A Review on Study of Mechanical Vibration

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Abstract— In recent trends, the industry is shifting from preventive maintenance to predictive maintenance. It essentially involves the human perception and a mixture of complex instruments to check the machine while it is running. Vibration analysis is one of the most effective tools for checking the condition of factory machinery and diagnosing the cause. By using conventional instruments for regular or continuous vibration monitoring to check the operating conditions of the machine, this can enable you to find faults as early as possible and take countermeasures to avoid catastrophic failures. In this article, I studied the common causes of vibration in rotating machinery. Each mechanical problem produces a specific spectral pattern, and these problems can be identified through frequency and phase analysis. Here, I have explained the frequency analysis, phase analysis, unbalance and balance process in detail. The vibration measurement and data acquisition equipment and acceptance criteria are also discussed. The different case studies I conducted in different industries included balance issues, misalignment issues and resonance. We eliminated them by balancing, cross-coupling alignment and dynamic shock absorbers. In a case study, we used vibration analysis to determine the location of the CMM machine.

Index Terms—: Mechanical vibration monitoring and analysis, frequency analysis, vibration analysis instrumentation, vibration monitoring and analysis**.**

1. INTRODUCTION

(I) Vibration Monitoring: - Vibration monitoring reveals the knowledge of the state of the machine and its rate of change, which can be determined by selecting appropriate parameters to measure the degradation and recording its value periodically or continuously. This value is strictly measured while the machine is running. The data obtained can then be analyzed to give fault warnings. This activity is called status monitoring. Most defects encountered in rotating machinery will produce unique vibration modes (vibration characteristic analysis technology). Vibration monitoring has the ability to record and identify the "signature" of vibration, which makes this technology very useful for monitoring rotating machinery. Vibration analysis is usually performed by using sensors to measure acceleration, velocity or displacement. The choice depends largely on the frequency being analyzed. Vibration analysis includes vibration monitoring and analysis. Vibration monitoring: Vibration monitoring usually consists of sensors installed in specific locations and specific directions.

Therefore, vibration monitoring shows the operating conditions of the machine. Vibration analysis is applied in industrial or maintenance environments, and aims to reduce maintenance costs and equipment downtime by detecting equipment failures. It provides accurate results and generates graphic designs, which is very helpful for service operators to detect faults.

During the actual use of mechanical equipment, the analysis of vibration trends is affected by many complex factors. Traditional methods are difficult to effectively predict the trend of vibration changes. In order to solve the problem of fitting and predicting the vibration trend of mechanical equipment, an ARIMA (Autoregressive Integrated Moving Average) model is proposed. Then the mathematical model and modeling process of ARIMA are introduced in detail. Analyze the application of ARIMA model in vibration prediction of mechanical equipment through examples. The ARIMA model is used to predict the vibration of mechanical equipment. Compared with the results of moving average and exponential smoothing method, the proposed method has better fitting and prediction accuracy. The research results show that the application of ARIMA to predict the vibration of mechanical equipment is accurate Sex and feasibility.

(II) ENGINE VIBRATION

Engine vibration has always been one of the serious problems of engine manufacturers in the world. The internal combustion engine design itself is a difficult task because it includes multiple parts of various sizes assembled together to form the engine. The internal combustion engine needs to be carefully designed to reduce the unbalanced forces generated by the engine components. If the design is not optimal, it will generate more vibration and transmit it to the supporting structure where the engine is installed. There are various parts in internal combustion engines, such as pistons, piston rings, engine blocks, connecting rods, engine covers, crankshafts, camshafts, flywheels, valves, pulleys, bells, etc. Among all these parts, few parts are regarded as vibration-producing parts by industry professionals. The main components that produce the four unbalanced forces and produce vibration are the piston, crankshaft, engine block and connecting rod. When these components are interconnected with each other, the resulting unbalanced force is transferred to engine components, such as the building blocks and contact structures of the engine.

(III) Occurrence of Vibration in Tribocontact

The macro and micro geometry of the surface layer is the decisive factor for vibration during friction. There are technical and operational surface geometries that appear after a certain period of running-in. The Hertz formula of a sphere or cylinder detailed in the paper is used to simulate the contact interaction of two surfaces. However, this method does not provide dynamic analysis functions and is very inaccurate. Empirical methods that take into account the surface microscopic geometry are often used in calculations.

The nature of the micro-geometry of the surface during the interaction depends on the undulation and roughness of the surface. These two parameters must be determined to determine the actual contact area during the relative sliding of the solid. The emerging friction force not only depends on the actual contact area and the normal pressure of the contact, but also greatly promotes the frictional coupling vibration.

(IV) Description of the technical system during the measurement and evaluation of the vibration

The 4507B-004 piezoelectric sensor from Bruru & Kjaer was used to monitor the frequency analysis of vibration. The sensor was fixed on the bearing seat of the TOS SV 18RB lathe by magic glue. The vibrating piezoelectric sensor monitors the vibration along the machining axis of the lathe during machining. The data collector records the acceleration of the vibration signal and integrates it with the velocity of the vibration signal. The acceleration as a physical quantity corresponds to the magnitude of vibration at most, and only acceleration is given. The vibration sensor measures the speed value, and then converts it to acceleration through a converter using integral mathematical operations.

(V) VIBRATION ISOLATION

Vibrations in an engine are never good, but they cannot be avoided, but they can be reduced to some level. When discussing vibration protection, it is useful to identify the three key components of a dynamic system: • The equipment (component, motor, instrument, etc.) The support structure (floor, base plate, concrete foundation, etc.).) The sturdy member was referred to as an insulator or base (rubber pad, air column, spring, etc.) inserted between the equipment and the support structure.

If the equipment is the source of vibration, the purpose of the isolation is to reduce the force transmitted by the equipment to the support structure. The direction of power transmission is from the equipment to the support structure. Vibration isolation is the process of isolating an object, such as a piece of equipment, from the vibration source.

II. TRADITIONAL METHODS

Mechanical defects are one of the main causes of GIS equipment failure. However, no detection devices and mechanical fault assessment methods are available for diagnosing mechanical GIS errors. First, the mechanism of mechanical vibration of GIS is studied in depth in this article. Based on research into the source and method of detecting the GIS vibration signal, the vibration acceleration sensor is used as a sensor to develop the GIS vibration signal detection device. Second, the GIS mechanical vibration test platform is integrated into the laboratory and the loose contact spring of the GIS bus connector is ejected into the test platform. The GIS shell vibration test was then performed provided that the bus connector is normal and the connector connection is loose using the self-developed vibration signal detector. Finally, the vibration signal characteristics of the normal and relaxed defect are derived based on the spectrum analysis method. The connection status assessment method and the GIS bus link base are given. The result shows that the apparent vibration signal can be detected in the GIS housing near an insulator. [1]

Sound is a form of energy produced by vibrations caused by the motion of particles. Sound can travel through solids (such as metal, wood, membranes), liquids (water) and gases (air). The sound vibrations that reach our ear are produced by the movement of particles in the air that surrounds the sound source. The motion or vibration of the particles produces sound waves. The sound waves are longitudinal and travel in the direction of the propagation of the vibrations. [2]

Vibration monitoring reveals knowledge of the condition of the machinery and its rate of change, which can be verified by selecting an appropriate parameter for measuring wear and recording the value on a regular or continuous basis. The values are strictly measured during the operation of the machine. The data obtained can then be analyzed to warn of failure. This activity is called condition monitoring. Most of the defects found in rotating machines create a distinct vibration pattern (vibration signature analysis techniques). Vibration Tracker has the ability to record and detect "Signature" vibrations that make the technique so powerful for tracking rotating machines. Vibration analysis is usually applied using inverters to measure acceleration, velocity or displacement. [3]

The paper discusses issues related to dynamic friction characteristics. Vibrations are analyzed in the "indenter on disk" system using samples of brass and steel as an example. The "Indenter on disk" system changes with the addition of an additional degree of freedom, which allows the analysis of the tangential component of friction. The technique of recording, processing and interpreting vibrations is determined, which takes into account the speed of interaction. The achieved results can be used in control systems of modern mechanisms with rights for vibration and alternating shocks. The emerging vibrations were found to occupy a significant range of spectrum and to have visible limits throughout the application. The spectroscopic method was applied for visualization. [4]

This article is aimed at undergraduate students in physics, engineering and mathematics, where it presents a methodology for the analysis of multiple degree mechanical freedom (DOF) vibrations excited by a harmonic force in the field of time and frequency. The Arduino microcontroller is used as an acquisition system and low-cost MEMS accelerometers to organize the system. The multi-DOF system is studied in a large number of problems in the mechanical sciences, however its experimental study is not always present in the courses due to its high cost and complexity. These problems are overcome with the study proposed in this project. In addition, the application presented has an interface with various disciplines at the graduation and graduation level. The proposed method can be easily applied and the results obtained were well accurate and consistent with the literature. [5]

With the development of science and technology, thematic mechanical equipment is becoming more and more complex, which shows that intelligent control and monitoring methods are essential for machines. The signal is widely used in the mechanical system for control and monitoring and helps to optimize the management of mechanical equipment. The vibration signal among the most popular signals is applied to the mechanical extraction of information. However, noise is inevitably present in the mechanical vibration signal. [6]

Vibration voltage analysis is influenced by many complex factors during the practical operation period of mechanical equipment. It is difficult for traditional methods to effectively predict the tendency to change vibration. This article proposes an ARIMA (Autoregressive Integrated Moving Average) model to solve the problem of adjusting and predicting vibration trends of mechanical equipment. Next, the mathematical model and the ARIMA modeling process are presented in detail. The application of the ARIMA model in the prediction of the vibration of the mechanical equipment is analyzed with examples. The ARIMA model is used to predict mechanical equipment vibrations, to compare the effect of the moving average and exponential smoothing method, the proposed method has better adjustment and prediction accuracy, the research result shows the accuracy and expediency of predicting mechanical vibration ARIMA. [7]

This article gives you a brief overview on compression injection engine, engine vibration sources and solutions. In today 's competitive world, the customer expects better products than existing ones. The diesel engine is critical equipment because its failure has high cost consequences. When designing any equipment, it is essential to consider reliability and maintenance, as they are the critical factors that determine equipment performance, operating costs and capital costs. Vibrations in an engine are undesirable, as

they can cause increased stress, additional wear, increased sound levels, material fatigue, energy losses and increased bearing loads. This can over time lead to mechanical failure and damage. Vibration reduction is significant which improves installation availability as well as reduced engine failure costs. Vibration insulator is used that reduces the power transmitted by the motor to the support structure. Various methods are used to reduce engine vibration. Anti-vibration supports (AVMs) are the structures used to absorb vibrations and reduce the forces that cause damage. An anti-vibration base can be made of different materials, rubber has many inherent properties that make it an ideal solution for this application. [8]

Centrifugal pumps are one of the most versatile and widely used rotary mechanical equipment products today. Pumps are essential in almost all utilities and power stations. The basic principle of operation of a centrifugal pump is that a shaft mounted on a rotating impeller inside a housing (volumetric) provides energy to the moving fluid. Centrifugal pumps use centrifugal force (hence their name) to increase the speed of the fluid as it passes through the impeller and exits at the edge or periphery of the impeller. [9]

The Alternate Current Motor Pump (ACMP) are components used in aircraft and operate in a heavy mechanical vibration loading environment that is harmonic or random in nature. In all these situations, the structure or component of the machine subject to vibration may fail due to the fatigue of the material resulting from the cyclic variation of the induced voltage. In case of coordination, large deviations and failure may occur. The result of these vibrations is an increase in the pressure levels in the components. Due to this, component failure may occur. [10]

A mathematical model is presented here to study the mechanical vibrations of a viscoelastic rectangular conical plate attached to all four ends. The main objective of this study is to assist engineers and researchers in the design of various structures in the field of science and technology, mainly used in satellite and aeronautical engineering. The model is presented here to study two directional thermal phenomena, i.e. linearly in the x-direction and linearly in the γ-direction with varying thickness in both directions, i.e. linearly in the x-direction and linearly in the γ-direction. [11]

The article observes the amount of vibration in the bearing of a pre-selected rotary lathe by changing the rotation per minute and the thickness of the removed material in a frontal lathe machining type. An increase in the values of mechanical vibration according to the value of the nominal thickness of the crusher was observed during the change of the technological parameters of the drilling process as a consequence of the rotation speed of the motor. The course of the vibration acceleration amplitude changes depending on the frequencies evaluated together for 400, 800 and 1200 r / min motors. A piezoelectric sensor type 4507B-004 from Bru¨el & Kjaer Company was used to monitor the vibration frequency analysis, which was attached to the bearing of the TOS SV 18RB lathe. The vibration signal measured during processing and during the time period is transformed through a fast Fourier transform in the frequency range in the range of 3.0-10.0 kHz. The measured values of the vibration acceleration amplitude were processed and evaluated by SignalExpress software. [12]

An active shock absorption system is proposed to suppress variable frequency vibration in flexible mechanical systems. Dynamic shock absorbers with spring-damper, differential strength and integrated fault compensation are used in the composition of a shock absorption scheme. Integrated fault compensation is also used to improve the strength of the active shock absorber to reduce tuned harmonic vibrations. The measurement of the variable output position in the primary system is required only for the application of the active shock absorption scheme. Some numerical results are included to show the effectiveness of the proposed control approach. [13]

Activities such as excessive vibrations of motor homes, uncontrolled explosions, marathons, karate, handling a tipper truck, vibrations transmitted by hand by power tools such as drilling machines, driving a bus or driving a truck, etc. cause excessive mechanical pressure on the circulation of the human body. Due to excessive mechanical stress in the human body, red blood cells are at risk of developing disorders. When a human body or part of the body is exposed to excessive mechanical vibration, red blood cell (RBC) fragmentation or hemolysis can occur. Damaged RBC causes a change in blood viscosity / surface tension and therefore blood circulation. In the present study, the effect of mechanical vibrations on human whole blood (in vitro) was studied based on a biochemical study, hemolysis using a single absorption wavelength of 540 nm, chemical bond studies using Fourier Transform Infra Red (FTIR) spectroscopy with a spectral range of 400 - 4000 cm-1 and morphological study using Scanning Electron Microscopy (SEM). [14]

The purpose of this paper is to present the results of a study on vibration problems in a 17-storey residential building while driving a stack in its area. The structural design of the building was tested according to the Brazilian standards NBR6118 and NBR6123, and using commercial finite element software. An experimental analysis was also performed using low frequency piezo accelerometers attached to the building structure. The vibratory structures were recorded under ambient conditions. Four follow-up tests were performed on different days. The goal of the first follow-up test was an experimental mode analysis. To obtain de modal parameters, the data were processed in the ARTEMIS commercial software using two methods: Stochastic Subspace Identification and Frequency Domain Decomposition. [15]

Mechanical-electrical analog circuit models are widely used in electromechanical system design as they represent the operation of a coupled electrical and mechanical system using an equivalent electrical system. This research uses electrical circuits to create a discussion of simple principles of active vibration control using two scenarios: an active vibration isolation system and an active dynamic shock absorber (DVA) using a voice coil motor actuator (VCM). Active control laws such as profit programming are explained intuitively using circuit analysis techniques. Active vibration control approaches are usually limited by electrical power requirements. [16]

Most of the time, mechanical vibration creates a particularly undesirable aspect in the construction industry. This is because vibrations waste energy and create unwanted noise. In addition, vibrations can cause unnecessary damage to bearings and large equipment foundation structures such as gasoline and diesel engines. Vibrations are often encountered with turbines and electric motors and generators. Therefore, it is very important for construction engineers to study in depth the subject of mechanical vibrations. According to the laws of physics, sound and vibration are very closely related. In other words, if the goal is to reduce noise, the vibrations must be reduced. [17]

III. METHODOLOGY

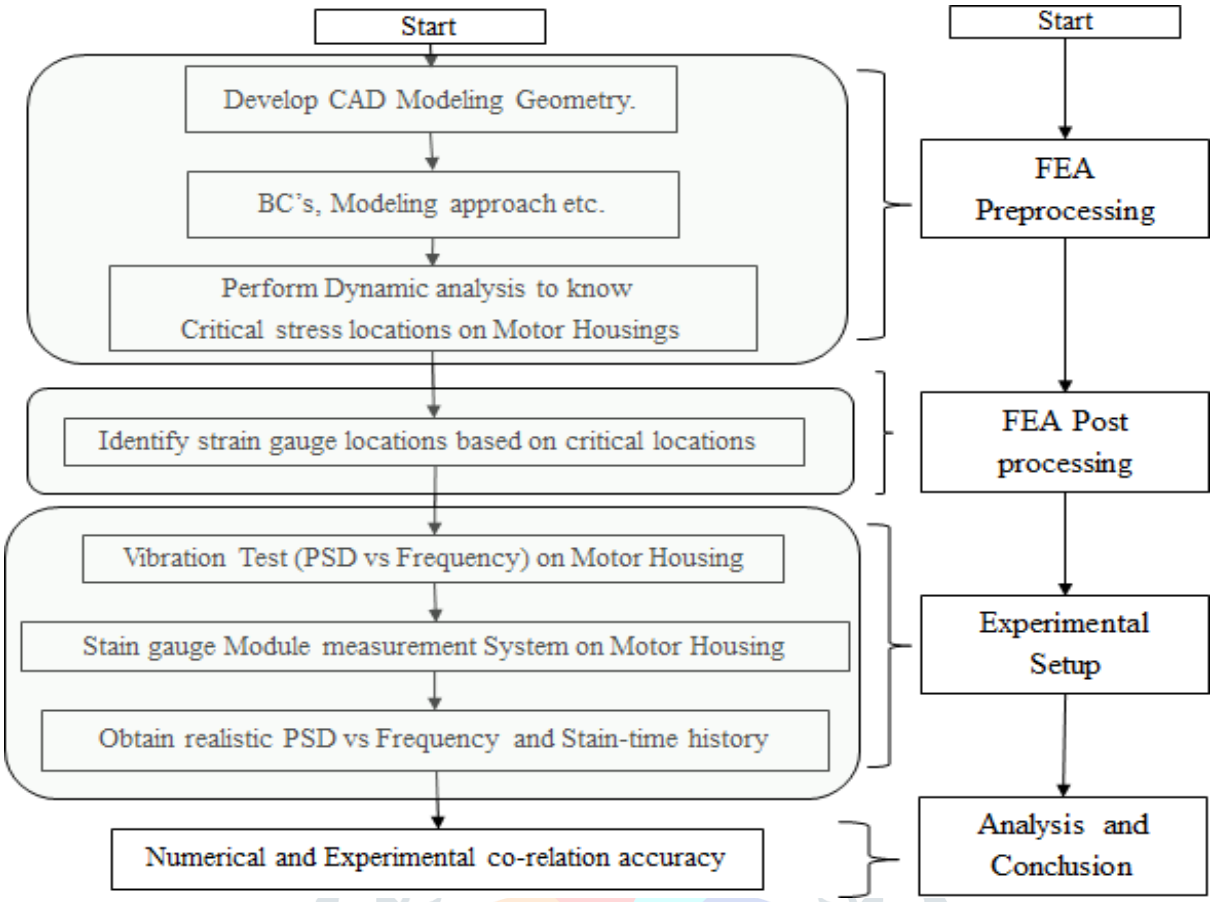

Figure: 1 Proposed Methodology

This work involves the study of the vibratory loading of the pressure analysis of the motor mounting screws using numerical analysis and measurement of stresses by experiments. The data for the analysis will be obtained using aerospace standards, for loading vibrations according to the position of the mounting components.

IV. CONCLUSION AND FUTURE SCOPE

Conclusion

In this study, the motor bracket was studied for its vibration response. The analysis method was performed numerically and the location of the high pressure area in the engine support plug was identified with a nodal solution. In the experimental studies the stress meters were placed in the critical area identified. The arithmetic work and the model were excited using the agitator panel and the stress measurement recorded using the NI stain gauge unit. This work leads to the following finding: A good correlation is achieved between experimental and numerical pressures. The variation in numerical results can be high due to simplification of model, material properties and raw geometry.

AUTHORS REVIEW

Author review many papers and he found Design & Development of a Hybrid Algorithm To investigate motor mounting lugs through numerically modal analysis using Finite Element Analysis (FEA). And To investigate motor mounting lugs through experimentally effect of vibration on induced stresses.

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