BORANG PENGESAHAN STATUS LAPORAN PSM

JUDUL:

DESIGN ANALYSIS OF BEARING FOR AUTOMOTIVE APPLICATION

SESJI PENGAJIAN: Semester 1 2009/2010

Saya **MOHD NASRUL AZLI BIN MOHD ARIS** mengaku membenarkan laporan PSM / tesis (Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM / tesis adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
4. *Sila tandakan (✓)*

- SULIT (Mengandungi maklumat yang berdjarah keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)
- TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dilaksanakan)
- TIDAK TERHAD

(TANDATANGAN PENULIS)
Alamat Tetap: NO 80 JALAN TTJ 1/6, TAMAN TUANKU JAAFAR, 71450, SEREMBAN, N.SEMBILAN

(TANDATANGAN PENYELIA)
Cop Rasmi:
NURAZUA BINTI MOHD YUSOP
Pengarah
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka

Tarih: 09/09/2010

* Jika laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.
DESIGN ANALYSIS OF BEARING FOR AUTOMOTIVE APPLICATION

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) with Honours.

By

MOHD NASRUL AZLI BIN MOHD ARIS

FACULTY OF MANUFACTURING ENGINEERING
2009/2010
DESIGN ANALYSIS OF BEARING FOR AUTOMOTIVE APPLICATION

STUDENT : MOHD NASRUL AZLI BIN MOHD ARIS
SUPERVISOR : PN NURAZUA BINTI MOHD YUSOP
PANEL 1 : MR BAHARUDIN BIN ABU BAKAR
PANEL 2 : MR ABDUL RAHIM BIN SHAMSUDIN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirement for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) with honours. The member of the supervisory committee is as follow:

Pn Nurazua Binti Mohd Yusop

Fakulti Kejuruteraan Pembaruan
Universiti Teknikal Malaysia Melaka
25 Mei 2010
DECLARATION

"I declare this report is on my own work except for summary and quotes that I have mentioned its sources"

Signature : 
Name of Author : MOHD NASRUL AZLI BIN MOHD ARIS
Date : 19 April 2010
ABSTRACT

The goal of this project is to make a design analysis towards bearing in automotive application. This analysis involves bearing theory and the improvement that can be made from the result. There are various methods used in making different specifications of bearings. In order to produce a quality bearing, there are many aspects that should be considered such as the original design of the bearing. Besides, there are also other parameters that are important during the production of bearing. There are several softwares used to analyze the bearing. In this project, MINITAB, ANOVA and R & R is used to analyze this result.
ABSTRAK

DEDICATION

This report is dedicated to all my lovely family and thankful to Allah s.w.t
ACKNOWLEDGEMENT

I would like to dedicate my appreciation to my lecturer, Pn Nurazua Bt Yusop for serving as my supervisor and for providing guidance while conducting the research and the writing of this Projek Sarjana Muda (PSM).

I would like to thank SKF Bearing Industries (M) Sdn. Bhd. personnel, especially Assistant Manager Quality assurance Mr. Kandiah Krishnan, and Quality Assurance staff for their ideas, opinions, assistance and support. Special thanks to my former internship supervisor for demonstrate what it truly means to go above and beyond my own limit. More importantly, I appreciate their professionalism and friendship.

Last but not least, I thank everyone who involved directly and indirectly in this project. The sacrifice and commitment given towards me earning my bachelor’s degree are indescribable and without them, this PSM thesis would have been impossible.
# TABLE OF CONTENT

<table>
<thead>
<tr>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval</td>
<td>i</td>
</tr>
<tr>
<td>Declaration</td>
<td>ii</td>
</tr>
<tr>
<td>Abstract</td>
<td>iii</td>
</tr>
<tr>
<td>Abstrak</td>
<td>iv</td>
</tr>
<tr>
<td>Dedication</td>
<td>v</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>vi</td>
</tr>
<tr>
<td>Table of content</td>
<td>vii</td>
</tr>
<tr>
<td>List of table</td>
<td>x</td>
</tr>
<tr>
<td>List of figure</td>
<td>x</td>
</tr>
<tr>
<td>List of Abbreviations</td>
<td>xii</td>
</tr>
</tbody>
</table>
Chapter 1 INTRODUCTION

1.1 Introduction

1.2 Project Background

1.3 Problems Statement

1.4 Scope

1.5 Objective

1.6 Methodology and work plan

Chapter 2 LITERATURE REVIEW

2.1 Introduction Design

2.2 Bearing Design

2.2.1 What is bearing

2.3 Bearing application in automotive

2.4 Bearing Types

2.4.1 Ball bearing

2.4.2 Roller bearing

2.4.3 Self Alignment Ball Bearing

2.5 Method Used by SKF

2.5.1 Axial Clearance Parameters

© Universiti Teknikal Malaysia Melaka
# Chapter 1  INTRODUCTION

1.1 Introduction  
1.2 Project Background  
1.3 Problems Statement  
1.4 Scope  
1.5 Objective  
1.6 Methodology and work plan

# Chapter 2  LITERATURE REVIEW

2.1 Introduction Design  
2.2 Bearing Design  
2.2.1 What is bearing  
2.3 Bearing application in automotive  
2.4 Bearing Types  
2.4.1 Ball bearing  
2.4.2 Roller bearing  
2.4.3 Self Alignment Ball Bearing  
2.5 Method Used by SKF  
2.5.1 Axial Clearance Parameters
2.5.2 Vibrations and vibration measurements
  2.5.2.1 Bearing Vibration
  2.5.2.2 Vibration Measurement
  2.5.2.3 Velocity Measurement

2.5.3 Waviness
  2.5.3.1 Fourier Analysis

2.6 Measure the roller Length

2.7 Recommendation
  2.7.1 AE application on monitoring of bearing defects

Chapter 3 METHODOLOGY

3.1 Introduction

3.2 Definition

3.3 Process Planning

3.4 Methodology and work plan

3.5 Gantt Chart
  3.5.1 PSM 1
  3.5.2 PSM 2
3.6 Research Methodology

3.6.1 Identify the problem statement, objective and scope

3.6.2 Literature review

3.6.3 Design Parameter

3.6.4 Software

Chapter 4 RESULT

4.1 Introduction

4.2 How to get information

4.3 Selecting the Bearing type

4.3.1 DGBB (Deep Groove Ball Bearing)

4.3.2 Introduction of DGBB

4.4 Analysis Result

4.4.1 Gage Capability

4.4.1.1 Introduction

4.4.1.2 Work Procedure

4.4.1.3 Result

4.4.2 MSA Waviness Measurement

4.4.3 Waviness Outer Ring

4.4.4 Process Capability for Outer Ring
Chapter 5  CONCLUSION AND RECOMMENDATION

5.1 Discussion  92
5.2 Conclusion  92
5.3 Recommendation  94

Reference  97
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 1</td>
<td></td>
</tr>
<tr>
<td>Table 1: Percentage of Bearing Market [1]</td>
<td>3</td>
</tr>
<tr>
<td>Chapter 2</td>
<td></td>
</tr>
<tr>
<td>Table 2.5.1: Tolerance Radial Clearance [6]</td>
<td>17</td>
</tr>
<tr>
<td>Table 2.5.2: Table of temperature [6]</td>
<td>18</td>
</tr>
<tr>
<td>Table 2.6: setting table [12]</td>
<td>26</td>
</tr>
<tr>
<td>Chapter 3</td>
<td></td>
</tr>
<tr>
<td>Table 3.5.1: PSM 1</td>
<td>34</td>
</tr>
<tr>
<td>Table 3.5.2: PSM 2</td>
<td>36</td>
</tr>
<tr>
<td>Chapter 4</td>
<td></td>
</tr>
<tr>
<td>Table 4.3.1: Table of temperature [6]</td>
<td>45</td>
</tr>
<tr>
<td>Table 4.4.1.3.1: Process Capability Result</td>
<td>49</td>
</tr>
<tr>
<td>Table 4.4.4.1: Result</td>
<td>68</td>
</tr>
<tr>
<td>Table 4.4.5.1: Disable noise rate [21]</td>
<td>71</td>
</tr>
<tr>
<td>Table 4.4.6.1: Spec of lubrication [22]</td>
<td>77</td>
</tr>
<tr>
<td>Table 4.4.6.2: Results</td>
<td>91</td>
</tr>
</tbody>
</table>

© Universiti Teknikal Malaysia Melaka
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chapter 1</strong></td>
<td></td>
</tr>
<tr>
<td>Figure 1: Pie Chart</td>
<td>3</td>
</tr>
<tr>
<td>Figure 1.6: Working Plan Flow Chart</td>
<td>7</td>
</tr>
<tr>
<td><strong>Chapter 2</strong></td>
<td></td>
</tr>
<tr>
<td>Figure 2.2: Design bearing[4]</td>
<td>9</td>
</tr>
<tr>
<td>Figure 2.2.1: Ball Bearing [4]</td>
<td>10</td>
</tr>
<tr>
<td>Figure 2.2.2: Sample Part Ball Bearing [4]</td>
<td>11</td>
</tr>
<tr>
<td>Figure 2.3.1: Bearing at brake system [5]</td>
<td>11</td>
</tr>
<tr>
<td>Figure 2.3.2: Transmission [5]</td>
<td>12</td>
</tr>
<tr>
<td>Figure 2.3.3: Bearing In Engine Parts</td>
<td>12</td>
</tr>
<tr>
<td>Figure 2.4.1.: Deep Groove Ball Bearing</td>
<td>13</td>
</tr>
<tr>
<td>Figure 2.4.2.: Spherical Roller Bearing</td>
<td>14</td>
</tr>
<tr>
<td>Figure 2.4.3: Self Alignment Ball Bearing</td>
<td>15</td>
</tr>
<tr>
<td>Figure 2.5.1: MGO 240 (Measuring Axial Clearance)</td>
<td>16</td>
</tr>
<tr>
<td>Figure 2.5.2.2: Contact Point [10]</td>
<td>19</td>
</tr>
</tbody>
</table>
Chapter 5

Figure 5.3: Basic principle of Acoustic Emission
LIST OF ABBREVIATIONS

OEM  (Original Equipment Manufacturer)
ANOVA (Analysis of Variance)
R&r (Repeatability and Reproducibility)
LCV (Light Commercial Vehicle)
MUV (Multi Utility Vehicle)
DGBB (Deep Groove Ball Bearing)
SABB (Self Alignment Ball Bearing)
SRB (Spherical Roller Bearing)
RMS (Root Mean Square)
ISO (International Standard Organization)
WPC (Wave per Circumference)
FFT (Fast Fourier Transform)
AE (Acoustic emission)
NDT (Non Destructive Testing)
PSM (Projek Sarjana Muda)
UTEK (Universiti Teknikal Malaysia)
wpc (Wave Per Circumference)
MEEB (Measuring Effect Bearing)
CHAPTER I
INTRODUCTION

1.1 Introduction

Nowadays, predictive maintenance has become an effective and efficient method for predicting failures of machines. Monitoring defects is a major aspect of predictive maintenance. Manual inspections of defects are not only expensive but also will cause risk of accidentally causing damages when reassembling a machine. For this reason, monitoring process for example predicting bearing defects is very useful in predictive maintenance until the next bearing replacement.

There are many types and specification of bearings. Roller bearing and journal bearing is the most popular and widely used in industry compare with other types. A roller bearing has two types of roller element, a roller type and ball type. In this project, it will be focused to monitor defects in a ball bearing. There are also different method used for monitoring and diagnosis of bearing defects such as vibration, temperature and wear debris measurement analysis. The vibration method is the most widely used in the industry now. But recently, many researchers have found that from ANOVA (Analysis of Variation) and R&r (repeatability and reproducibility) have many advantages compared with the vibration method. This project will focus on the application of affected on bearing and also monitoring bearing defects.
Although the development of SKF ball and Roller bearing industry is not quite evitable, it can be said without contradiction that Malaysia has relatively strong base for the manufacture of bearings. Almost all the units have foreign collaboration, the SKF Bearing industry manufactures around 500 types of bearing as against over 30,000 types of bearings being used by the industry in Malaysia. Major products are inputs to areas like fans, electric motors, water pumps. The major of this production go into a huge automotive sector which is being developed in Malaysia for example. In this, automotive segment accounts for 45 percent of the revenues and the remaining 55 percent of revenues are being contributed by industrial demand. In the automotive bearings market, the organized segment manufactures cater to 50 percent of the demand. About 15 percent of the production is by the unorganized segment in Malaysia, and the remaining 35 percent of demand is fulfilled through imports. Out of the total revenues in the automotive segment, 60 percent of the revenues are contributed by the OEMs and the remaining 40 percent is by the demand from the aftermarket. There has been a growth of 15 percent in the aftermarket segment and OEM demand has increased by more than 25 percent from the financial year 2005-06. Though the demand from the aftermarket segment is increasing, the growth rate is declining compared to the year 2005 - 06. In the aftermarket, 6 percent demand is from the engineering applications segment, 5 percent from LCV segment, 4 percent from MUV segment, 8 percent from car segment, 11 percent from tractor segment, and the remaining 15 percent from automotive ancillary segment. Rest of the 50 percent demand is from the Railway sector. [1]

In the automotive industries, can seeing the good competition between the bearing factories manufacturer as the SKF (Sweden), NSK (Japan), KOYO (Japan), Timken (USA) and FAG (Germany). This company always give the good product to the customer. As the user the company want the good bearing to use, in the automotive basically there are choose the high quality of bearing. In this case to evaluate the SKF bearing because is a high quality comparing the others manufacturer. Below has shown the percentage bearing manufacture market on 2007.
Table 1: Percentage of Bearing Market. [1]

<table>
<thead>
<tr>
<th>Company</th>
<th>Market share</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKF</td>
<td>28%</td>
</tr>
<tr>
<td>NBC</td>
<td>20%</td>
</tr>
<tr>
<td>FAG</td>
<td>17%</td>
</tr>
<tr>
<td>TATA</td>
<td>8%</td>
</tr>
<tr>
<td>TIMKEN</td>
<td>10%</td>
</tr>
<tr>
<td>NRB</td>
<td>12%</td>
</tr>
<tr>
<td>Others</td>
<td>5%</td>
</tr>
</tbody>
</table>

Figure 1: Pie Chart

The fortunes of the bearing industry in Malaysia are linked to the growth of automotive industry. The overall growths in commercial vehicle industry were at 9.7% in 2007. OEM industries such as two-wheeler, is facing price competition in their own markets and continue to exert price pressure on local bearing suppliers. The growth of Malaysia middle class with increasing purchasing power along with strong growth of economy over the past few years will accelerate demand from the automotive industry and other sectors like steel, power & heavy engineering, thus providing a favorable market environment for the bearing industry.
Over the last few years, there has been sharp increase in the prices of steel which forms the basic material for bearings and also currently increase in fuel prices which has affected to the demand of automobiles and indirectly to the bearing industry. The overall margins of bearings manufacturer are under severe pressure. The company expects that there will be a risk on its margins on account of intense competition from the unorganized sector in the domestic industry and flow of cheap imports of bearings from china and other low cost countries. To dilute this risk besides any cyclic fluctuations in bearing demand from Automotive or various other industries, the company will focus on technologically advancement and more profitable products-market segments. The company will continue to work in the areas of higher productivity, better efficiency and cost reductions in order to grow. [2]

1.2 Project Background

For this case, the abovementioned problems will be analyzed by using appropriate method. Each part of the bearings will be identified and analyzed as below:

- Analyze the surface roughness on facing bearing,
- Analyze roughness on groove,
- Surface roughness ball/roller
- Cage clamping
- Greasing
- Lubrications
- Materials
- Noise (disable)