UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Mechanical Engineering and Manufacturing Technology

DEVELOPMENT OF FUTURE BEARING BY OPTIMISED INTERNAL GEOMETRY

Muhammad Hazrul Aiman bin Jalal

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DEVELOPMENT OF FUTURE BEARING BY OPTIMISED INTERNAL GEOMETRY

MUHAMMAD HAZRUL AIMAN BIN JALAL

**A thesis submitted
in fulfillment of the requirements for the degree of
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2021

DECLARATION

I declare that this thesis entitled "Development of Future Bearing by Optimised Internal Geometry" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : Muhammad Hazrul Aiman bin Jalal

Date : 9/6/2021

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

Signature	:	
Supervisor Name	:	Dr. Muhammad Ilman Hakimi Chua Bin Abdullah
Date	:	

DEDICATION

This research is wholeheartedly dedicated to my beloved parent, who have been our source of inspiration and gave me strength when I am always think of giving up and they are continually provide their moral, emotional and spiritual support.

This is also dedicated to my dear friends and lecturer who always share their words of advice and encouragement throughout this research to make sure it is completed.

And lastly, I am so grateful to God and thank you for the guidance, strength and giving me a healthy life. Also, thank you for giving me inspiration of idea to finish this research.

ABSTRACT

Internal geometry plays an important role in the aspect of bearing determination where it influences many factors that contribute to the condition of the bearing. It becomes a fundamental priority to this bearing manufacturing process because each parameter depends on the function of the bearing. Each dimension on the bearing needs to be identified before the fabrication process take place. The purpose of this study was to analyse the optimum parameter based on fabricated 3-D printed bearing by using SLS machine. The optimised internal geometry has to be emphasized to make sure the bearing is at its best performance. The further investigation is made to test the fabricated bearing with a certain test to validate its functionally with the new optimised parameter. The current commercial bearing was set to be benchmark to the fabricated product as it will follow the current bearing resolution. There are 5 type of samples that has been studied which are solid, circular, rectangular, square and triangular geometries of bearing. For analysis data result, the overall performance of the prototypes is being tested in a simulation SIMSOLID software. Thus, in this research, each type of geometry shows different result data where it has an effect in determining the effectiveness and readiness of the bearing.

ABSTRAK

Geometri dalaman memainkan peranan penting dalam aspek penentuan galas di mana ia mempengaruhi banyak faktor yang menyumbang kepada keadaan galas. Ini menjadi keutamaan asas untuk proses pembuatan galas ini kerana setiap parameter bergantung pada fungsi galas. Setiap dimensi pada galas perlu dikenal pasti sebelum proses fabrikasi berlangsung. Tujuan kajian ini adalah untuk menganalisis parameter optimum berdasarkan galas bercetak 3-D yang dibuat dengan menggunakan mesin SLS. Geometri dalaman yang dioptimumkan harus ditekankan untuk memastikan galas berada pada prestasi terbaik. Penyelidikan lebih lanjut dilakukan dengan menguji galas buatan dengan ujian tertentu untuk mengesahkan fungsinya dengan parameter dioptimumkan yang baru. Galas komersial semasa ditetapkan sebagai penanda aras bagi produk fabrikasi kerana ia akan mengikuti resolusi galas semasa. Terdapat 5 jenis sampel yang telah dikaji iaitu geometri galas pepejal, bulat, segi empat tepat, segi empat tepat dan segi tiga. Untuk keputusan data analisis, prestasi keseluruhan prototaip sedang diuji dalam perisian simulasi SIMSOLID. Oleh itu, dalam penyelidikan ini, setiap jenis geometri menunjukkan data keputusan yang berbeza di mana ia mempunyai kesan dalam menentukan keberkesanan dan kesediaan galas.

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CAM – Computer-Aided Manufacturing

CAD – Computer-Aided Design

2-D – 2 Dimensional

3-D – 3 Dimensional

SLS – Selective Laser Sintering

CHAPTER 1

INTRODUCTION

1.1 Overview

A bearing is a machine component that restricts relative motion and is used to reduce friction between moving components so that the desired motion may be achieved. For example, a bearing sustains the load of a rotating fan while reducing noise and vibration and restricting movement to a radial axis. A little thought will reveal that overcoming frictional resistance loses a certain amount of power owing to relative motion between the contact surfaces, and that if the rubbing surfaces are in direct contact, fast wear will ensue. In some circumstances, a coating of fluid (known as lubricant) may be applied to reduce frictional resistance and wear, as well as to take away heat generated.

Force is transmitted from one bearing ring to the other through the rolling parts of a bearing that is under load. Internal stresses have a significant impact on a bearing's life and efficiency. Radial and axial play, raceway curvature, and contact angle of misalignment are all important elements in bearing internal geometry. Rolling bearings and sliding bearings are the two types of bearings. Rolling bearings attempt to decrease friction and sliding between surfaces in a junction by introducing interfaces such as balls or rollers that rotate or roll in lieu of sliding. (Cheng, 2019).

1.2 Background research

Due to the early industrial demand for bearings, several thrust pad bearings were theoretically investigated in the 1950s by investigators for design and manufacture of high-performing bearings. Many researchers have already investigated thrust bearings with various surface patterns on the pads. Bearing design advancements were focused on field practise, with full-scale rig tests of new prototypes added in from time to time. These advancements were aided by a growing body of research that aided in the improvement of context information.

The circumferential and axial waviness of the bearing working surface are employed in microgeometry. The matching form can result in increased load capacity and lower friction torque in the journal bearing. The geometry of the surfaces cooperating in the sliding bearing is a significant factor, in addition to adequate relative clearance and journal and bearing material selection (Benham Ghalamchi, 2016). In other words, the texture of the surface will be determined by the creation of lubricating microgrooves. This sort of surface shaping is directly responsible for the increase in friction torque and uniform temperature distribution (texturing). The purpose of this surface roughness is to safeguard the bearing by trapping hazardous particles that can contaminate the lubrication and cause premature wear. The burnishing procedure can be used to generate these microgrooves. All ways of structuring the sliding surface, however, have the ability to impact the creation of the oil film while also changing the working circumstances between the cooperating components. (Knežev, 2019).

1.3 Problem Statement

Despite a large number of studies conducted by researchers from various countries, there are still some anomalies in the field of ball bearing accuracy normalisation geometric specifications. Since there is no standardised solution to normalising bearing parameters, the standards do not completely address the issue of high accuracy. When examining the criteria of international standards for tolerances of geometric specifications of rings and bearing assemblies, certain inconsistencies relating to the normalisation of optimum accuracy of geometric specifications and the difficulty of using the definitions presented arise (Glukhov, 2017).

Despite their apparent simplicity, rolling-element bearings exhibit a number of complex issues under real-world conditions. Before the 1960s, the majority of bearing research was done by experimental measurements. Bearing modelling theory and implementation have experienced enormous growth, triggered and pioneered, since the 1960s, with the rapid development of computers. This work is devoted to the study of the internal geometry optimization in statically loaded single-row angular contact ball bearing for machine tools spindle (SKF 7011 CDGA/P4), and double row angular contact for agricultural mechanization (FKL V30-VAE).

1.4 Objectives

The objective of the project is stated as follows:

1. To design and model a bearing with optimum geometry.
2. To fabricate the optimum geometry bearing by using SLS machine.
3. To simulate the performance of the bearing.

1.5 Project Scope

The scope of the project is developed based on the objectives of the project as below;

1. Designing and modelling a bearing with optimum geometry.
2. Fabricating the optimum geometry bearing by using SLS machine.
3. Simulating the performance of the bearing by using SIMSOLID software.

CHAPTER 2

LITERATURE REVIEW

2.1 Bearing

Bearings are one of the most commonly used machine components because their rolling motion makes almost all movements easier while reducing friction. Basically, bearing consists of some components which are two rings, rolling elements and cage. The bearing loads (radial, axial, and moment), speeds, operating temperature range, precise geometry of the housing and shaft, their fits, and the materials used to make them are all factors to consider (Velling, 2020). All of these variables contribute in proper bearing operation. To ensure that the maximum and minimum mounted internal bearing geometries result in optimal running conditions and maximum bearing life, the bearing design must account for the extremes of each variable. There are various types of bearings where each type has its own characteristic features for its own function. For examples, Deep-groove ball bearings, angular contact ball bearings, thrust ball bearings and self-aligning ball bearings.

2.1.1 Types of bearing

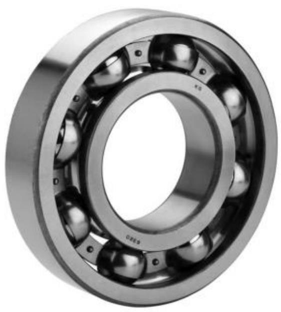

Figure 2.1: Deep-groove ball bearing

Deep-groove ball bearing is the most commonly used bearings. This bearings are utilised in a wide range of applications due to their simple design, which makes them easy to maintain and less sensitive to operating circumstances. A ring of balls is trapped between the two races, transmitting the load and allowing rotating motion between them.

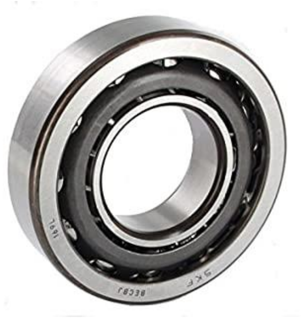

Figure 2.2: Angular contact ball bearing

A contact angle distinguishes Angular Contact Ball Bearings. This implies that forces are transmitted from one raceway to the next at a certain angle. Angular-contact ball bearings are therefore suitable for mixed loads requiring both axial and radial forces to be transmitted.

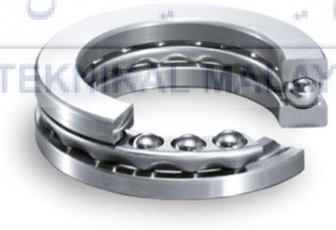

Figure 2.3: Thrust ball bearing

Two bearing discs with raceways for the balls make up thrust ball bearings. Thrust ball bearings were created to endure axial forces in only one direction, allowing the shaft to be axially placed in only one direction. When running at high speeds, these ball bearings are intended to manage thrust stresses and can resist axial but not radial loads.

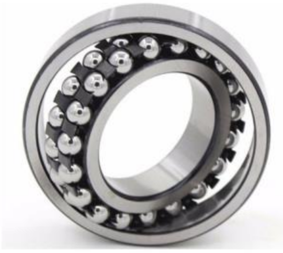

Figure 2.4: Self-aligning ball bearing

Self-Aligning Ball Bearings contain a cage-driven double row of balls and a double row inner ring raceway, but they also have a continuous spherical outer ring racetrack that allows the inner ring / ball complement to revolve within the outer ring. When there is a difficulty with shaft and housing alignment (misalignment) and the shaft may deflect, this type of bearing is advised. Radial forces are best absorbed by self-aligning ball bearings.

2.2 Internal Geometry

When a ball bearing is loaded, force is transmitted from one bearing ring to the other through the balls. Mild loads can result in stresses of tens of thousands, if not hundreds of thousands, of pounds per square inch because to the limited contact area between each ball and the rings. Internal stresses of this size have a significant influence on the life and operation of a bearing. Internal bearing geometry, such as radial play, raceway curvature, and contact angle, must thus be carefully chosen to ensure that loads are distributed uniformly for optimal performance.

2.2.1 Radial and axial play

A modest degree of looseness between the balls and raceways is present in the majority of ball bearings. The looseness is referred to as radial and axial play. Radial play is the maximum distance that one bearing ring can be moved with respect to the other in a direction perpendicular to the axis when the bearing is unmounted. Axial play is the greatest relative movement between the two rings of an unmounted ball bearing in a direction parallel