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Review on Failures of Rear Axle Housing

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Abstract: ***A study of the mechanical system which is responsible for transferring power to the wheels and to bear the load of the vehicle, which is known as axle housing, is provided in the paper. Axle housing may fail for many reasons. The reasons which are responsible for the failure of the axle housing and corrective actions for failure are discussed in this paper. Some papers were studied related to the failure of axle housing and the summary of those papers is provided in this paper. The study in this paper highlights what kind of issues happen with the axle housing which lead to failure of the axle housing and how to tackle them.***

Keywords: Axle housing, differential carrier, Analysis, FEM, FEA, ANSYS.

I. INTRODUCTION

When it comes to vehicles, axle housing plays an important role in carrying the overall weight of the vehicle and acts as a case for differential assembly. The axle housing carries the oil which is required for the lubrication of the gears used to transfer the power. It is necessary that the axle housing should not fail or undergo any structural damage that may lead to a sudden stoppage of the vehicle. So, in this paper, the study related to failure of the rear axle housing is done. For understanding the nature of the failure and actions need to be taken to avoid such failures, this paper is provided. In this paper, various types of failures of axle housings for different vehicles are studied. Also, what corrective actions have been taken are also discussed in this paper. This paper will give a clear idea about failures occurring in vehicles and this methodology is followed to minimize these kinds of issues.

II. LITERATURE REVIEW

In this section, the literature study related to failure of axle housings is discussed briefly, which was done by some researchers earlier. This section represents a summary of a literature work.

1) Liang Yu [1]

The study conducted by authors focuses on the prediction of oil leakage in the rear axle housing of four-wheel farm transporters using Finite Element Method (FEM) analysis. The objective of the research is to identify potential leakage areas and develop effective preventive measures to minimize oil leakage. The researchers begin by providing a brief introduction to the importance of rear axle housing in farm transporters and the detrimental effects of oil leakage on their performance and longevity. The significance of accurate prediction and prevention of leakage is highlighted as it can save costs associated with repairs and maintenance. Next, the study describes the methodology employed, which involves the utilization of FEM analysis. The Finite Element Method is a numerical technique used to solve complex engineering problems by dividing the structure into smaller elements to calculate stress, strain, and other parameters. In this case, FEM analysis is applied to model the rear axle housing and simulate its behavior under various loading conditions. The research then discusses the assumptions made and the material properties considered for the FEM analysis. The rear axle housing is assumed to be made of a specific material, and its properties such as modulus of elasticity, Poisson's ratio, and yield strength are incorporated into the analysis. The findings of the study reveal the critical areas prone to oil leakage in the rear axle housing.

These areas are identified based on the stress distribution and deformation patterns obtained from the FEM analysis. The study suggests that certain regions, such as joints and interfaces, are more susceptible to oil leakage due to high stress concentration and deformation. To mitigate oil leakage, the research proposes preventive measures such as reinforcing the weak areas, optimizing the sealing system, and employing suitable materials. These measures aim to enhance the overall structural integrity and reduce the likelihood of oil leakage in the rear axle housing. In conclusion, the author's study utilizes FEM analysis to predict oil leakage in the rear axle housing of four-wheel farm transporters. The research identifies critical areas prone to leakage and provides recommendations for preventive measures. By implementing these measures, it is anticipated that the occurrence of oil leakage can be minimized, leading to improved performance and reduced maintenance costs for farm transporters.

2) Khairul Akmal Shamsuddin [2]

The study conducted by authors focuses on the stress distribution analysis of a rear axle housing using Finite Element Analysis (FEA). The objective of the research is to understand the stress distribution patterns in the rear axle housing and evaluate its structural integrity under different loading conditions. The authors begin by providing a brief introduction to the importance of rear axle housing in automotive applications and the significance of accurate stress analysis. The rear axle housing plays a crucial role in transmitting power from the engine to the wheels and supporting the vehicle's weight. Therefore, understanding stress distribution is vital to ensure its reliability and durability. Next, the study describes the methodology employed, which involves the utilization of Finite Element Analysis (FEA). FEA is a numerical technique used to solve complex structural problems by dividing the structure into smaller elements and analysing their behaviour under different loading conditions. In this case, FEA is applied to model the rear axle housing and simulate its response to various loads. The research discusses the assumptions and simplifications made for the FEA analysis. The rear axle housing is modelled as a solid structure, and appropriate material properties such as modulus of elasticity, Poisson's ratio, and yield strength are considered. The study also mentions the boundary conditions applied to simulate real-world scenarios. The findings of the study reveal the stress distribution patterns in the rear axle housing under different loading conditions. The FEA analysis provides insights into the areas experiencing high stress concentrations and potential failure points. This information is crucial for identifying critical regions that may require design modifications or reinforcement to enhance the structural integrity. The research discusses the significance of stress distribution analysis in improving the design and performance of rear axle housing. By understanding the stress distribution patterns, engineers can optimize the geometry, material selection, and manufacturing processes to ensure a robust and reliable rear axle housing. In conclusion, the author's study employs Finite Element Analysis to analyze the stress distribution in a rear axle housing. The research provides valuable insights into the structural behaviour of housing under different loading conditions. This analysis can guide design improvements and help ensure the durability and reliability of rear axle housings in automotive applications.

3) Shivani Jog and Dr. Prashant Nehe [3]

The study conducted by authors focuses on the failure analysis of the rear axle housing of a utility vehicle. The objective of the research is to investigate the causes of failure in the rear axle housing and identify potential measures to enhance its reliability and durability. The author begins by providing an introduction to the importance of rear axle housing in utility vehicles and its critical role in transmitting power to the wheels. The failure of the rear axle housing can result in vehicle breakdowns, safety hazards, and increased maintenance costs. Therefore, understanding the root causes of failure is crucial for improving the design and performance of housing. Next, the study describes the methodology employed for the failure analysis. It involves a combination of visual inspection, non-destructive testing, and material characterization techniques. The failed rear axle housing specimens are carefully examined to identify any visible signs of damage, such as cracks, fractures, or deformations. Non-destructive testing techniques, such as ultrasound and X-ray, are employed to detect internal flaws or defects. Material characterization tests, such as hardness testing and microstructure analysis, are conducted to evaluate the material properties and assess its suitability for the intended application. The findings of the study reveal the various factors contributing to the failure of the rear axle housing. These include high stress concentrations, material defects, inadequate design, manufacturing processes, and operating conditions. The analysis helps in pinpointing the root cause of failure, such as fatigue, overload, or material degradation, and provides insights into the failure mechanisms. Based on the findings, the research suggests potential measures to enhance the reliability and durability of the rear axle housing. These measures may include design modifications, material selection improvements, manufacturing process optimization, and enhanced maintenance practices. By addressing the identified root causes and implementing these measures, the reliability and service life of the rear axle housing can be significantly improved. In conclusion, the author's study focuses on the failure analysis of the rear axle housing in a utility vehicle. The research highlights the importance of understanding the causes of failure and provides insights into potential measures to enhance the reliability and durability of housing. By implementing these measures, utility vehicle manufacturers and operators can mitigate failures, improve vehicle performance, and reduce maintenance costs.

4) Nikita A. Duble and A. D. Diwate [4]

The study conducted by authors focuses on the design and Finite Element Analysis (FEA) of a differential cover for the rear drive axle of a light commercial vehicle. The objective of the research is to develop an optimized design for the differential cover and evaluate its structural integrity using FEA. The author begins by emphasizing the significance of the differential cover in protecting the differential gears and other internal components of the rear drive axle.

The cover plays a crucial role in preventing debris, contaminants, and moisture from entering the differential assembly, thereby ensuring its smooth operation and longevity. Next, the study describes the methodology employed for the design and FEA analysis. The design process involves considering various factors such as load conditions, material selection, geometric constraints, and manufacturing feasibility. Computer-aided design (CAD) software is used to create the differential cover model, incorporating the necessary features and dimensions. After the design phase, FEA is performed to assess the structural integrity of the differential cover. FEA allows for the simulation of real-world loading conditions and provides insights into stress distribution, deformation, and potential failure areas. The study utilizes appropriate boundary conditions and material properties to accurately represent the operating conditions of the differential cover. The findings of the research reveal the stress distribution patterns in the differential cover under different loading scenarios. The FEA analysis helps identify areas of high stress concentration, such as fillets, bolt holes, and critical interfaces. This information guides design improvements to reinforce these vulnerable regions and enhance the overall structural integrity of the differential cover. Furthermore, the study discusses the optimization of the differential cover design based on the FEA results. Design modifications, such as adding ribs or increasing the thickness in critical areas, are suggested to improve the strength and rigidity of the cover. In conclusion, the author's study focuses on the design and FEA analysis of a differential cover for the rear drive axle of a light commercial vehicle. The research emphasizes the importance of protecting the differential assembly and highlights the role of FEA in evaluating the structural integrity of the cover. By incorporating design improvements based on the FEA results, manufacturers can enhance the reliability and durability of the differential cover, ultimately leading to improved performance and longevity of the rear drive axle in light commercial vehicles.

5) Chetan Papat, Idris Poonawala and S. M. Gaikwad [5]

The study conducted by researchers focuses on the design of an axle housing bolted joint using an analytical method. The objective of the research is to develop a design approach that ensures the structural integrity and reliability of the bolted joint in the axle housing. The author emphasizes the significance of the bolted joint in connecting various components of the axle housing, such as the housing itself, flanges, and other related parts. The joint must be designed to withstand the operational loads and prevent any potential failure or loosening of the connection. The study describes the analytical method used for the design of the bolted joint. It involves the application of established engineering principles, formulas, and calculations to determine the appropriate bolt size, tightening torque, and other design parameters. The analytical approach ensures that the joint can withstand the expected loads and provides a margin of safety against failure. The research highlights the importance of considering factors such as material properties, friction coefficients, preload requirements, and operational conditions in the design process. These factors influence the clamping force, stress distribution, and overall performance of the bolted joint. In conclusion, the researcher's study focuses on the design of an axle housing bolted joint using an analytical method. The research emphasizes the importance of considering various design parameters and engineering principles to ensure the structural integrity and reliability of the joint. By employing the analytical approach, manufacturers can optimize the design of the bolted joint and enhance the overall performance of the axle housing in terms of strength, durability, and safety.

6) Monica P and Mahendra Babu [6]

The study conducted by authors focuses on the analysis of the rear axle housing of a heavy truck using the ANSYS software. The objective of the research is to investigate the structural behaviour and performance of the rear axle housing under different loading conditions. The author begins by highlighting the importance of the rear axle housing in heavy trucks and its role in supporting the vehicle's weight and transmitting power to the wheels. Understanding the structural integrity of the housing is crucial for ensuring the safe and reliable an operation of the truck. The study describes the methodology employed, which involves the utilization of the ANSYS software for Finite Element Analysis (FEA). ANSYS is a powerful engineering tool that allows for the simulation and analysis of complex structural problems. In this case, the rear axle housing is modelled using appropriate CAD software and imported into ANSYS for the analysis. The research discusses the various loading conditions applied to the rear axle housing, such as vertical loads, torsional loads, and bending moments. These loading conditions simulate real-world scenarios that the housing would experience during an operation. The effects of these loads on the housing's stress distribution, deformation, and potential failure areas are analyzed using ANSYS. The findings of the study reveal the stress distribution patterns in the rear axle housing under different loading conditions. The analysis provides insights into areas of high stress concentration, potential weak points, and critical regions that may require design modifications or reinforcement. This information is valuable for optimizing the structural design of the rear axle housing to enhance its strength and durability. Additionally, the research discusses the validation of the analysis results by comparing them with experimental data or established design standards.

This validation ensures the accuracy and reliability of the ANSYS analysis and enhances confidence in the obtained results. In conclusion, the researcher's study utilizes ANSYS software for the analysis of the rear axle housing of a heavy truck. The research demonstrates the capability of ANSYS in simulating and evaluating the structural behaviour of the housing under various loading conditions. By identifying areas of concern and implementing design improvements based on the analysis results, manufacturers can enhance the reliability and performance of the rear axle housing in heavy trucks.

7) Meng, Zheng and Fengjun [7]

The study conducted by authors focuses on the prediction of fatigue failure faults in the rear axle housing of trucks, specifically when subjected to random road roughness. The objective of the research is to analyze the effects of road roughness on the structural integrity of the rear axle housing and predict potential fatigue failures. The author begins by highlighting the significance of fatigue failures in the rear axle housing of trucks, which can lead to catastrophic consequences if not addressed. Road roughness is a critical factor that introduces dynamic loads and vibrations to the axle housing during vehicle operation, thereby influencing its fatigue life. The study describes the methodology employed, which involves the use of simulation techniques to analyze the response of the rear axle housing to random road roughness excitation. The road roughness profiles are generated based on measured data, representing real-world road conditions. Finite Element Analysis (FEA) is utilized to model the rear axle housing and simulate its dynamic behaviour under these roughness-induced loads. The research discusses the fatigue analysis techniques employed to predict the fatigue life of the rear axle housing. The stress history obtained from the FEA simulations is used in conjunction with established fatigue models and methodologies to assess the number of fatigue cycles the housing can endure before failure. The study also considers the material properties, loading conditions, and environmental factors that influence fatigue life. The findings of the research reveal the predicted fatigue failure locations and the corresponding fatigue life of the rear axle housing under random road roughness excitations. The analysis identifies critical regions prone to fatigue failure, such as weld joints or high-stress concentration areas, and provides insights into potential design modifications or maintenance practices to mitigate these failures. In conclusion, the author's study focuses on the prediction of fatigue failure faults in the rear axle housing of trucks subjected to random road roughness. The research emphasizes the importance of considering road conditions and their impact on the structural integrity of housing. By predicting and addressing potential fatigue failures, truck manufacturers and operators can enhance the reliability and safety of the rear axle housing, ultimately improving the overall performance and longevity of the trucks in real-world operating conditions.

III. CONCLUSION

From the above literature study, it can be concluded that many researchers worked on stress analysis as well as fatigue analysis of the axle housing to improve the lifespan of the axle housing for better reliability. Many times, the axle housing may fail because of the overloading of the vehicle or due to a sudden hit of stone or speed breakers, etc. The literature survey also defines the approach to solving the issue of failing axle housings with proper methodology. From this literature study, failure of the axle housing is a very severe issue and manufacturers should perform FEA of the axle housing and try to minimize the failure.

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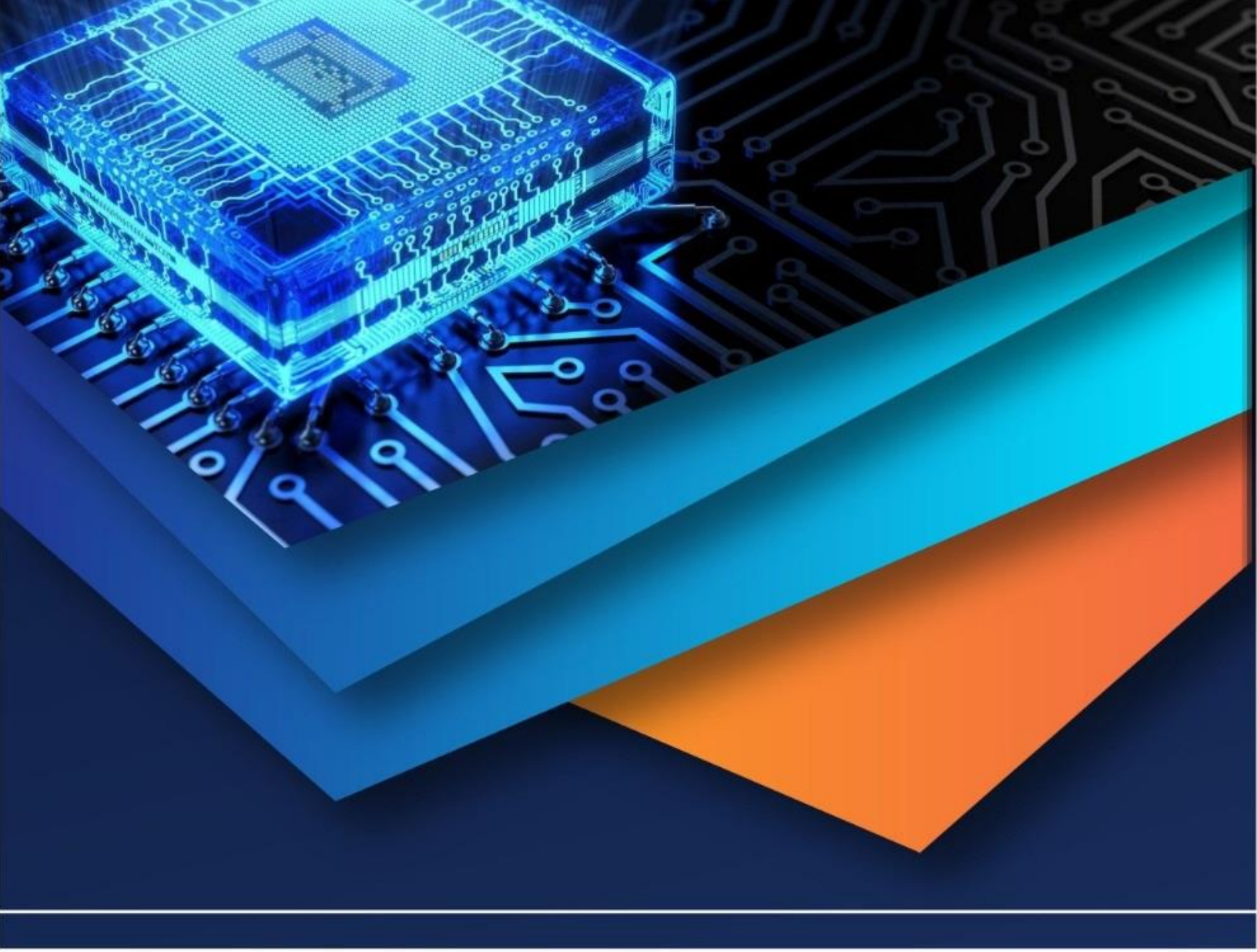

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