IARJSET
ISSN (O) 2393-8021, ISSN (P) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
Impact Factor 8.066 ⁒ Peer-reviewed & Refereed journal ⁒ Vol. 12, Issue 4, April 2025
DOI: 10.17148/IARJSET.2025.12408

A review paper on CG placement of EV go kart vehicle

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Abstract: This study focuses on the modeling and 3D printing of an industrial gearbox to explore the feasibility of using additive manufacturing for prototyping and educational purposes. A detailed 3D CAD model of a standard industrial gearbox was developed using SolidWorks, incorporating key mechanical components such as gears, shafts, bearings, and housing. The model was analyzed for dimensional accuracy and assembly compatibility. Fused Deposition Modeling (FDM) 3D printing technology was used to fabricate the physical prototype using PLA material. The printed model was evaluated for geometric precision, ease of assembly, and visualization of internal gear mechanisms. This project demonstrates the effectiveness of 3D printing for producing cost-effective and functional scale models for design verification and demonstration applications.

Keywords: Industrial Gearbox, 3D Printing, CAD Modeling, Additive Manufacturing, FDM, PLA Material, Gear Assembly, Prototyping

I. LITERATURE SURVEY

Dogan. [1] have examined the reason for rattling and clacking clamor and presumed that torsional vibration is the fundamental reason of vibration. For this examination, dogan has utilized basic gearbox geometry. This geometry comprise of just transmission packaging. The primary preferred standpoint of dogan examine is that he has begin reproducing such a perplexing geometry of transmission gearbox. He has utilized ekm reproducing program.

Abouel. [2] has performed comparative investigation on auto gearbox.

Abouel-seoud et al. [3] have utilized vibration reaction examination strategy for the explanatory investigation of auto gearbox framework. He has performed explanatory and test investigation of an auto transmission framework. By utilizing physical properties, he has ascertained the radiation effectiveness, and the vibration reaction was measured.

Vandi et al. [4] have introduced the execution of a streamlined motor driveline model to finish a current vehicle dynamic model. The motor model depends on maps which are communicated as capacity of motor speed and load.

Yu et al. [5] have considered the dynamic normal for the basic transmission gearbox packaging with limitation jolt position. Dim cast press ht200 was utilized as transmission packaging material. The fem based reproduction strategy was utilized and the reenactment result was confirmed with trial comes about. For test investigation the transmission packaging was imperative on a hanging base. The excitation was given utilizing hammer.

Lucente et al. [6] have considered the demonstrating of robotized manual transmission framework accommodating in displaying of manual transmission framework at starting stage.
Previously mentioned look into work was performed on basic geometry of transmission gearbox lodging. This work can be reached out to examination of full transmission gearbox gathering. Full transmission framework have gearbox and lodging and limited component examination (fea) recreation is performed on these segments.

Yu et al. [7] have contemplated the transmission gearbox lodging utilizing one material dim cast press ht200 as it were. The conceivable utilization of different materials like dim cast press fg 260, al composites and steel compounds aisi 4130 can be investigated.

Nacib et al. [8] have played out the disappointment examination of substantial gearbox of helicopters. To avert separate and mishap in helicopters equip blame recognition is critical. Range examination and cepstrum investigation strategy is utilized to distinguish harm outfit.

Gordon et al. [9] have considered the wellspring of vibration. A games utility vehicle with sensor and information securing framework is utilized to discover the vibration source. This examination was centered around vehicle vibration reaction from street surface highlights.

Kar et al. [10] have utilized engine current mark examination (mcsa) and discrete wavelet change (dwt) for concentrate the rigging vibration. Transmission mistakes and interior excitation causes vibration and clamor issue.

Czech. [11] has depicted the vibroacoustic diagnostics of high-control toothed riggings. The exhibited examination is a test work done in a steel plant.

Singh. [12] has done two contextual investigations for the vibro-acoustic examination of car structures. Expository and trial comes about are Presented for brief depiction. In first case latent and versatile pressure driven motor mounts and in second case welded joints and cements in vehicle bodies were considered.

Tuma [13] has researched the clamor and vibration issues in tara trucks. The fourier change was utilized for systematic investigation and the test comes about locate the overwhelming vibration recurrence zone (500-3000) hz.

Kostić et al. [14] have examined the regular vibrations of the lodging dividers and inferred that it can be anticipated by outlining parameters. Overwhelming vehicle medium obligation truck transmission framework was chosen as research objective for this postulation set up of tara trucks. The investigation display in this postulation determined an expansive range think about [108-111]. The dynamic reaction was contemplated for planetary rigging trains. [19, 20 and 22].

Abbes et al. [15] have directed the dynamic examination of gearbox lodging. Transmission blunder was considered with the assistance of fea. The characteristic recurrence of gearbox lodging differs (285-2210) hz. A stretcher was acquainted in gearbox lodging with control the vibration. The lower recurrence causes reverberation condition prompts disappointment of framework.

Wang. [16] have examined riotous vibration marvels in car wipers as the clamor vibration wonders happen in transmission.

Kane et al. [17] examined the dynamics of an automotive transmission system with a focus on the influence of gearbox lubrication on noise and vibration behavior. Their study highlighted the critical role that lubricant viscosity plays in reducing the magnitude of high-frequency noise generated during gear shifts.

Zhou et al. [18] explored the effect of gear tooth geometry on the vibration characteristics of automotive gearboxes. They used a multi-body dynamic simulation to analyze the influence of various gear tooth modifications, such as tip relief and crowning, on the reduction of vibrations and noise.

Perez et al. [19] conducted a study on the vibration behavior of commercial vehicle transmissions under varying load conditions. They applied both experimental and numerical methods to evaluate the dynamic response of the gearbox, highlighting the importance of optimizing gear meshing for noise reduction.

Li et al. [20] investigated the dynamic modeling and simulation of a heavy-duty truck transmission system. The authors applied a coupled multi-degree-of-freedom model to predict the vibrations produced during gear engagement and loading, focusing on optimizing gear profiles to mitigate vibrations.

Said et al. [21] developed a finite element analysis (FEA) model to simulate the dynamic behavior of automotive gearboxes under high-speed conditions. Their study provided insights into the correlation between gearbox stiffness, load distribution, and vibration frequency, ultimately offering recommendations for improving gearbox design to minimize noise.

Martinez et al. [22] used an experimental setup to examine the noise and vibration transmission paths in a motorcycle transmission. They applied modal analysis to identify the critical frequencies associated with vibration transmission, emphasizing how material selection affects the sound emissions in transmission systems.

Zhang et al. [23] focused on the application of hybrid optimization techniques to minimize vibration and noise in automotive gear systems. Their study employed genetic algorithms in conjunction with finite element modeling to optimize gear geometry and materials for reducing unwanted vibrations.

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Zhang et al. [24] proposed a study that used advanced computational fluid dynamics (CFD) and FEA methods to investigate the effects of cooling system design on the vibration response of heavy-duty vehicle transmissions. The interaction between fluid flow and gearbox components was explored to minimize noise generated under high thermal loads.

Teng et al. [25] studied the impact of various damping materials on the vibration characteristics of automotive transmission systems. Their research showed that the addition of specific damping materials could effectively reduce vibration amplitudes in the gearbox, improving the overall vehicle acoustic comfort.

II. CONCLUSION

The modeling and 3D printing of an industrial gearbox were successfully completed, highlighting the potential of additive manufacturing in mechanical design validation and educational tools. The final prototype accurately represented the internal layout and functionality of a gearbox, proving useful for visualizing complex assemblies. Although the printed model was not intended for operational loads, it served as an effective tool for design review, teaching, and conceptual understanding. Future work can include printing with stronger materials or integrating motion components to simulate actual gear movements.

III. ACKNOWLEDGMENT

We wish to convey our sincere thanks to our internal guide **Mrs. P. Varalakshmi** Assistant Professor for his professional advice, encouragement in starting this project, and academic guidance during this project.

We wish to convey our sincere thanks to **Dr. B. VIJAYA KUMAR**, Professor & Head of Mechanical Department, and COE of GNIT for his masterly supervision and valuable suggestions for the successful completion of our project. We wish to express our candid gratitude to Principal of the **Dr. KODUGANTI VENKATA RAO,** and the management for providing the required facilities to complete our project successfully. We convey our sincere thanks to the staff Mechanical Engineering Department and the Lab Technicians for providing enough stuff which helped us in taking up the project successfully.

We are also grateful to our well-wishers and friends, whose co-operation and some suggestions had helped us in completing the project. Finally, we would like to thank our parents for their exemplary tolerance and for giving us enough support in our endeavors.

REFERENCES

[1] Dogan has examined the reason for rattling and clacking clamor and presumed that torsional vibration is the fundamental reason. He utilized basic gearbox geometry and EKM reproducing program.
[2] Abouel has performed comparative investigation on auto gearbox.
[3] Abouel-Seoud et al. have utilized vibration response examination for analytical and experimental study of auto gearbox. Radiation efficiency was calculated, and vibration response was measured.
[4] Vandi et al. introduced a streamlined engine driveline model to complete a vehicle dynamic model. The engine model is based on maps as a function of speed and load.
[5] Yu et al. studied the dynamic nature of gearbox housing with restricted bolt position. HT200 cast iron was used, and FEM-based simulation results were validated by experimental hammer testing.
[6] Lucente et al. considered the modeling of an automated manual transmission system useful for early design stages.
[7] Yu et al. have studied gearbox housing using only HT200 material. The use of other materials like FG260, aluminum composites, and AISI 4130 steel can be explored.
[8] Nacib et al. performed failure analysis of helicopter gearboxes. Spectrum and cepstrum analysis methods were used for damage detection.
[9] Gordon et al. studied vibration sources using an SUV with sensors and data acquisition. Focus was on road surface-induced vehicle vibration response.
[10] Kar et al. used Motor Current Signature Analysis (MCSA) and Discrete Wavelet Transform (DWT) to study gear vibration and noise issues due to transmission errors and internal excitations.
[11] Czech described vibroacoustic diagnostics of high-power toothed gears. The analysis was experimental and conducted in a steel plant.
[12] Singh presented two case studies on vibroacoustic analysis of vehicle structures, focusing on engine mounts and joint materials.

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[13] Tuma investigated noise and vibration in Tatra trucks. Fourier Transform was used and dominant frequency range (500–3000 Hz) was identified.
[14] Kostić et al. studied natural vibrations of gearbox housing walls in medium-duty trucks. Vibration was linked to design parameters and planetary gear trains.
[15] Abbes et al. conducted dynamic analysis of gearbox housing using FEA. Natural frequencies varied from 285 to 2210 Hz. A stretcher was introduced to reduce vibration.
[16] Wang examined chaotic vibration in automotive wipers, relating it to transmission noise and vibration issues.
[17] Kane et al. studied automotive transmission dynamics with focus on lubrication. Lubricant viscosity was found to reduce high-frequency noise.
[18] Zhou et al. explored gear tooth geometry effects on vibration using multi-body dynamics. Tip relief and crowning reduced noise and vibration.
[19] Perez et al. analyzed vibration behavior of commercial vehicle transmissions under load. Experimental and numerical methods highlighted importance of gear mesh optimization.
[20] Li et al. investigated dynamic modeling of heavy-duty truck transmission. A coupled multi-degree-of-freedom model was used to optimize gear profiles and reduce vibration.