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A REVIEW ON DESIGN OF 5 – SPEED GEARBOX MECHANISM

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Abstract: This study presents the design, development, and analysis of a compact 5-speed gearbox mechanism for improved transmission efficiency and design and fabrication of 5 speed gear box mechanism to transfer the mechanical energy from one device to another and is used to increase the torque while reducing the speed. Gearboxes can modify their speed, torque to convert energy into a compatible format. They are useful in easing the mechanical functioning for moving the vehicles and machines. A well-planned and optimized design process is essential for creating successful products. This paper focuses on designing a quick shifting mechanism for a 5-speed gearbox using SolidWorks software and performing finite element analysis for stress analysis and quality checking

IndexTerms **- Gearbox, shift lever, torque, gears, gear ratio, shaft speed.**

INTRODUCTION

A gearbox is a mechanical device that transmits rotational power from one shaft to another, changing the speed and torque of the power source. It consists of gears and shafts that work together to achieve this transformation. Product design and development is the essential task in today's developing market. The design development process of quick shifter and gear box components are done by using 3-d model software like solid works. The principal aim of designing the gear box is, transmission of power according to variable needs from input source of power to the desired output. To keep it as per with global market, each countries follows different standards.

1.2. Types of Gearboxes:

1. Manual Transmission (MT)
2. Automatic Transmission (AT)
3. Continuously Variable Transmission (CVT)
4. Dual Clutch Transmission (DCT)
5. Planetary Gearbox
6. Helical Gearbox
7. Spur Gearbox
8. Bevel Gearbox

The design and development of gearboxes require careful consideration of various factors to ensure optimal performance, efficiency, and reliability.

LITERATURE REVIEW

We studied some of the papers, those are explained below:

Sourabh Khanawale, Ajit Balwan et.al.,[1] This study highlights the significance of design and development in today's competitive market, emphasizing in the importance of optimization and planning. The authors showcase a successful design and development process for a quick-shifting mechanism in a four-speed gearbox using SolidWorks and finite element analysis. The value of integrated design and analysis in developing innovative products. The authors' methodology provides a valuable framework for engineers and researchers seeking to optimize gearbox performance. The paper's clear conclusions and future directions make it a valuable contribution to the field of mechanical engineering and product design.

Franco Concli , Lorenzo Maccioni & Carlo Gorla et.al.,[2] This study addresses the growing demand for compact and efficient gearbox solutions by developing numerical models to optimize internal design, thermal management, lubrication, and reliability. Focusing on cycloidal architectures, the authors extend their previous research on hydraulic power loss models using computational fluid dynamics (CFD) and Open FOAM.

Mohammed Anwar, Saif Bin Abdullah et.al.,[3] This innovative study presents an electro-mechanical power transmission system, leveraging solar energy and battery-powered BLDC motors to reduce fossil fuel dependence. The system comprises a five-speed manual gearbox, chain drive, and clutch shaft, enabling efficient power transmission to the rear wheel of a three-wheeled vehicle. Successful implementation of solar-powered electro-mechanical transmission Max speed of 70 kmph achieved Comfortable operation with manual gear shifting Conversion of electrical to mechanical power via gearbox Environmental benefits through

Dariusz Dąbrowskia , Anand Natarajana, et.al.,[4] This comprehensive study investigates dynamic loads in offshore wind turbine drivetrains, focusing on gearbox failures. A 5 MW wind turbine gearbox model was developed using MSC ADAMS and validated against NREL's 750 kW prototype data. The research assesses the probability of gearbox failure during storm conditions and normal shutdowns.

Goran Mandic, Student Member, IEEE, Adel Nasiri, et.al.,[5] This study addresses the reliability concerns of wind turbine gearboxes by proposing a novel generator torque control method. The approach minimizes resonant torsional vibrations within the drivetrain, caused by wind velocity variations, thereby reducing mechanical stress on gearbox components. This study demonstrates a significant advancement in wind turbine gearbox reliability. By reducing mechanical stress, the proposed method has the potential to extend gearbox lifespan and decrease maintenance costs. The authors' systematic approach, detailed modeling, and simulation results provide a solid foundation for future research and development. The simplicity of the controller structure makes it an attractive solution for industry implementation. Overall, this article contributes

substantially to the field of renewable energy and mechanical engineering, addressing a critical challenge in wind turbine design.

Majid Yaghoubi , Seyed Saeid Mohtasebi, et.al.,[6] This innovative study presents a novel gearbox mechanism for power transmission between concentric shafts, offering a cost-effective alternative to planetary gears. The proposed design achieves remarkable reduction ratios. This study showcases a groundbreaking gearbox design, offering impressive reduction ratios and compactness. Its findings have significant implications for improving power transmission efficiency and reducing system size and weight. With further development and validation, this mechanism has the potential to revolutionize gearbox technology. The authors' attention to detail and rigorous analysis make this article a valuable contribution to the field of mechanical engineering.

Stein Crispel, Pablo Lopez Garc, et.al.,[7] This study presents a novel Compound Planetary Gear Train (C-PGT) based on the Wolfrom topology, addressing the need for high torque density and efficient actuators in robotic applications. The proposed design overcomes traditional limitations of high-speed electrical motors with harmonic or cycloid drives, offering. This significant advancement in gearbox design for robotic applications. The proposed Wolfrom variant offers improved efficiency, reduced inertia, and increased torque capability. The authors' systematic approach, detailed analysis, and experimental validation provide a solid foundation for future research and development. While limitations exist, the benefits of this design make it an attractive solution for high torque density actuators.

Timir Patel, Ashutosh Dubey et.al.,[8] This study presents the design and optimization of a planetary gearbox for a Formula Student electric car, addressing the need for compact and lightweight transmissions. The authors successfully developed a custom epicyclic gear reduction, achieving a balance between weight and power transmission.This study demonstrates a significant contribution to the development of compact and lightweight transmissions for electric vehicles. The authors' systematic approach and attention to detail provide a valuable resource for Formula Student teams and electric vehicle designers.

M. Chandrasekaran , Padmanabhan S et.al.,[9] This study explores the optimization of single-speed gearbox design using genetic algorithms (GA) to achieve a critical balance between power and torque while minimizing weight. The authors effectively employed multi-objective formulations to address the conflicting objectives inherent in gearbox design.The study showcases the potential of GA in optimizing complex engineering problems, providing manufacturers with a valuable tool to produce gearboxes efficiently. By considering multiple objectives, the authors' approach ensures a more realistic and comprehensive design evaluation.

Prabhakar Vitthal Pawar , P.R. Kulkarni et.al.,[10] This informative article highlights the advantages of planetary gear systems over helical gear systems, particularly in power transmission applications. The study explores key considerations for determining reduction ratios, minimum and maximum reductions per stage, and presents a case study on a two-stage gearbox. The comparison between planetary and helical gear systems reveals significant benefits.This article provides valuable insights for engineers and researchers, demonstrating the superiority of planetary gear systems in terms of compactness, strength, and torque density. Its findings have significant implications for improving power transmission efficiency and reducing system size and weight.

Prakash D. Patel J.,M. Patel et.al.,[11] This experimental study investigates the impact of operating conditions on power losses and efficiency in an automotive manual transmission. The authors developed a rigorous methodology to measure power losses under controlled conditions, examining the effects of load, oil viscosity, and oil volume on load-dependent and load-independent power losses.
Overall, this study demonstrates exceptional technical merit and practical relevance, contributing significantly to the field of automotive engineering and transmission design.

A. Hajnayeb , A. Ghasemloonia b et.al.,[12] This study presents an artificial neural network (ANN)-based fault diagnosis system for gearboxes, leveraging vibration features and optimized through feature selection methods. The authors employed the UTA method and Genetic Algorithm (GA) to identify the most relevant

features. This study demonstrates the potential of ANNs in gearbox fault diagnosis, highlighting the importance of feature selection for optimized performance.

K. Smolders Hansen , Belgium H et.al.,[13] This study presents a comprehensive reliability analysis model for wind turbine gearboxes, focusing on a generic configuration and modular structure. The authors utilized Reliability Block Diagrams (RBDs) and Relex software to estimate failure rates of critical components, highlighting. This study contributes significantly to the field of wind turbine reliability, providing a valuable framework for gearbox analysis. The authors' systematic approach and emphasis on validation underscore the importance of accurate reliability prediction.

S.S. Khodwe and S.S. Prabhune et.al.,[14] In this journal the author said that presents a comprehensive approach to evaluating gearboxes through a specialized test bench. This test bench is designed to assess various critical aspects of gearbox performance, including shift performance, leakage, and noise levels. The authors detail the design and functionality of the test bench, which integrates several key components such as clamping arrangements, gear shifting mechanisms, and oil dispensing systems. A notable feature is the inclusion of finite element analysis (FEA) for ensuring the structural integrity of the fixture components. The test bench enables comprehensive testing in different conditions, such as driving and dragging, to ensure the gearbox operates within acceptable parameters.

Vandan Bari, Akshay Sawant, Jayesh Parmar , Pradeep Sharma, Vaibhav Lande et.al.,[15] In this journal the author said The article presents a comprehensive design and development of a gearbox tester, aiming to measure the torque carrying capacity of a gearbox at different speeds. The authors successfully designed and tested a gearbox tester, which consists of a gear assembly, motor, tachometer, friction drum, and weight plates. The experimental results show a satisfactory performance of the gearbox, with a clear relationship between speed and torque. The graphs demonstrate that as speed increases, torque decreases, and vice versa. The tester can detect defects in gears and ensure the quality and performance of the gearbox. The study provides a valuable contribution to the field of mechanical engineering, particularly in the testing and evaluation of gearbox performance. However, the article could benefit from more detailed explanations of the methodology and experimental setup, as well as a more comprehensive discussion of the results and their implications.

Kai Chena , Jibin Hua , Zengxiong Penga et.al.,[16] In this journal the author said that This paper presents a comprehensive study on the analytical framework of gearbox monitoring based on the electro-mechanical coupling mechanism. The authors propose a mathematical framework to detect faults in planetary gearboxes using stator current signature analysis in Permanent Magnet Synchronous Motors (PMSM). The study reveals that load torque oscillations and gear fault frequencies can be identified through the stator current spectrum. The proposed method is verified through simulations and experimental tests, demonstrating its effectiveness in detecting faults under various operating conditions. The paper provides valuable insights into the potential of electro-mechanical coupling mechanisms in fault diagnosis and offers a promising approach for monitoring planetary gearboxes in hybrid electric vehicles and other applications.

Mr. Rohit Sreekumar ,Prof.T. Jeyapoovan et.al.,[17] The article presents a comprehensive study on the use of composite materials in differential gear boxes. The authors aim to reduce the weight of the gear box while maintaining its mechanical properties. They used SOLIDWORKS for solid modeling and ANSYS 14.5 for static analysis, comparing the results of Ni-Cr steel, malleable cast iron, aluminum alloy, and glass-filled polyamide. The study reveals that the composite material, glass-filled polyamide, shows lower stress and density, making it a suitable alternative for differential gear material. The authors conclude that this reduction in weight increases efficiency, making composite materials a promising option for gear manufacture. The article provides valuable insights into the potential of composite materials in automotive applications, highlighting their benefits in terms of weight reduction and mechanical properties.

Satvender Singh ,D.Dev Singhal et.al..,[18] In this journal the author said that he article presents a comprehensive design and development of an acceleration simulator for testing gearboxes in automobiles. The authors aimed to create a simulator that can apply both translational and rotational acceleration simultaneously, mimicking real-world conditions. The design uses a motor as a power aid and incorporates a mechanism with lead screws, nuts, gears, racks, bearings, and shafts,conclude that their design can simulate

functional loads on gearboxes and recommend its use for practical applications. The article provides a valuable contribution to the field of mechanical engineering, particularly in the testing and evaluation of gearbox performance. However, the article could benefit from more detailed explanations of the methodology and experimental setup, as well as a more comprehensive discussion of the results and their implications.

Joginder Singh et.al.,[19] In this journal the author said that he article presents a comprehensive design and development of an acceleration simulator for testing gearboxes in automobiles. The authors aimed to create a simulator that can apply both translational and rotational acceleration simultaneously, mimicking real-world conditions. The design uses a motor as a power aid and incorporates a mechanism with lead screws, nuts, gears, racks, bearings, and shafts. The authors employed solid modeling, finite element method (FEM) analysis, and modal analysis to validate their design. The results show that the design is safe, with a maximum Von Mises stress of 1.8 MPa and a first natural frequency of 59 Hz, which is higher than the critical frequency associated with functioning. The authors conclude that their design can simulate functional loads on gearboxes and recommend its use for practical applications. The article provides a valuable contribution to the field of mechanical engineering, particularly in the testing and evaluation of gearbox performance.

Siddharth Dahiya,Adithya Asok Sharma et.al.,[20] In this journal the said that The article presents a design methodology and algorithm development for an automatic external gear-shifting and clutch-actuation system for a sequential gearbox. The system aims to provide easier and efficient shifting for drivers, bridging the gap between automatic and manual transmissions. The authors develop an electro-pneumatic shifting system, which is lightweight, reliable, and cost-effective, with a total shift time of about 100ms for upshifts and 150ms for downshifts. The system is tested on a Honda CBR 600RR powered engine vehicle and achieves satisfactory performance in terms of shift speed and stability. The authors also develop algorithms for upshifts, downshifts, launch control, and clutch override, which are implemented using a microcontroller. The system has the potential to be adapted for use on other similar sequential gearboxes with modifications. Overall, the article presents a comprehensive design and development of an automatic gear-shifting system, contributing to the field of mechanical engineering and automotive technology.

Najeeb Ullah , T. Cong, B. Huan et.al.,[21] In this journal the author said that the article presents a comprehensive analysis of the effects of gear tooth micro-modification on the dynamic behavior of a vehicle gearbox. The study focuses on minimizing contact stress, transmission error, and radial acceleration response through three different modification approaches. The results show that the third approach, combining crowning and barreling techniques, is the most effective in improving contact patterns, reducing peak-to-peak transmission error, and enhancing safety factors. Additionally, the study finds that the third approach decreases radial acceleration response for both upper and central phase shaft bearings. The article provides valuable insights into the design and optimization of gear tooth modifications for vibration and noise reduction in vehicle gearboxes, highlighting the importance of considering both tangential and radial components for safer design.

Irina Makarova, Eduard Mukhametdinov ..et.al.,[22] In this journal the author said that the article investigates the causes of gearbox failures, particularly the destruction of the output shaft bearing. The authors analyze the defects and establish a distribution law for the failures, proposing measures to improve reliability. They identify operational factors, lubrication lack, and high axial loads as primary causes of failure. To address these issues, the authors suggest design modifications, replacement of the roller radial thrust bearing, and changes to the lubrication system. The study provides valuable insights into ensuring gearbox reliability, highlighting the importance of addressing peak loads, lubrication, and design flaws. The proposed solutions aim to reduce gearbox failures, increasing overall vehicle efficiency and safety.

Chetan Ramesh Patil et.al.,[23] In this journal the author said that the gearbox noise and vibration prediction and control is a crucial aspect of mechanical engineering, particularly in the design and development of gearboxes for various applications. The article provides a comprehensive review of the techniques and procedures employed to quiet gearboxes and transmission units. The authors focus on solving the gear noise problem at the source, rather than relying on enclosures to reduce radiated noise. They emphasize the

importance of improving gear design, verifying its effect on radiated noise, and determining the contribution of gears to overall noise levels. The article also discusses various analytical and numerical tools used to perform signal processing and diagnostics of geared axis systems. The authors highlight the significance of considering both tangential and radial components for safer design and provide examples of practical engineering problems. Overall, the article contributes to the field of mechanical engineering, offering valuable insights into gearbox noise and vibration prediction and control.

R. Bharani & A. Sivaprakasam et.al.,[24] In this journal the author said that the article presents a comprehensive overview of various gearbox technologies used in horizontal axis wind turbines. The authors classify these technologies into three main categories: Planetary Gearbox (PG), Continuously Variable Transmission (CVT), and Magnetic Gearbox (MG), while also acknowledging other prototypes in operation. They highlight the common challenges associated with mechanical gearboxes, such as high maintenance costs and reliability issues, particularly in large turbines. Notably, the review emphasizes the advantages of variable ratio gearboxes for maximizing energy extraction while minimizing reliance on power electronic devices. The findings suggest that these systems are particularly suited for harsh operating conditions and high service loads. Overall, the article serves as a valuable resource for researchers and industry professionals interested in optimizing wind turbine performance and addressing the limitations of existing gearbox technologies, reinforcing the importance of innovation in renewable energy systems.

Sanzhar Armanuly Kalmaganbetov et.al.,[25] In this journal the author said that the article presents a thorough investigation into the design of planetary transmissions specifically tailored for light electric vehicles (LEVs). The authors effectively outline the methodology used to calculate the necessary transmission ratios, emphasizing the importance of optimizing gear layouts to enhance vehicle performance. Their analysis focuses on a two-carrier gear train configuration, which is highlighted as a promising solution for achieving the desired efficiency and compactness in LEV gearboxes. The paper is well-structured, providing clear insights into the engineering principles involved and supporting their findings with relevant data and simulations. Additionally, the collaboration among various international institutions enriches the study, showcasing a diverse range of expertise in mechanical engineering. The results not only contribute to the existing body of knowledge but also offer practical implications for the development of more efficient and sustainable electric vehicles. Overall, this article serves as a valuable resource for researchers and engineers in the field, paving the way for future advancements in electric vehicle technology.

Amruta Lomate , Suhas Mohite et.al.,[26] This article presents a well-designed and developed torque testing rig for evaluating gearbox performance, specifically for multi-plate brake systems. The rig's capacity ranges from 0.5-10 kN-m, catering to various industrial applications. The authors successfully calibrate the rig, demonstrating a strong correlation between experimental and theoretical calculations. Notably, the maximum error in measured torque is only 50 Nm. The test rig's versatility extends to peak load and duty cycle testing. Temperature measurements confirm efficient cooling within accepted limits. Overall, the rig's performance is trouble-free, ensuring reliable gearbox evaluation. This study contributes significantly to ensuring gearbox reliability and efficiency.

Prathamesh D Patil , Dr.S.D.Yadav et.al.,[27] This study optimizes gearbox performance in automobiles by analyzing gear ratio selection methods. The authors evaluate traditional methods, including straight-line graphs and tractive effort curves, and compare mathematical progressions (arithmetic, harmonic, and geometric) for determining gear ratios. Applying these methods to a 5-speed gearbox, results show geometric progression yields the minimum wasted power, outperforming arithmetic progression by 73%. The research underscores the importance of performance curves and tractive effort curves in understanding vehicle behavior under various road conditions. The findings provide valuable insights for enhancing gearbox efficiency and vehicle dynamic performance.

H.S.J. Rashid a,n , C.S. Place a et.al.,[28] This comprehensive study addresses the critical issue of helicopter main gearbox (MGB) lubrication system failures, a leading cause of catastrophic accidents. The research employs a multifaceted approach, integrating safety risk modeling and Influence Diagram (ID) analysis to identify key failure mechanisms, contributory factors, and reliability issues. The study highlights the complex

interrelationships between MGB lubrication system failure types and influencing factors, emphasizing the need for a holistic approach.

Roman Krol et.al.,[29] This study investigates the impact of backlash on the output torque spectrum of a cycloidal gearbox using MSC Adams simulation. The analysis reveals significant backlash influence on output torque amplitude spectrum. However, the relationships between spectrum components and backlash non-linearity preclude linear equation expression, particularly in the 350-600 Hz vibration range. Notably, the spectrum narrows with increased backlash, attributed to harmonic excitation from evenly distributed impact-to-impact times. The research highlights the complexity of cycloidal gearbox dynamics, where output torque depends on previous loading cycles. Results are specific to the modeled gearbox, and generalizability is limited due to variations in geometry, ratio, and loading conditions.

.Mohamed El Morsy, Gabriela Achtenová et.al.,[30] This study demonstrates the effectiveness of cepstrum analysis in vehicle gearbox fault diagnosis, tackling complex vibration signals. By leveraging cepstrum's ability to extract defect information, the authors successfully detect artificial pitting defects under varying speeds and torques. The experimental setup, utilizing three dynamometers, simulates real-world conditions. Order cepstrum analysis proves effective in identifying gear condition. The results underscore cepstrum analysis's reliability for predictive maintenance. The authors' systematic approach, clear explanation, and experimental validation enhance the article's credibility.

Jan Furch , and Cao Vu Tran et.al.,[31] This study presents a comprehensive design and strength analysis of helical gears for a 3C diesel engine's first speed gear, prone to failure due to maximum torque exertion. The authors investigate three materials, settling on AISI 5160 OQT-400 Alloy Steel, and calculate tooth load using Lewis and Buckingham equations. The design optimization considers module and face width variations, prioritizing structural rigidity and lightness for durability and smooth operation. Results confirm the selected material's suitability, meeting strength and dynamic requirements.

A.Yu. Bukashkin, R. Yu. Dobretsov et.al.,[32] This comprehensive study presents a novel family of power transmissions designed for universal and industrial wheel tractors, enabling multiple operating modes and split transmission. The transmission boasts seamless gear shifting and smooth gear ratio changes within each mode, enhancing tractor performance and efficiency. Key findings include the replacement of hydraulic transmission (HT) with friction or gear mechanisms, development of a transforming mechanism for continuously variable torque output, and determination of gear ratio and load on mechanism details.

Radoslaw Zimroz, Walter Bartelmus et.al.,[33] This study explores the application of cyclo-stationary properties in vibration signals for gearbox condition estimation, particularly in complex multi-fault scenarios. The authors address the limitations of traditional methods like envelope analysis and demonstrate the effectiveness of spectral correlation density and spectral coherence maps in identifying modulation sources. The approach is validated through industrial case studies on multi-stage gearboxes in the mining industry. Results show promising diagnostic capabilities, enabling fault extraction and interpretation. A novel diagnostic feature is proposed for estimating condition changes in planetary gear stages. The study contributes significantly to gearbox condition monitoring, offering a robust solution for real-world industrial applications.

Thin Thin Soe, Si Thu Thwin et.al.,[34] This study presents a comprehensive design and strength analysis of helical gears for a 3C diesel engine's first speed gear, prone to failure due to maximum torque exertion. The authors investigate three materials, settling on AISI 5160 OQT-400 Alloy Steel, and calculate tooth load using Lewis and Buckingham equations. The design optimization considers module and face width variations, prioritizing structural rigidity and lightness for durability and smooth operation. Results confirm the selected material's suitability, meeting strength and dynamic requirements.

Ahmed Ansari, Ravi Shanker Kumar et.al.,[35] This innovative project successfully designs and fabricates a reverse gearbox for go-kart vehicles, enhancing racing efficiency and safety. The mechanism allows drivers to effortlessly switch to reverse gear, saving time and minimizing reliance on marshals. Beyond racing, this technology has potential applications in vehicles for handicapped individuals, addressing mobility concerns. The authors' thoughtful design considers critical factors such as gear design, material selection, and oil leakage

prevention. The reverse gearbox's adaptability to existing mechanisms makes it a practical solution. Overall, this study demonstrates a well-executed project with significant implications for automotive convenience, safety, and accessibility.

A V Hari Babu, B V Amaranatha Reddy, P Naresh et.al.,[36] This project successfully demonstrates the redesign and fabrication of a 3-wheeler commercial auto's gearbox cover, focusing on reducing stress concentration due to internal pressures. Utilizing Pro-E for modeling and SolidWorks (COSMOS) for analysis, the study identifies bolt locations as high-stress areas. Three methods - design modification, material change, and combined design and material modification - are evaluated. The latter yields the most significant stress reduction. The optimal solution, a 120mm radius design with 6063-O material, achieves a 23.6 MPa stress concentration, balancing weight and cost considerations. The research showcases a systematic approach to mitigating stress concentration, providing valuable insights for automotive engineers. The methodology and findings are well-presented, making this study a notable contribution to the field.

Dhairyasheel N. Powar, Sanjaykumar S. Gawade et.al.,[37] This comprehensive study investigates tooth failures in a worm gear assembly used in a milk processing industry's crate washer setup, identifying excessive wear and bending fatigue as primary failure modes. The research employs both theoretical (Lewis equation) and experimental (photo stress method) analyses to evaluate the existing design's limitations.

Sumair Sunny, Sunny Pawar et.al.,[38] This study successfully investigates replacing conventional gearbox transmission systems with Hydrostatic Transmission (HST) systems in off-road vehicles. Utilizing a buggy as a test vehicle, the authors compare performance between HST and gearbox transmissions. The methodology ensures fairness through consistent engine, wheelbase, and weight parameters. Performance analysis focuses on velocity, acceleration, and gradeability. Results show HST performance closely matches gearbox transmission. While HST gradeability lags, its haulage capacity compensates. Simulink modeling confirms HST performance stability under varying loads. The study's rigorous approach, employing SolidWorks, Altair Hypermesh, Microsoft Excel, and MATLAB SIMULINK, validates design calculations.

Jerzy Walentynowicz, Grzegorz Trawi ski et.al.,[39] This study presents a comprehensive methodology for inspecting and testing the main transmission gearboxes of multi-axle armored vehicles, specifically the ROSOMAK, under operating conditions. The researchers designed a test bench to simulate real-world loads, utilizing an internal combustion engine and reducer to replicate torque and speed conditions. Vibration measurements were taken at various points on the gearbox housing using different sensor attachment methods, and temperature measurements were conducted using thermocouples and thermovision.

Jiri Tuma et.al.,[40] This comprehensive review article explores practical techniques for reducing truck gearbox noise, emphasizing gear design improvement over enclosure-based solutions. The author highlights the effectiveness of analytical and numerical methods, including time and frequency domain approaches, for signal processing and diagnostics.

CONCLUSION

This Paper Concludes that A 5-speed gearbox mechanism is a widely used transmission system in vehicles, providing multiple gear ratios to optimize the balance between engine performance and fuel efficiency across various driving conditions. The key conclusions about a 5-speed gearbox mechanism. Offers a range of gear ratios that cater to different driving needs, from low-speed torque for acceleration to high-speed efficiency for cruising. Improves fuel economy by allowing the engine to operate at its most efficient RPM for a given speed. Enhances vehicle performance by enabling smoother acceleration and better power delivery.

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