UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CASE STUDY FOR REAR WHEEL BEARING FOR MOTORCYCLE

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance) with Honours.

by

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This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Kualiti galas mempengaruhi jangka hayat dan prestasi bahagian berputar. Metodologi yang disyorkan adalah berdasarkan mengukur dan menganalisis getaran dan suhu yang dihasilkan oleh galas setelah dikenakan beban yang tetap dan kelajuan yang berbeza. Kajian ini bertujuan untuk mengkaji prestasi tiga jenis galas yang berbeza iaitu galas berkualiti standard, galas yang berkualiti sederhana dan galas yang berkualiti tinggi. Galas yang digunakan adalah jenis 6301. Ini telah dicapai dengan menggunakan dua ujian eksperimen yang berbeza iaitu analisa getaran menggunakan analisis sampul dan pemantauan suhu. Selain itu, penyesuai dibuat khas untuk menyesuaikan galas ke dalam perumah galas dan penyesuai aci juga dibuat khas untuk menyesuaikan aci ke dalam takal. Penyesuaian galas dan aci dibuat khas dengan menggunakan mesin larik. Untuk analisis sampul surat PT 500.04 Analisis Getaran Berkomputer telah digunakan manakala untuk pemantauan suhu pula, Pengimejan Terma Inframerah telah digunakan untuk mengkaji prestasi galas. Keputusan yang diperoleh daripada eksperimen ini dianalisis dengan menggunakan kaedah tertentu dan hasilnya dengan jelas menunjukkan bahawa galas yang berkualiti tinggi mempunyai indeks kerosakan yang baik dan suhu yang lebih rendah berbanding dengan yang lain, walaupun galas telah diberikan kecacatan kakisan.

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ABSTRACT

The quality of the bearings affected the life span and the performance of rotating part. The recommended methodology is based on measuring and analyzing bearing vibrations and temperature under fixed loading condition and speed. This research aims to study the performance of three different types of deep groove ball bearing quality which is standard, medium and high-quality types of bearing. The bearing was used is 6301 type. This was accomplished by using two different experiment test which are vibration analysis using the envelope analysis and temperature monitoring. Other than that, the custom-made adapter of bearings was used to fit the bearings into the housing of the bearing and the custom-made adapter of shaft was used to fit the shaft into the pulley. These custom-made adapter of bearing and shaft was built using lathe machine. For the envelope analysis the PT 500.04 Computerized Vibration Analyses was used meanwhile for the temperature monitoring, the Infrared Thermal Imaging was used in order to analyze the performance of the bearings. The result gained from this experiment was analyzed using specific method and the result clearly shows that the high-quality bearings has a good damage index and lower temperature compared to others, even though the bearing was given a corrosion defect.

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DEDICATION

I would like to thank and appreciate all the support and encouragement from my beloved parents, Fazir bin Husain and Maimunah binti Nurdin as long as I complete this thesis.

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LIST OF SYMBOLS

Xi	-	instantaneous amplitude
$\bar{x}$	-	mean
Σ	-	standard deviation
'n'	-	sample length
N	-	number of balls in rolling element bearing
Db	-	ball diameter
Dp	-	bearing pitch diameter,
Φ	-	bearing contact angle
Fr	-	rotor frequency
x(t)	-	denote signal
'S'	-	denote scale index which is a reciprocal of frequency
τ	-	time shifting parameter,
ψ(t)	-	wavelet function

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LIST OF ABBREVIATIONS

IRT	Infrared Thermal Image
PdM	Predictive maintenance
CBM	Condition based monitoring
RMS	Root-mean-square
SK	Spectral Kurtosis
FFT	Fast Fourier transform
DFT	Discrete Fourier transform
WVD	Wigner-Ville Distribution
WT	Wavelet Transform
STFT	Short Time Fourier Transform
DWT	Discrete Wavelet Transform
ASTM	American Society for Testing and Materials

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CHAPTER 1

INTRODUCTION

1.1 Background

A bearing is a machine component that reduces friction between moving parts and restricts relative motion to only the desired motion. The bearings design can, for example, provide a free rotation around a fixed axis or for free linear movement of the moving, or by dominate the vectors of normal forces that support on the moving parts, it may prevent a motion occurring. By minimizing friction, most bearings ease the desired motion. Bearings are broad categories by the directions of the loads (forces) applied to the parts, types of operations, or movements.

To prevent rolling elements, sliding friction like as rollers or ball with a circular cross section are lies between the journals or races of the bearing manufacture, in the roller bearing or ball bearing. In order for the application request to be filled accurately for efficiency, reliability, durability and maximum performance, there are various types of bearing designs.

Therefore, is a need to study and understand the vibration response that ball bearing excitations generated, primarily in the defect's existence. Measurement of vibration reaction is an essential and successful method for detecting defects in rolling element bearings. Even the perfect geometric bearings under radial load can create vibrations due to the to time varying contact forces that exist between the different bearing components. The vibration response is reinforced with the existence of structural deformities in the bearing. There are two types of defects in bearing which are distributed

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and localized defects. Off-size rolling elements, waviness, surface roughness, and misaligned races are included in distributed defects which are commonly caused by production error, abrasive wear or improper installation. Cracks, pits are caused due to fatigue on the rolling surfaces are included in localized bearing defects.

Condition monitoring of bearings has been used time domain and frequency domain in vibration measurement. The frequency domain method, which mainly means the vibration signal spectrum analysis, is broadly utilized to detect defects. However, when a defect on the surface of a rolling bearing attacks another surface, it generates an impulse that can stimulate the resonant on the bearing. When the bearings spinning, these impulses will happen periodically with frequencies distinct determined by the defect location, can be in the outer ring, inner ring, or one from the rolling elements. According to (Nakra et. al 1992) in their paper, for condition monitoring of rolling bearing, they have provided a detailed review of various acoustic and vibrations technique, such as vibration measurements in acoustic emission method, time and frequency domain, shock pulse technique and sound measurement.

According to (Jayaswal Pratesh et. al 2008) they have studied the qualification of fast Fourier Transform (FFT) & band pass analysis for defect recognition of rolling element bearings with multiple defects. They run the experiment on three healthy and faulty conditions bearing. The filtered signals under three frequency bands can be precious signatures for faulty recognition and the Root Mean Square (RMS) value of the filtered signal can be utilized as an essential diagnostic parameter are the conclusion from their research. The suitableness of vibration monitoring and analysis techniques to locate faults in antifriction bearings was well described by (M Amarnath et. al 2002) Frequency domain analysis, spike energy analysis and time domain analysis have been implemented to recognize various faults in bearings.

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1.2 Problem Statement

A set of steel balls held together by a steel ring is called a wheel bearing. To help turn the wheel and minimize friction while you are riding down the road is the job of the wheel bearing and they also help the wheel to spin freely giving you a smooth ride. It will start to make a noise, if a wheel bearing starts to get worn. It is not a good idea to ride with a worn wheel bearing because it is an essential part of holding the wheel onto your vehicle.

At riding speed with a wheel bearing failure can lead to a serious crash that injury or death can happen. Seals are one of the critical parts for the life span of a bearing. Contaminants could cause a wear pattern called bruising, if they from the outside find their way in. Never re-utilize seals because utilized seals can contaminate brake linings and leak or can cause premature of bearing failures. Expose the bearing with the surrounding without protect it with lubrication could give them a defect such as corrosion, when exposed them into rain water too long.

Most bearing parts are heat-treated to harden the metal. Be that as it may, the heat-treating can only penetrate so far into the metal. Once the bearing has worn through this layer, catastrophic and rapid wear happens to the softer metal below. "Spalling" is a kind of fatigue failure and this kind of damage causes the metal to break into pieces. Bearings are precision products that need complex production processes. Inferior bearings that utilization low quality steel and have low heat treatment can wear and spall before time. Also, low-quality steel may have hard or soft inclusions that can cause premature failure.

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1.3 Objective

1. To monitor the bearing damage index by using PT 500.04 Computerized vibration analyser and Infrared Thermal Image (IRT).

2. To compare the defected bearing damage index and heat dissipate with a healthy bearing and generate results accordingly using envelope analysis.

3. To investigate which quality of bearing materials, have a good protection from the corrosion.

1.4 Scope of work

This scope is focused on wheel set bearing on rear wheel of the motorcycle.

1. The bearing material are stainless steel type.

2. The bearing is been used are 6301

3. These bearing are been investigate using a PT 500.04 Computerised vibration analyse and Infrared Thermal Image (IRT)

4. These bearing been investigated under parameters; speed, temperature and load.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In order to understand the impact of bearing and related property, the review of literature on impact of bearing, various of wear and how to detect or know the failure occur has be done separately. The importance of condition based monitoring is point out. The first parts deal mainly with bearing including types of wear and other parts deals with types of vibration signal.

2.2 Types of bearing

Bearing is a machine part that assigned to support rotating loads or to decrease frictional power between rotating parts. There are two kinds of bearings which are by employing the principle of sliding friction, there is the sliding, or plain like as the journal bearing and the thrust bearing and the antifriction type, operating on the principle of rolling friction, such as the roller bearing and the ball bearing. Depending upon the application the roller bearings are either tapered (conical) or cylindrical, they used rolling contact to overcome frictional resistance and are suitable to heavy manufacture. Ball bearings are typically found in precision light machinery where high speeds are maintained, friction being lessened by the action of the hard steel ball polishing. In both kind the rollers or ball are called a race which is it was caged in an angular grooved track, and commonly known a plummer block or pillow block where the bearings has been hold in place by a frame. Roller bearings lessen friction more than sliding bearings do. Other

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benefits of antifriction bearings include easy lubrication and capability to work at high speeds.

2.2.1 Ball bearing

The type of rolling element bearing that utilizes balls to maintain the separation between the bearing races is known as a ball bearing as shown in Figure 2.1. To lessen rotational friction and support axial and radial loads is the aim of ball bearing. By utilizing not less than three races to load the ball, it can deliver the load through the ball. In most implementations, one race is stationary and the other is fixed to the rotating mount such as shaft or hub. If one of the bearing races turns, then it makes the balls rotate also. Since the balls are rolling, the coefficient of friction is much lower compared to if two level surfaces were sliding against each other. Ball bearings tend to have lower load capacity for its size than other types of elemental rolling due to the littler contact area between the ball and the race. Nevertheless, they can endure some misalignment of the outer and inner races. We can differentiate three types of ball bearings:

2.2.1.1 A deep groove ball bearing

A deep groove ball bearing as shown in Figure 2.1 is the most generally utilized type in the industry and is broadly utilized in different fields. They are suitable for a very high rotating velocity because of their design is simple. They are strong in operation and need minimal maintenance. For high radial loads, the deep groove ball bearing can be utilized. As extra information, as the number of sizes and ball increases, the capacity axial and radial direction load also increases too.

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Figure 2.1: Deep Groove Ball Bearing

2.2.1.2 Angular contact ball bearing

An angular contact ball bearing, as shown in Figure 2.2, has been designed in one direction only to bear a relatively high radial or axial load. It relies on the contact angle magnitude. Angular contact ball bearings should be utilized in pairs which is face-to-face or back to back combination. The use of angular ball bearings is an optional option where high accuracy is required, like as jet engines and high-speed turbines.

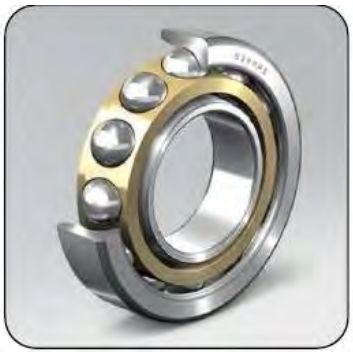

Figure 2.2: Angular Contact Ball Bearing

2.2.1.3 Self-aligning ball bearing

Self-aligning ball bearings have two rows of balls, a regular sphered raceway in the outer ring and two deep uninterrupted raceway grooves in the inner ring as shown in

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