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A Review of Stress Analysis of Ball Bearings with Applied Load Using CATIA and ANSYS software

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ABSTRACT

The ball bearing is the most important component in a mechanical gearbox. It supports the rotating parts by hanging from the rotator and connects the roller with the inner and outer rings. In this way the transmission between power and motion can be done. In this paper rolling bearings are generally used to reduce friction in rotational motion. Components include rings, folding elements and cage. A Ball Bearing consists of solid, spherical balls that rotate between two surfaces and reduce friction. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. Design of bearings based on parameters like bore diameter, depth and load ratings for dynamic and static loads have been considered in this work. A three-dimensional model of the ball bearing was created using CATIA. High stress regions were identified and design changes were proposed if necessary. Bearing life is also calculated based on rotational speed and load characteristics.

KEYWORDS- Ball bearings; CATIA software; ANSYS software:

1. INTRODUCTION

Fluid transfer is defined as a barrier where all negative or negative reactions are isolated in a specific phase of the fluid. Another type of bearings that are commonly used are conventional bearings that are commonly used in compressors, turbines, pumps, electric motors, and generators. A sphere consists of two spheres rotating relative to each other. The outer ring is vertical while the inner ring rotates with angular velocity. The main purpose of the transmission is to support the rotating machine with sufficient lubrication to isolate the moving parts and reduce friction. Due to the change in the lubricating power of the hydrodynamic film, a higher pressure of the fluid is created in the race. The rotation of the axis from the center is called a rotating shaft.

The performance structure of the ball is directly related to the level of reliability and safety of the entire mechanical system. In addition, carrying the ball is a part that is easily injured. Statistical data shows that about 30% of machine failures are caused by the failure of ball bearings. As a result, the stiffness, contact stress and deformation of the soccer ball became a major problem in engineering research.

The difficulty in learning ball bearings is the connection between the rotation and the inner or outer thread. It is a point contact where the load is zero, while the contact area is extended to the cabinet in an elliptical contact area. The shape, size, contact pressure and friction coefficient of the contact surface which are indirect contact problems are not known in advance, and this is related to the size of the applied load. The paper takes the example of deep groove ball bearings and builds its 3D finite element model using the commercial FEM (Finite Element Analysis) ANSYS Workbench software. Based on this, the contact stress and deformation are analyzed and calculated, which provides a basis for the design and optimization of deep groove ball bearings.

The finite element technique is a useful tool for obtaining numerical solutions for a wide range of design problems. The process is general enough to handle any odd shape or geometry, for any object subject to constraints and overlapping conditions. The comprehensive definition of the finite element method meets the testing needs of today's complex buildings and structures where closed-loop control of balance conditions is often unattainable. It is also an effective planning device where fashionistas can create parametric structures by considering different plan cases (different shapes, materials, loads, etc.) and analyze them to choose the right plan.

2. ROLLING CONTACT BEARING

Bearings are used to carry radial loads, to carry loads and a combination of compression and radial. These bearings are widely used because of their low cost, almost no wear and ease of use. However, friction increases with the winding speed of communication cycles and can be noisy during

operation. The bearing is designed with cylindrical holes for mounting with or without an insert.

Bearing rollers support heavy loads and axial loads in all directions. Needle roller bearings are not strong enough to handle heavy duty and high speed test conditions. These bearings can support radial and axial loads. They can support axial load in one direction. So scaling requires more studies. Many types of needles are used in power generation, heavy construction materials, and machinery.

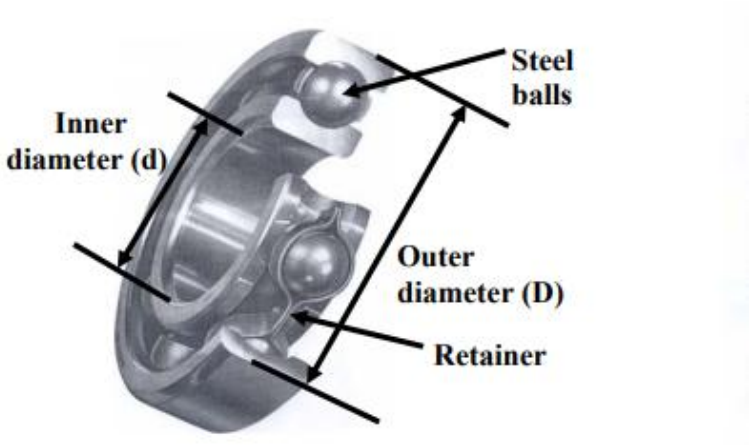

Figure 1 Ball bearing

It is used to carry radial loads but can also carry large axial loads. The stopper has steel balls inside and a rod under the steel balls of the inner ring and above the outer ring. The outer ring, called the outer ring, is usually installed on the coupling shaft, while the inner ring holds the rotation of the shaft.

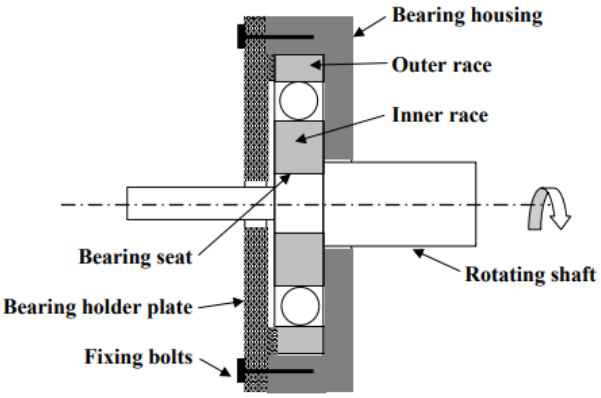

Figure 2 Ball bearing with housing

3. LITERATURE REVIEW

N. Tandon et al. (2010). The most common sources of contamination are worn debris, residual particles from the machining process and contaminated lubricants. Wear particles can enter the bearings from nature or build up inside the bearings. In automotive and industrial applications, two types of impurities are often seen: ductile particles such as Fe, Al, Ag and Zn and transverse particles such as SiC and silica. Oil contamination affects the lifetime of rolling bearings. Lubricating oils undergo significant physical and chemical degradation during operation. These changes are not simply due to high temperature operation but are rather the result of the combined effects of heat and machinery, combined with the presence of metal debris and moisture. **Hua-rong XIN and Lin ZHU, (2014),** reasonable adjustment of boundary conditions, contact stress and length calculated by Static Structural (ANSYS) using the finite element method, and contact stress and tension of the inner ring, outside. The ring and surrounding objects they found. Counting values also correspond to Hertz values. The ball bearing is the most important component in a mechanical gearbox. It supports the rotating parts, depending on the rotator and the rotating connection with the inner and outer ring. This allows the transfer between power and motion to be made. The performance structure of the ball bearing is directly related to the level of reliability and safety of the entire mechanical system.

Y Siva krishna and Y Rajesh Kumar (2014), In this article, we present bearings that are commonly used to reduce the friction of rotary motion. The parts consist of bearing rings, roller elements and cage. A ball bearing consists of solid, spherical balls that rotate between two surfaces and reduce friction. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. Bearing design based on parameters like bore diameter, depth and load ratings for dynamic and static loads have been considered in this work. A three-dimensional ball bearing model was created using CATIA and a finite element mesh was created for it using Hyper Mesh software. RADIOSS was used to solve the model and displacements and voltages were reported. High voltage regions are identified and design changes are suggested if necessary. Drag life is also calculated based on rotational speed and load characteristics. The displacement is at the top of the inner ring of radial and axial load, and the stress is also at the top of the outer ring of radial loads within the boundaries. Compared to the radial load, the axial load caused more stress. The tensile life is also calculated based on the axial and radial load.

Xin Zhang et.al. (2014), roller element bearings can have defects in the surface during operation, which can cause complex vibration response of the bearings. Considering the bearing shaft and pedestal, a 4F degree of freedom (DOF) model for the dynamics of composite bearings in the built environment is established based on the time-varying characteristics and vibration of the bearing. The developed model is verified by vibration signals in the test in the time domain and frequency domain. **Fanzhao Kong et.al (2015)** A model is proposed to predict the vibration of ball bearings with surface defects, based on the Hertzian distribution of contact voltage. **S. Tyagi and S. K. Panigrahi, (2015),** the error ball in the spectrum or time range where the error is in the first phase. In addition, it is difficult to obtain vibration test signals due to the low error in the first stage. Therefore the need for accurate simulation of ball failure in the early stages is considered important. A small fit for the outer race was created using CAD and FEM software. In addition, a dynamic load distribution method is developed to simulate the load distribution in the outer ring track due to the load transfer from the shaft through the balls.

N.S.R. Apandi et.al, (2015), this article provides a numerical method to characterize the frequency of new and malfunctioning bearings. A 3D model of the carrier system with 0.5 mm artificial defects, including the outer and inner race, was modeled using CATIA software. Numerical simulations were completed using ANSYS WORKBENCH. The result of the simulation shows the presence of significant and asynchronous peaks that represent new patterns and bears with characteristics of the system frequency. **Zhinan Zhang et al. (2016),** this article provides insight into the stresses found in the strained area of the wire when the roll elements undergo strain. The effects of radial charge, rotational speed and initial defect size on stress level are investigated. The results show that the maximum stress occurs when the balls pass through the defect. Radial charge and particle size have a significant effect on particle stress level, while low rotational speed has negative effects.

4. OPERATING CONDITIONS

The calculated life of the bail depends on the load it carries and the speed of its operation. Lifetime with normal applied load is inversely proportional to the cube of the bearing load. The maximum rated load of the bail (as specified for example in the SKF data sheet), is for a lifetime of 1 million rotations, at 50 Hz (ie, 3000 RPM) which is a lifetime of 5.5 operating hours. 90% of bearings of that type have at least that lifetime, and 50% of bearings have a lifetime at least 5 times longer.

5. TERMS USED IN JOURNAL BEARING

1. Diametral clearance
2. Radial clearance
3. Diametral clearance ratio
4. Eccentricity
5. Minimum oil film thickness

6. DESIGNS

Bearings are standard features that vary in size from 10 mm in diameter to several meters in diameter, and have the capacity to carry loads from a few tens of grams to many thousands of tons. The most common type of rolling-element is the ball bearing. The bearing has inner and outer races between the rolling balls. Each race consists of a hub that is usually shaped to fit the ball slightly. So, in principle, football affects each race in a very small area. However, a load on too small a surface can cause too high a contact pressure. Essentially, the ball deflates (deflates) a bit when it hits the race just like a tire deflates when it meets the road. The race also releases a bit where each ball is pressed. Therefore, the connection between football and race is of limited size and limited pressure. Also note that handicap and race balls do not roll smoothly because different parts of the ball

move at different speeds as they roll. Therefore, there are opposing forces and sliding motions at each ball/race contact. Overall, these cause drag on the bearing.

Most rolling-element bearings include cages. Cages reduce friction, wear, and binding by preventing parts from rubbing against each other. Enclosed roller bearings were invented by John Harrison in the mid-18th century as part of his work on chronometers.

7. CONCLUSIONS

Bearings are important tools that help maintain the linearity and rotation of a machine. The loads that the bearings must carry are important if we want to ensure a long service life. The load is assumed to be static in several situations such as static bearings, low oscillations when operating at low speeds or taking short large shocks while rotating. This work aims to analyze the behavior of ball bearings under static load, using CATIA, ANSYS software. The displacement is higher in the inner ring for radial and axial load application and the stresses are higher in the outer ring for radial loads within the limits. Compared to the radial load the axial load caused more stress. Bearing life is also calculated based on axial and radial load. The results and data obtained from this study can be used to improve the characteristics and geometries of bearings for next generation products.

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