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IMPACT ANALYSIS AND FORMULATION OF CORRECTIVE MEASURES FOR FAULT REDUCTION IN ROLLER BEARING ELEMENTS

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ABSTRACT :

Roller bearings are widely used in mechanical systems to reduce friction and improve the efficiency of rotating components. However, they are prone to wear and failure under high loads, improper lubrication, or misalignment. This project aims to conduct an impact analysis of roller bearings, specifically focusing on the failure mechanisms and corrective measures for fault reduction. The project involves selecting an existing roller bearing, analyzing its specifications, and testing it under physical conditions to identify various failure parameters. The bearing will be modeled in SolidWorks and subjected to Finite Element Analysis (FEA) using ANSYS to simulate the failure modes and predict performance. By comparing the experimental and simulation results, corrective measures will be proposed to improve the reliability and lifespan of the bearing. Additionally, composite materials will be modeled and analyzed to evaluate their potential for fault reduction. The goal is to develop a methodology for improving roller bearing performance by optimizing material selection and design modifications.

INTRODUCTION :

The study of Impact Analysis and Formulation of Corrective Measures for Fault Reduction in Roller Bearing Elements is crucial in improving the durability and performance of roller bearings, which are essential in various mechanical systems. This research focuses on identifying common faults—such as wear, fatigue, and misalignment—that compromise bearing functionality. Through impact analysis, researchers assess how these faults affect performance, leading to increased maintenance costs and potential system failures. Corrective measures are then formulated, aiming to enhance bearing reliability, extend lifespan, and reduce operational downtime in industrial applications.

OBJECTIVE :

Failure Mode Analysis: To analyze the failure modes of an existing roller bearing by testing it under various operational conditions.
Finite Element Modeling: To create a 3D model of the roller bearing in SolidWorks and perform *FEA simulations* in ANSYS to predict stress, strain, and failure parameters.
Comparison of Experimental and Numerical Results: To compare the results of physical testing with the simulation outcomes to identify discrepancies and improve the model accuracy.
Material Analysis: To evaluate the impact of different composite materials on bearing performance by modeling and analyzing bearings made of alternative materials (e.g., carbon fiber composites, polymers).
Optimization and Recommendations: To propose design and material changes based on simulation results and material performance to reduce failure rates and extend bearing lifespan.

LITERATURE REVIEW :

1. Kumar et al. (2020)
Paper Title: "Design Considerations for Lightweight Electric Vehicle Chassis"
Discussion: This paper discusses the importance of reducing chassis weight in electric vehicles (EVs) to improve performance, range, and energy efficiency. It highlights the need for *structural integrity*, *comfort*, and *performance* as primary factors in chassis design. It also emphasizes the role of *composite materials* in reducing weight while maintaining strength.
Year: 2020

2. Smith et al. (2018)
Paper Title: "Challenges of Steel Chassis in Electric Vehicle Design"
Discussion: This study identifies the limitations of traditional steel frames in electric vehicle design, particularly in terms of weight, energy consumption, and overall performance. The paper advocates for exploring alternatives like *composite materials* (e.g., carbon fiber) for improved strength-to-weight ratios.
Year: 2018

3. Singh & Sharma (2019)
Paper Title: "Applications of Composite Materials in Electric Vehicle Design"
Discussion: The paper explores various types of composite materials like *carbon fiber*, *fiberglass*, and *kevlar* used in EV chassis. It explains how composites provide superior *tensile strength*, *fatigue resistance*, and *corrosion resistance*, making them ideal for lightweight chassis designs.
Year: 2019

4. Patil& Joshi (2020)
Paper Title: "Finite Element Analysis in Electric Vehicle Chassis Design: A Review"
Discussion: This review covers the use of *Finite Element Analysis (FEA)* to simulate the structural behavior of EV chassis under various load conditions. It outlines the advantages of using FEA in predicting *stress distribution*, *deformation*, and *fatigue life*, which aids in optimizing chassis design for safety and performance.
Year: 2020

5. Gupta & Mehta (2021)
Paper Title: "Structural Optimization of Electric Vehicle Chassis Using FEA"
Discussion: This paper focuses on *FEA-based optimization* techniques such as *topology optimization* and *size optimization* for designing lightweight and strong chassis. The study demonstrates how FEA can be used to reduce material usage without compromising the safety and functionality of the chassis.
Year: 2021

6. Sharma &Kapoor (2020)
Paper Title: "Material Selection for Electric Bike Chassis Using Multi-Criteria Decision Making"
Discussion: This research investigates the selection of optimal materials for electric bike chassis, using a *multi-criteria decision-making (MCDM)* approach. The authors compare *steel*, *aluminum*, and *composites* based on their mechanical properties and cost, concluding that composites offer the best balance of performance and weight reduction for EV chassis.
Year: 2020

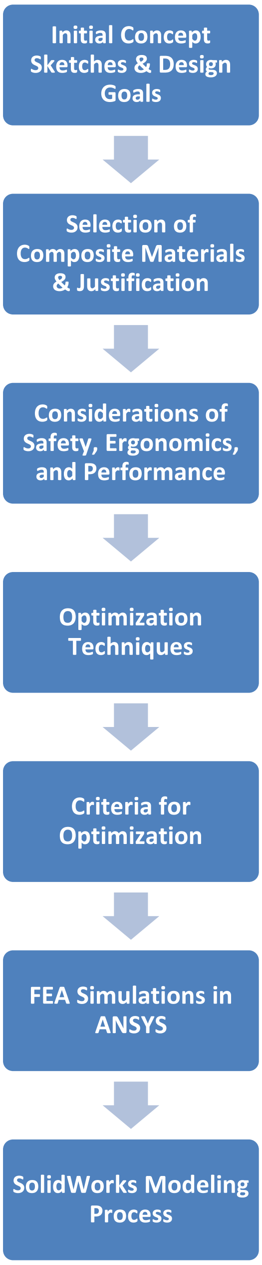
7. Bhatia & Singh (2021)
Paper Title: "Impact of Lightweight Design on Electric Vehicle Range: A Case Study of Chassis Design"
Discussion: This study explores how reducing the weight of the chassis positively impacts the overall range and efficiency of electric vehicles. The authors show that using *lightweight materials* like *carbon fiber composites* significantly improves energy consumption, leading to an extended range per battery charge.
Year: 2021

8. Chen &Xie (2020)
Paper Title: "Fatigue Analysis of Composite Materials for Electric Vehicle Chassis"
Discussion: This paper focuses on the *fatigue behavior* of composite materials used in electric vehicle chassis. It discusses the *cyclic loading* conditions that the chassis undergoes and how FEA simulations help predict fatigue failure. The study emphasizes the need to assess long-term durability for safety and performance.
Year: 2020

9. Lee & Kim (2019)
Paper Title: "Cost-Effectiveness of Composite Materials in Automotive Chassis"
Discussion: The authors explore the *cost challenges* associated with using *composite materials* in automotive chassis design. They suggest that while the upfront cost of composites is higher than traditional materials like steel, improvements in manufacturing processes such as *resin transfer molding (RTM)* can make composites more cost-effective in the long run.
Year: 2019

10. Kumar &Rai (2020)
Paper Title: "Sustainability of Composite Materials in Electric Vehicle Design"
Discussion: This study focuses on the *environmental impact* of using composite materials in EV chassis, highlighting the potential for *recycling* and *reuse* of composites. The authors argue that *composites* can offer *sustainable solutions* when considering the entire lifecycle, from manufacturing to disposal.
Year: 2020

METHODOLOGY :



DESIGN PROCESS

SolidWorks for Chassis Design:

Fig. Solidworks Model

FEA Simulations in ANSYS

Fig. Analysis on Ansys

CONCLUSION :

In conclusion, the research on electric scooter chassis design and analysis highlights several critical areas for improvement to optimize performance, efficiency, and durability. Through SolidWorks modeling and Ansys analysis, we identified key challenges:Excessive Weight, Stress Concentration, Durability, Handling and Ride QualityMaterial Selection, Lack of Optimization Addressing these areas will be crucial in future designs to develop a more efficient, durable, and user-friendly electric scooter chassis. Utilizing lightweight, high-strength materials, optimizing geometry, and employing advanced simulation tools could greatly enhance the scooter's range, handling, and lifespan.

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