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PERFORMANCE STUDY OF MOTORCYCLE BEARINGS UNDER STATIC LOADS WITH FINITE ELEMENT ANALYSIS (FEA) APPROACH

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Abstract: Bearings are one of the important components in mechanical systems that function to reduce friction and support loads. This study aims to analyze the stress distribution and deformation in bearings due to loading using Fusion 360 software-based simulation. The simulation was carried out on a bearing with the code 6202 made of Steel Alloy by giving a load of 940.50 N to the outer bearing. The results of the analysis show that the minimum stress value that occurs in the bearing is 0.014 MPa, while the maximum stress reaches 6.728 MPa. This voltage distribution is displayed in a color scale, where dark blue indicates the lowest voltage value and red indicates the highest value. In addition, the values of the strains obtained ranged from 8,245 x 10-8 to 5,010 x 10-5 with the highest deformation areas occurring in certain parts of the bearing. Based on the simulation results, it can be concluded that the bearing is able to withstand the given load within a certain limit, according to the characteristics of the material. This research is expected to be a reference in the design and analysis of bearing resistance to dynamic loads in industrial applications.

Keywords: *Bearing, tension, strain, simulation, Fusion 360.*

INTRODUCTION

Many different kinds of mechanical equipment, particularly engines and gearbox systems, employ roller bearings extensively. The inner and outer rings experience cyclic contact loads due to the periodic rolling of bearing rollers between their raceway surfaces, which can cause rolling contact fatigue (RCF), a fatigue failure of the bearings (Li et al., 2018). Wheel bearings are one of the important components in a motor vehicle system that functions to reduce friction between the axle and the motorcycle wheelhouse. In the design of wheel loads for motorcycles that experience the heaviest load, it is in the bearings. Wheel bearings are essential to support vehicle loads and provide stability while driving(My-cardictionary.com, 1987). Bearing damage can lead to a variety of problems, such as higher friction, wheel imbalance, and possible accidents(SKF, 2017). Therefore, in order to guarantee the best performance and safety of the vehicle, the analysis of bearing strength under static load is essential(Zhu et al., 2023).

Finite element analysis is one of the most commonly used techniques in the structural analysis of mechanical components of materials under various loading conditions(Castro et al., 2022). With today's technological advancements, software like Autodesk Fusion 360(autodesk, 2025) It allows static stress simulation to evaluate the distribution of stress and deformation in motorcycle wheel bearings. The purpose of this study was to analyze the reaction of wheel bearings to static loading to determine the limit of bearing capability before it fails using Fusion 360

Finite element method-based numerical analysis can provide accurate prediction of bearing mechanical failure(Zhang et al., 2007). Simulation modeling can help find weak points in bearings and provide better design recommendations(Yuan et al., 2005). Therefore, simulations conducted with software such as Fusion 360, are a very helpful tool for assessing the durability of mechanical components. With the increase in people's mobility, the performance and durability of motorcycle components are essential, especially in terms of durability and resistance to the loads received. As long as the vehicle is running, the motorcycle wheel bearings function to withstand static and dynamic loads. Therefore, knowing how stresses and deformations occur in bearings is essential to predict their service life and choose the best materials and designs(Lazović et al., 2024).

Finite element methods have been used to analyze vehicle bearings in several previous studies. Numerical simulation can help identify the stress distribution in bearings more effectively than experimental methods(Castro et al., 2022). Meanwhile, FEA-based modeling is able to provide deeper insights into bearing mechanical failures as well as design improvement recommendations(Yüksel & Börklü, 2024). There have not been many studies that have used Fusion 360 software to perform static stress analysis on bearings. It is hoped that this study will provide more information about the resistance of motorcycle wheel bearings to static loading. The simulation results can be used as a basis for better maintenance, replacement, and manufacturing of bearing materials to improve service life and driving safety.

METHOD

The research began by gathering information on the technical specifications of Yamaha Vixion NVL wheel bearings from the manufacturer's catalog and relevant references. We also collect information about bearing materials, loading forces, and operating conditions. Furthermore, three-dimensional (3D) bearing modeling was performed using Autodesk Fusion 360 taking into account the actual dimensions of the components used. If necessary, the geometry is simplified, but the main bearing characteristics are preserved.

Once the modeling is complete, the limit conditions are set to show the static loading scenario that the bearing experiences during normal use(Thai et al., 2020). The vehicle's technical data is used to determine the force and load acting on the bearing. After that, the bearing model is fed into the simulation module and simulated using the element method to calculate the voltage distribution, deformation, and safety factor in the bearing(Pujara et al., 2024). The simulation results are analyzed to find the maximum stress point on the bearing. To assess the resistance of a bearing to static loads, the bearing material strength limits are compared and the safety factor is calculated to determine how safe the bearing is under certain loading conditions(J. Ochshorn, 2010). From the results of this analysis, conclusions are made about the ability of bearings to withstand static loads.

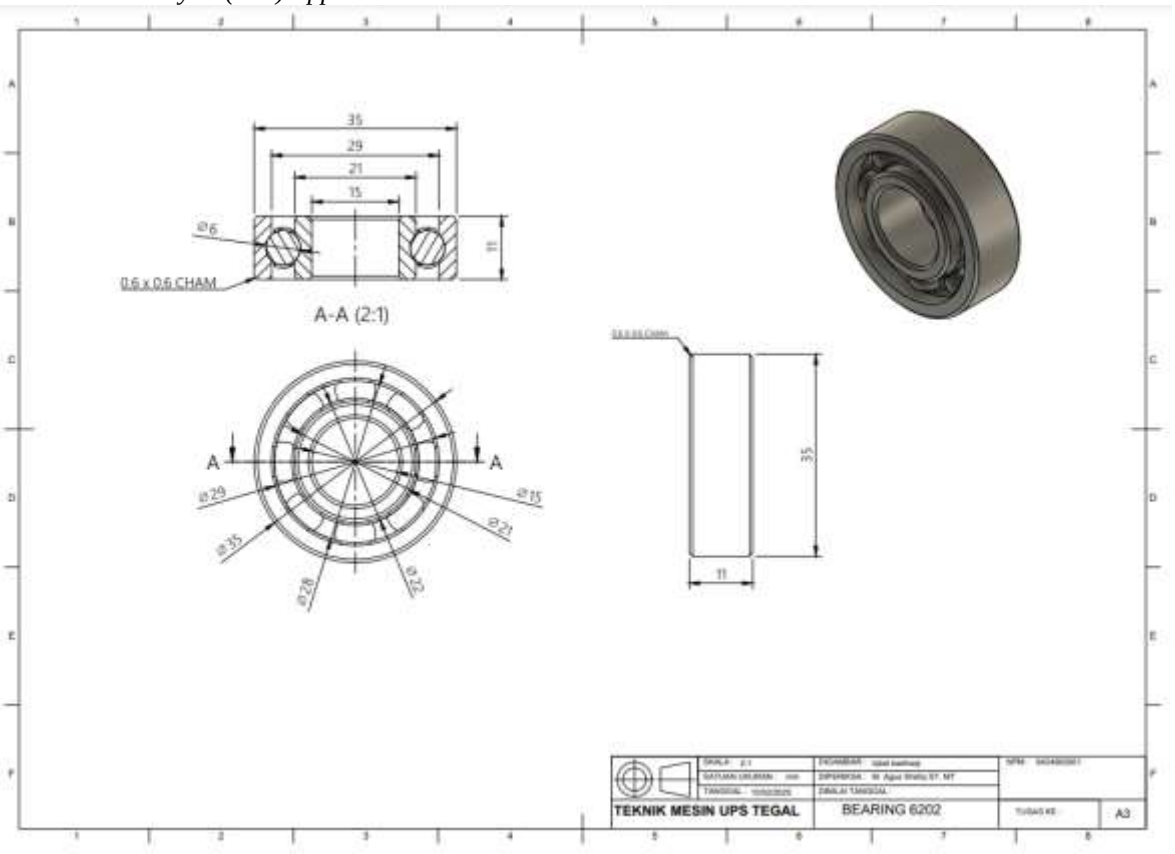

Figure 1. Bearing working drawing

Based on literature studies, the empty weight of a motorcycle is 129 kg and its full weight can be calculated by adding the weight of the fuel and oil content. If the capacity of the gas tank is 12 liters and the average weight of gasoline is around 0.75 kg/liter, then the total weight of full gasoline is 9 kg. As for the oil capacity, it is 1 liter with a general oil weight of 0.9 kg. So the full weight is 138.9 kg or 139 kg. In calculating the load received by the bearing, especially on the front wheel with a full load condition, it is necessary to distribute between the front and rear wheels. In general, the weight distribution for light sports motorcycles is 45% front wheels and 55% rear wheels. So the calculation of the total load is the full load of the motor + the weight of the driver (if the weight of the driver is 70 kg) the result is 209 kg, then to find out the load received by the front wheel bearing is 45% x the total load, so that the result is 94.05 kg if converted to Newton to 940.5 N, assuming a gravitational acceleration of 10 m/s. The bearing used is bearing number 6202 (Single-Row Deep Grove Ball Bearing) which has a diameter of d= 15 mm, D= 35 mm and l= 11 mm with Steel Alloy material.

RESULTS AND DISCUSSION

From the calculation of the load received by the front wheel bearing based on the problems experienced, it can be concluded that:

- A load of 940.5 N will be received by the front bearing, which will affect the compressive force and contact tension on the ball bearing surface.

- Using Finite Element Analysis in Fusion 360, the distribution of stress and deformation due to this static load can be determined.
- If the stress that occurs exceeds the yield limit of the Steel Alloy material, then there is a potential for bearing failure that can cause damage to wheel components(Islam et al., 2022).

Furthermore, the simulation is carried out on the bearing components by applying a load according to the data that has been received on the outer bearing.

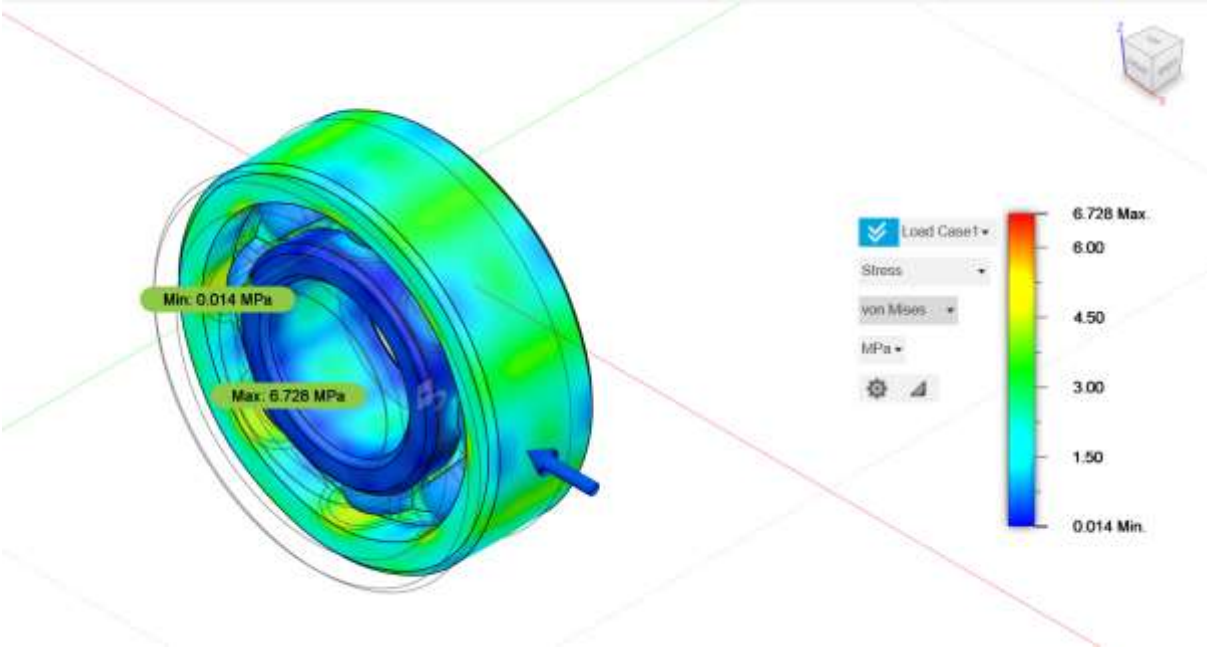

Figure 2. ***Static stress bearing***

The loading is carried out by applying a load of 940.50 N to the outer bearing. Maximum stress occurs in the contact between the ball bearing and the inner race and between the outer race and the housing. If this stress exceeds the yield limit of the material (Steel Alloy), the bearing is at risk of permanent deformation or even premature failure. In the Fusion 360 simulation, the voltage distribution is visualized with a color scale to indicate the area that is experiencing high voltage, i.e. in red. However, this does not happen, so the boundary of the yiled material is safe. Based on simulations that have been carried out with Fusion 360 software, the bearings are able to withstand loads with varying pressure distributions. The lowest pressure is marked in blue with a value of 0.014 MPa and the highest pressure is 6.728 MPa with a red mark.

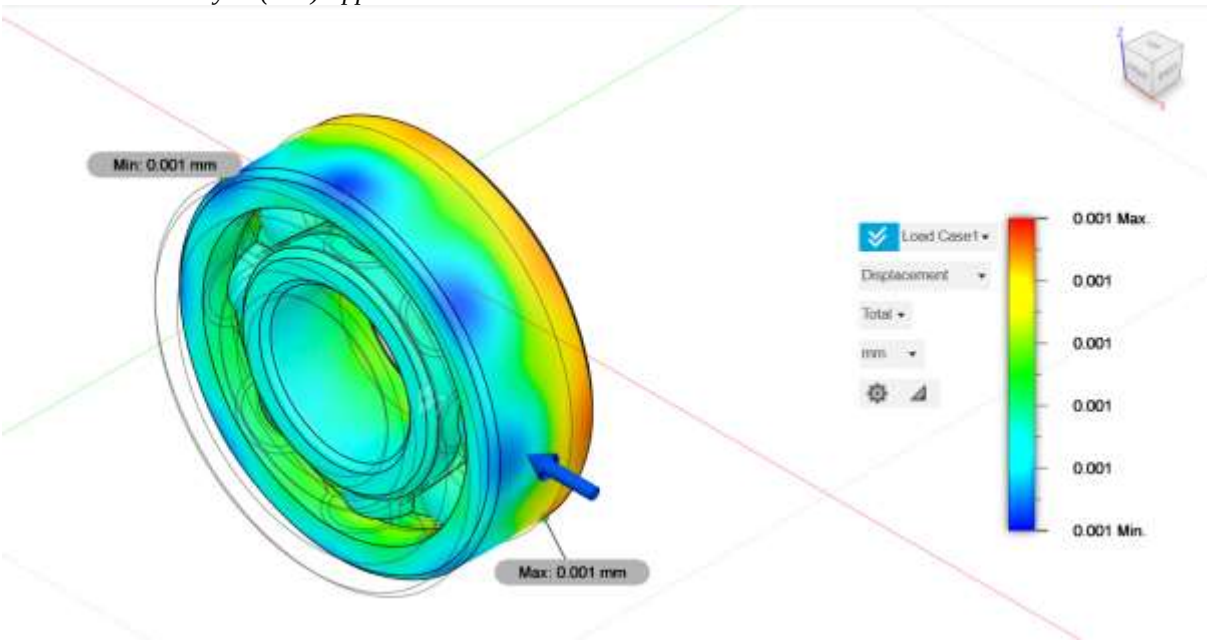

Figure 3. ***Displacement bearing***

Displacement is the elastic deformation response of a bearing due to loading. The bearing material is Steel Alloy, has a high modulus of elasticity, so the displacement due to the load is relatively small. The contact between the ball and the race bearing produces minor deformation, but if the load exceeds capacity, a plastic deformation occurs that causes wear or failure. In the analysis with Fusion 360 used to predict displacement with color scale, showing the bearing with the greatest deformation in orange color of 0.001mm. The results of *the Bearing Displacement* simulation show that the bearing has a deflection with the same value at each point, which is 0.001 mm. So this is still far from being damaged, aka still safe.

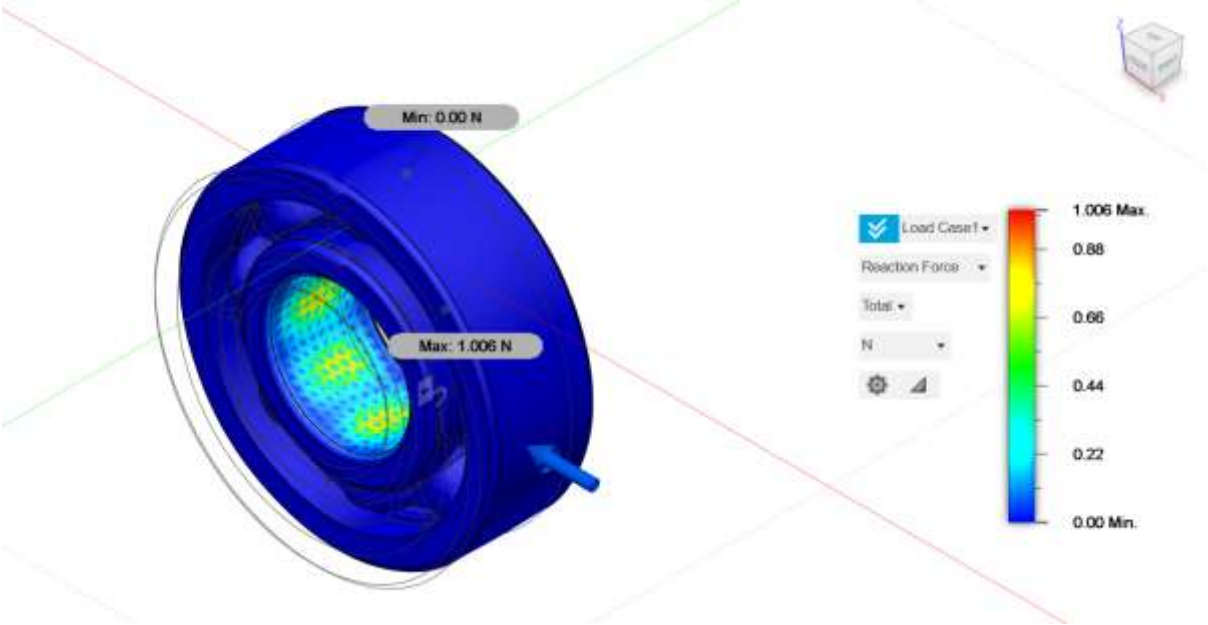

Figure 4. ***Reaction force bearing***

Reaction force is a reaction force that occurs due to an external force acting on the bearing. In this study, a load of 940.5 N acting on the front wheel will be distributed to two bearings that support the wheel axle. There are two bearings, each bearing about 470.25 N and is considered to be evenly distributed load and no misalignment or uneven load distribution, one bearing can experience greater reaction force, which can lead to uneven wear or material fatigue. Calculate the reaction force at the contact point between the bearing ball and the race, as well as its distribution on the housing. Based on the simulation results, the bearing experiences a diverse distribution of reaction forces scattered around the inner bearing surface with the area experiencing the highest reaction force marked with a red color of 1,006 N and the one experiencing the lowest reaction force with a value of 0.00 N marked with a dark blue color.

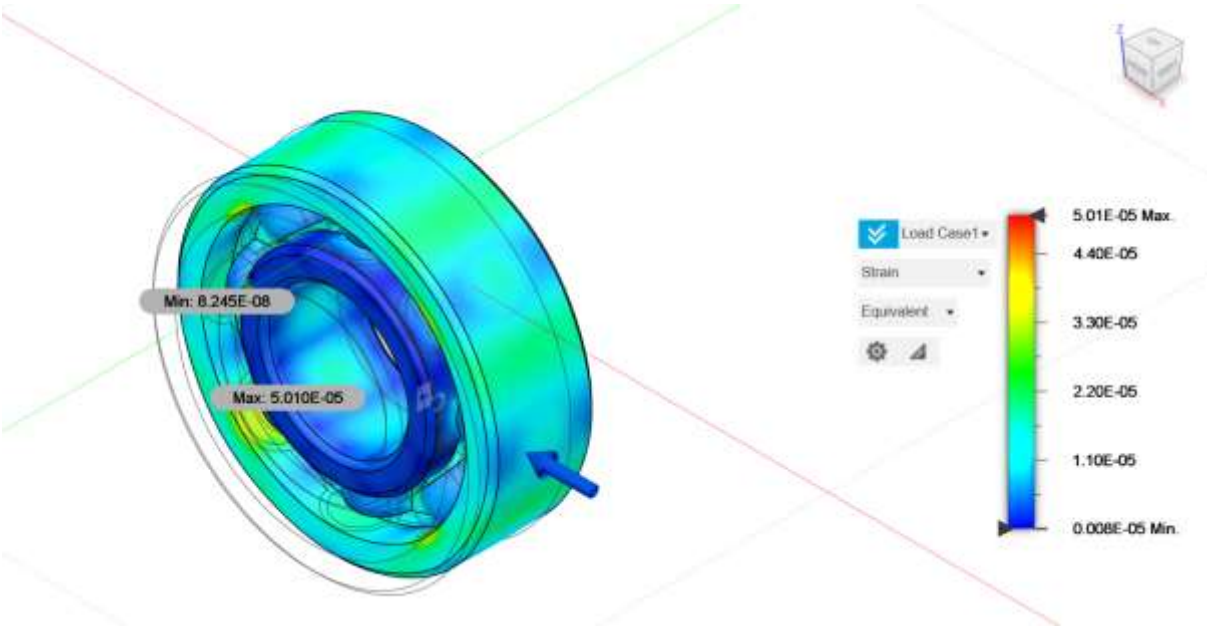

Figure 5. ***Strain bearing***

A strain is a change in relative shape due to the stress received. In this bearing will experience Elastic strain, which occurs when the material is still within its elastic limit and returns to its original shape after the load is released, Plastic strain, which occurs when the load exceeds the yield strength of the material, causing permanent deformation and in Steel Alloy, the strain value is generally small because this material has a high modulus of elasticity. The simulation results show that the bearing undergoes a dimensional change due to the force or load acting with the lowest value of 8,245 x 10^{-8} And the highest score was also obtained reaching 5,010 x 10^{-5}. The strain that occurs is still within the elastic limit so as to avoid permanent deformation or bearing failure.

CONCLUSION

Based on the simulation results on the 6202 bearing which is often used on motorcycle wheels with Stell Alloy material can withstand a maximum load of 6,728 Mpa and can withstand a deflection of 0.001 mm. In addition, the bearing is able to withstand a reaction force of 1,006 N and has a maximum strain value of 5,010 x 10^{-5} . This calculation shows that the static load on the front wheel bearing has a significant value, so it is necessary to conduct an in-depth analysis to ensure the durability of the bearing against the working force. By leveraging simulations in Fusion 360, further evaluation of voltage distribution, deformation, and possible failures can be performed to improve system reliability.

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