries with it a greater risk of sudden collapse. Even though the presence of a crack (or cracks) may not lead to sudden failure, it will considerably affect its dynamic behavior. In the last four decades, many numerical and experimental studies have been carried out to identify the effects of different type of cracks, such as transverse, longitudinal, slant, breathing cracks and notches. In these studies the researchers have used different methods to identify crack presence in structures, viz., (i) Traditional vibration-based methods using modal testing and numerical analysis; (ii) Non-traditional methods based on ultrasonic guided waves, magnetic induction, radiofrequency identification tag, acoustic intensity and acoustic L ser-Doppler vibrometry (Sabnavis, Gordon, Kasarda, & Quinn, 2004); and (iii) Numerical procedures using FEM in conjunction with modal analysis, wavelet transforms, neural net works, genetic algorithms and fuzzy set theory.

There are two stages of crack development in rotating shafts: crack initiation, and crack propagation. The first is caused by mechanical stress raisers, such as sharp keyways, abrupt cross-sectional changes, heavy shrink fits, dents and grooves, and/or metallurgical factors, such as fretting and forging flaws. The second stage can accelerate the growth rate under certain conditions, viz., (i) operating faults like sustained surging in compressors; (ii) negative sequence current or grounding faults in generators and coupled turbines; (iii) the presence of residual and thermal stresses in the rotor material; and (iv) environmental conditions such as the presence of a corrosive medium. Also, from the physical morphology of a cracked rotor, cracks can be classified based on their geometries as follows: (i) transverse cracks that are perpendicular to the shaft axis; (ii) cracks parallel to the shaft axis known as longitudinal cracks; (iii) slants cracks that are at an angle to the shaft axis; (iv) open and close cracks when the affected part of the material is subjected to tensile stresses and A crack on a structural member introduces a local flexibility which is a function of the crack depth.

Major characteristics of structures, which undergo change due to presence of crack, are:

1. The natural frequency.
2. The amplitude response due to vibration
3. Mode shape
4. Type of material component.

An important part of dynamic finite element analysis is model analysis. Computer modeling alone can not determine completely the dynamic behavior of structures, because certain structure properties such as damping and non rarity do not conform to traditional modeling treatment. There are also boundary condition uncertainties which modeling needs additional help to work. Substantial advances in experimental techniques have complemented modeling with the experimental determination of structural properties. A milestone of this endeavor is the advent of digital Fourier Transform analyzers. The experimental techniques are nurtured by the theory of modal analysis.

model fault load was minimized by least squares algorithm. Also they used finite element method to validate theoretical results. By this method, it was found easy to identify a crack even when the vibrations were measured with 4 DOF (8, 16, 20, or 24 DOF) systems. They found the method to be very sensitive to the mode shapes and location of the crack. Downer (2010) used this technique and design of experiments approach to extract the frequencies, mode shapes and damping ratio. He also determined the effect of various structural factors on a measured response and related the modal frequencies to these structural parameters (defect, size and location). He used two types of beam, viz., www.ccsenet.org/mer Mechanical Engineering Research Vol. 2, No. 2; 2012 54 a cantilever beam (clamped-free) and a real prototype beam (Electric transmission tower wooden poles). He used two types of non-destructive test methods to detect hidden internal defects and the strength of the poles. Additionally from experimental work he created regression models of multiple modal frequencies of the beam by using the theory of the design of experiments. The author mentioned that once the regression models were acquired it can be easily used to detect defects in the poles. Finite element analysis also was carried out to validate his experimental work. One of the best results in this research is the capability to predict the

1.3 Survey

Condition Monitoring is defined as the collection, comparison and storage of measurements defining machine condition The monitoring of the shaft is to recognize damage, once get the maximum time to schedule repairs ultimately minimum disruption to operation and production. Vibration monitoring is important method to monitor the behavior of the rotating shaft. It gives the state of health of machine and its possibility for diagnosing and converting malfunctions leading to an optimum management of engine operation. Due to unexpected operating conditions, various faults such as cross-sectional cracks, looseness and misalignment may occur during their service life. In this paper experimental studies have performed on a rotor bearing system to predict the vibration spectrum for shaft misalignment. Here accelerometer is used along with a device called as Fast Fourier Transform (F.F.T.) Analyzer RMS accelerations for vibration is higher in horizontal direction in case of both bearing supports, and increases when misalignments increased. The work reported in this paper is part of an ongoing research on the experimental investigations of the effects of cracks and damages on the integrity of structures, with a view to detect, quantify with the study of some parameter such as critical speed, RMS velocity method of identifying parameter such as critical speed and RMS velocity gives positive identification on structure. Critical speed decreases with increase in crack depth .Lower the critical speed as the crack closer to disc. Higher the critical speed as crack away from the disk.RMS velocity increases as crack depth increases. In this stage of the project, particular piezoelectric element, accelerometer is used along with a device called as Fast Fourier Transform Analyzer.

1.4 Problem Definition:

Vibration in a rotating machine cannot be completely eliminated, but can be controlled within an acceptable limit.

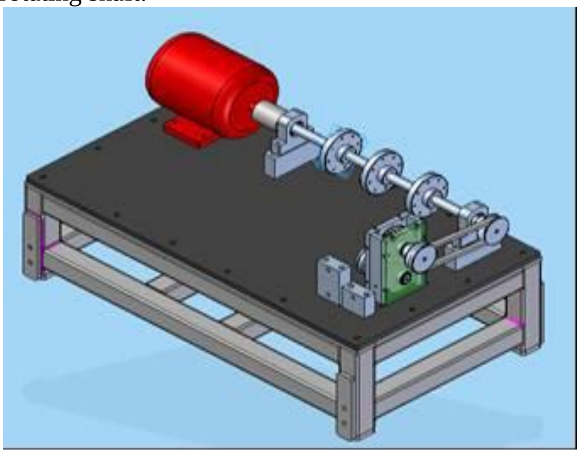
The following lists some of the reasons for performing a vibration analysis:

1. Establish "baseline data" for future analysis needs.
2. Identify the cause of excessive vibration.
3. Identify the cause of a significant vibration increase.
4. Identify the source of crack in the shaft.
5. Overall Analysis of the rotating shaft & its correlation with FEA Analysis

1.5 Objectives of the proposed work

The main intent of the proposed work is to analyse the frequencies generated in the rotating shaft due to its dynamic's state of motion. These large amplitude vibrations need to minimize to avoid the noise generated due to its frequencies.

To have the Surety of the Experimental results, The FEA approach is being used to correlate the results. The proposed work is to get the frequency response curves for rotating shaft & Minimize the amplitude of its vibrations and detection of crack in rotating shaft.



Proposed System

II. Conclusion

In this paper an over-view of some efficient shaft the better durability and less noise in the system. For particular range of speed. The effort required to select the shaft for particular range of speed will reduces. It will ultimately reduces the expenses for the analysis and testing of shaft and also the multiple crack can be detected.

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