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Bearing Wear Line Contact Simulation for Lubricated Surfaces

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Abstract: Cylindrical roller bearings have a large radial load capacity and are suitable for accurate and speedy operation. Most bearing of the machines, less than 20% of bearing failures are not due to improper lubrication. This means that proper lubrication is a must in the machinery industry. This includes not enough lubricant, incorrect lubrication and high temperatures that lower the grade of the lubricant. In order to minimize friction, excess heat and wear, the lubricant film must be included in order to separate the moving parts (Beats, 2005). The main objectives for this project are to analyse roller bearing wear in several lubrication condition (non-lubricated, grease and lubrication oil). Also to compare simulation result from ANSYS 19.2 software and SOLIDWORKS simulation for non-lubricated condition. Develop 3D bearing models by using SOLIDWORKS software. Using the non-lubricated, grease and lubrication oil to lubricate the bearing. The loads are constant in magnitude and direction, for radial bearing loads and for thrust bearing axial loads which acts centrically. The parameters such as The rotation speed, lubricant, viscosity (grease = 32 mm^2/s, oil = 15 mm^2/s) and load is set to 3kg.

Keywords: Cylindrical roller bearing, Wear, SOLIDWORKS, ANSYS

1. Introduction

Lubrication mechanism, load and environmental condition are the most dominant factors affecting the normal operating life of bearings [1]. All of these factors contribute to bearing wear. Frictions and wears are two of the main factors, in the system. Most wear occurs during running-in. During this phase, wear particles remain in the lubricated system also accelerate wear. These wear particles are generated by the local plastic deformation of the operating surface [2]. In general, grease provides protection against dust, corrosion, friction, ease of use, stability under harsh operating conditions, but has poor mechanical stability and is suitable for lubrication of bearings with limited life. Grease service life significantly decreased with an environmental temperature of more than 60-70 ºC. In order to increase the temperature by 10-15 ºC, service life becomes half. Analysis of grease microstructure and lubricating oil film thickness decreased due to deterioration of grease streak structure [3].

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All studies on wear of roller bearings have been reported in the literature. Most roller bearing wear and bearing wear are due to misalignment between the shaft and bearing. Roller bearing wear and vibration response. How the wear rate increases with increasing bearing temperature and decreasing lubricating film thickness [4].

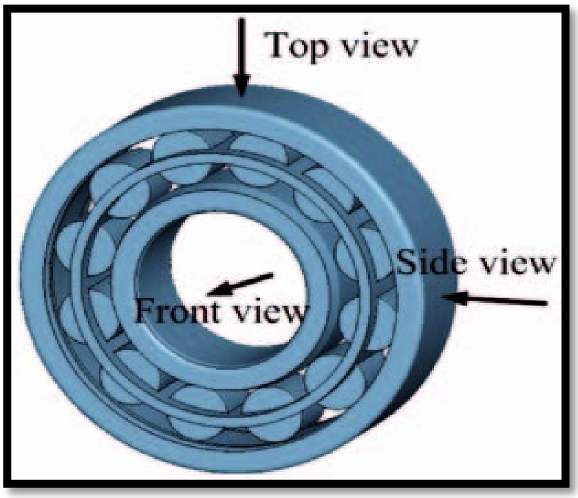

Figure 1: Schematic of a cylindrical roller bearing [5]

Roller bearings designed to carry loads while helping to reduce friction. These bearings have longer roller diameters and can withstand higher loads than ball bearings. Our cylindrical roller bearings can carry large radial loads and can be used in high speed applications. Roller bearings are used in a wide range of applications from heavy machinery and machinery to power generation, manufacturing, and even aerospace applications [5]. Roller bearings use cylinder roller components rather than balls to transfer loads and maintain the distance between the moving parts of the bearing. Such flexible bearings can contain more than one row of rolling elements. Having multiple rows greatly improves radial load carrying capacity. In addition, different roller geometries are used to further minimize friction and support radial and axial loads. [6].

Roller bearings come in a variety of shapes and sizes and can be customized for special situations. In addition, flanges, cages, and multiple rows of bearings may provide better performance to meet the needs of your particular application [5]. In 1950 Tyson Bearing Company produce roller bearing, the applications include use in automotive wheels and axles, engines and engines, and construction and mining machinery. The Anti-Friction Bearing Manufacturers Association collected bearings for a public relations exhibition in the early 1950s and donated them to the Museum in 1977 [7].

2. Materials and Methods

This study is to determine and evaluate the elements of roller bearing. The outcome expected to be gained from the study is to see the effect types of lubrication use towards the bearing wear line contact. The simulation of the study was using three types of lubrication properties and simulated using the CFD simulation, ANSYS 19.2 and using SOLIDWORKS software.

2.1 Geometrical Parameter

Figure 2 and Table 1 shows the geometric parameters of cylindrical roller bearing NU2220. Model used as the primary model for the entire work.

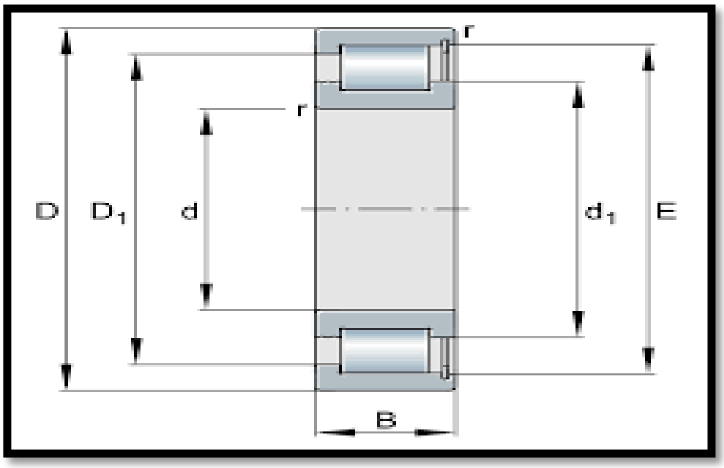

Figure 2: Cross section for the bearing [8]

Table 1: Geometric parameters of cylindrical roller bearing NU2220 [8]

Nomenclature	Specification
Width of bearing (B, mm)	46
Width of roller (b_{RE}, mm)	16
Inner bore diameter (d, mm)	100
Outer diameter (D, mm)	180
Inner (bore) diameter (d_i,mm)	119
Outer diameter ($D_o$mm)	163
Diameter of roller (D_{RE}mm)	22

2.2 Von Mises Stress principles

When two objects with curved surfaces come into contact under force, the point or line contact between these objects becomes surface contact and generates 3-dimensional stress. These stresses are contact stresses. Knowledge of contact stress is important for calculating the strength of bearings, gears and worm drives, ball and cylindrical rollers, and cam mechanisms. Typical failures are seen as cracks, dents or flaking in the surface material [9]. The contact stress calculator is designed to calculate the contact pressure and contact stress of spherical and cylindrical contacts. The maximum shear stress is plotted against the depth from the contact surface [10].

3. Results and Discussion

The result of the study on the roller bearing characteristic used two different software, SOLIDWORKS software and CFD simulation. This study same type of bearing with different software to evaluate them. This simulation study was carried out by using ANSYS 19 Student software to run the CFD simulation. The 3-D model of roller bearing which simulates the steady state rolling in a single phase by using lubrication substance as a fluid. The main objective of this simulation study is to analyze the roller bearing wear in several lubrication conditions (non-lubricated, grease and lubrication oil).

Simulation study was run different software in order to compare the wear of the bearing in non-lubricated condition. For the condition of grease and lubrication oil will be compare in ANSYS software only. In this study the variable using for the simulation was friction between roller and outer bearing.

3.1 Non-lubricated bearing surface.

For the non-lubricated surface, the results were compared between Solidworks (Figure 3 and Figure 4) and ANSYS 19.2 result (Figure 5). Both displayed different as their were different sofware. For the Solidworks, the minimum value for total deformation was 1.00x30 mm and the maximum value were 2.50x-04 mm. Meanwhile, the mainimum value from ANSYS 19.2 were 5.01 mm and the maximum value were 9.0936 mm. The effect also happen at different part where by for Solidwork at the inner race but for ANSYS at the outer race. For the equivalent, the minimum value were 0.116x01 Nm^2 and the maximum value were 1.438x04 Nm^2.

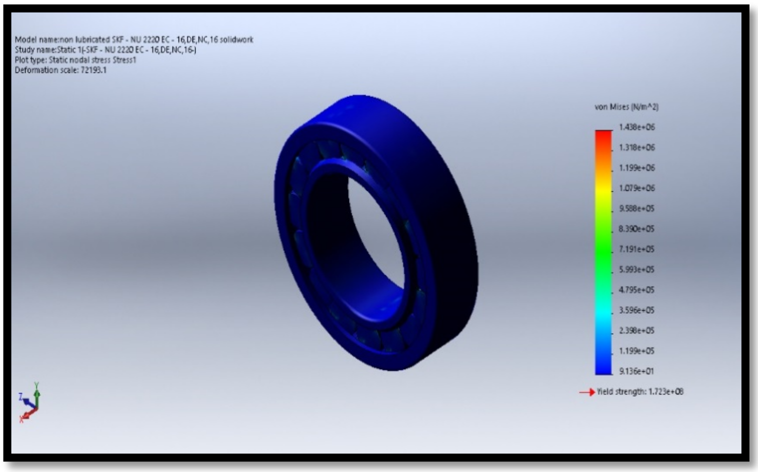

Figure 3: Equivalent force on the cylindrical roller bearing without lubrication by SOLIDWORKS

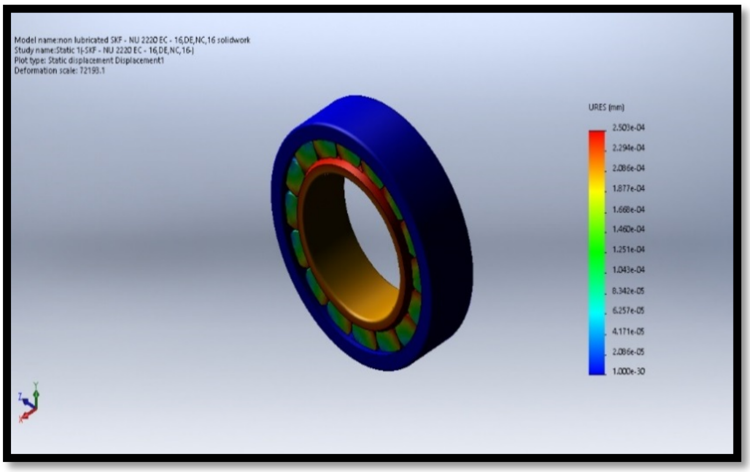

Figure 4: Total deformation on the cylindrical roller bearing without lubrication by SOLIDWORKS

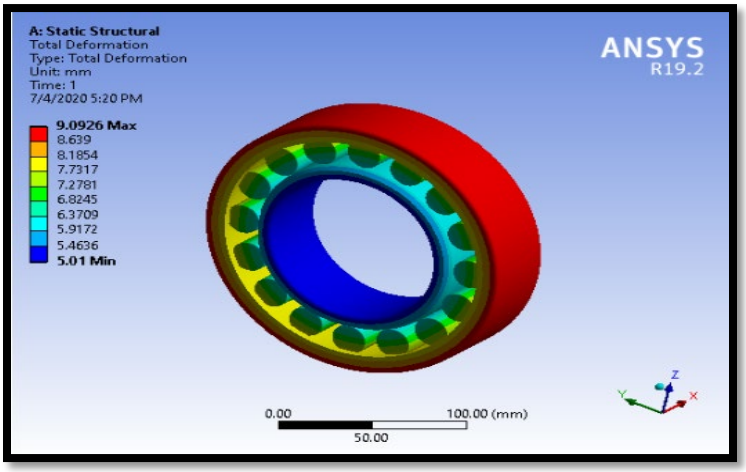

Figure 5: The total deformation on the cylinderical roller bearing without lubrication by ANSYS

3.2 Grease lubrication and oil lubricant

For the grease lubrication, Figure 6 showed the result of total deformation for cylindrical roller bearing using grease lubrication by ANSYS 19.2. The minimum value was 1.0016mm and the maximum value was 1.8186mm.

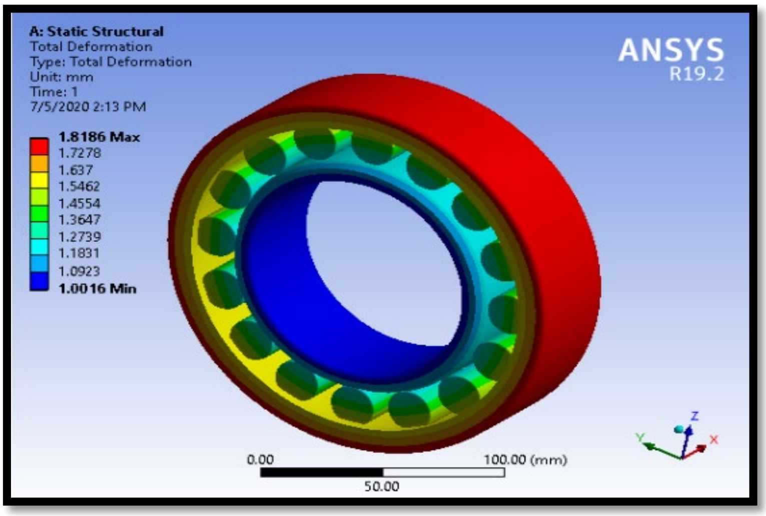

Figure 6: Total deformation on the cylinderical roller bearing using grease lubrication

For the oil lubrication, Figure 7 showed the total deformation with oil lubrication. The minimum value was0.50078 mm and the maximum value was 0.90928 mm. The results showed that the simulation for the study of cylindrical roller bearing is inaccurate. The margin of the percentage difference was big between 5 to 60 percent. Even though the boundary condition and the parameter of bearing used the same as the previous study but the result were opposite and far from the result that supposed to be gained. Obviously the reason due to this difference because of the meshing technique that being applied to the model. The meshing supposed to be done by using fine meshing. At first the meshing were run by using the fine mesh unfortunately the meshing cause the meshing software to stop working every time running it.

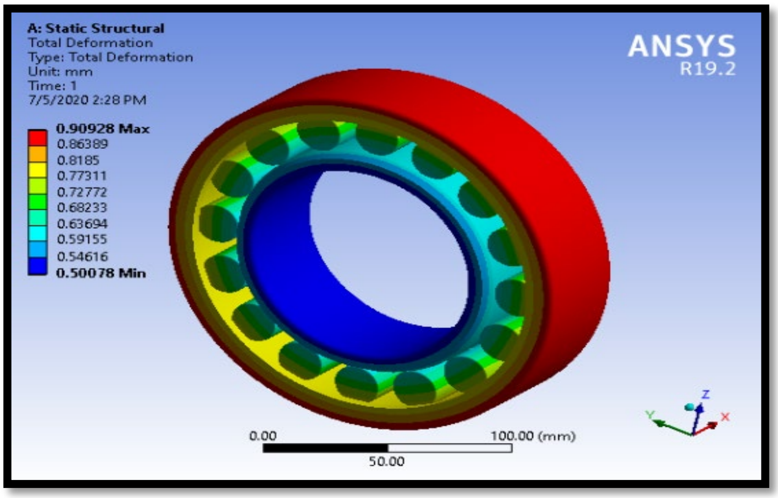

Figure 7: Total deformation on the cylinderical roller bearing using oil lubrication

4. Conclusion

The study was about a simulation research of comparison condition for roller bearing presented using of the computational fluid dynamics (CFD) software. The three-dimensional model was developed which contain of full shape of cylindrical roller bearing. The objective of this simulation was successfully achieved. This project has managed to analyze cylindrical roller bearing wear in several lubrication conditions (non-lubricated, grease and lubrication oil). This project also compared simulation result from ANSYS 19.2 software and SOLIDWORKS simulation. Simulations using ANSYS and SOLIDWORKS can help many people perform fatigue analysis, and more. The project also taught a lot, especially in building simulations. The Von-Mises method should be used to measure the contact stiffness between the log profile roller and the safety rail. When the roller passes through a local surface defect, for a defect type with a defect type greater than the defect length, both time-varying deflection excitation and time-varying contact stiffness excitation should be provided. However, for defect forms with a length that is less than the length of the roller, only contact stiffness excitations that vary with time can occur.

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