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# Reduce the Frequency Amplitude and Road Condition Implement on Vehicle Chassis

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**ABSTRACT:** The chassis stands as a crucial and integral component within the framework of a vehicle. The primary objective of this undertaking revolves around conducting static structural analysis as well as harmonic analysis to explore the fundamental characteristics of a truck chassis. In the realm of stationary response, the focus is on identifying the location of failure zones and areas with high stress concentrations. Simultaneously, this analysis aims to determine the extent of deformation experienced by the truck chassis. For a comprehensive understanding of the dynamic response of the truck chassis, factors such as natural frequencies and mode shapes are meticulously planned through the utilization of the Finite Element Analysis (FEA) technique. The ensuing numerical analysis is then devised to validate the results obtained from the FEA models. To enhance the design and performance of the chassis, strategic modifications are envisaged. This involves the incorporation of a tuned mass damper to optimize the vibrations associated with the truck chassis and, in turn, mitigate the likelihood of failure. The ultimate objective is to curtail the frequency amplitude, particularly under favorable road conditions. Through these interventions, the goal is to achieve a chassis design that not only meets structural integrity requirements but also minimizes vibrations and enhances overall performance on the road.

**KEYWORDS:** Truck Chassis, Lader Frame, Stress, Strain, Deformation, Finite Element Analysis, CATIA, ANSYS. Structural Strength design, Structural interaction with fluid runs, Analysis of shock (underwater & in materials), Mass diffusion, Buckling problems, Dynamic analyses, Electromagnetic evaluations, Metal forming, Coupled analyses

## I. INTRODUCTION

The truck chassis serves as a foundational structure for business vehicles, enduring significant loads and forces. Dynamic analysis is crucial to prevent resonance and structural failure during operation, minimizing vibration and noise issues. The chassis typically consists of longitudinal and cross members, with an upswept frame to accommodate axle movement and maintain low height. The front overhang extends beyond the front axle, while the rear overhang extends past the rear axle. Commercial vehicles often employ framed construction for higher ground clearance and steering flexibility. The engine, clutch, and transmission form a rigid assembly mounted at the front end of the frame, isolated from shocks and vibrations by rubber blocks. Various cross-sections, such as channel and square box sections, provide bending stiffness for side members, often joined by riveting or lap welding for heavy-duty applications.

## II. RELATED WORK

M. Ravi Chandra et al says here existing TATA 2515EX vehicle is taken for displaying and examination of an overwhelming vehicle body. The three different composite substantial vehicle skeleton structure have been displayed for three diverse cross-areas. For example, C, I and Box type cross areas And likewise with regards to different composite materials named as Carbon/Epoxy, Eglass/Epoxy and S-glass/Epoxy. After experienced examination with the assistance of ANSYS 12.0 they found that whole outcomes said as polymeric composite substantial vehicle undercarriage of I area for a similar burden conveying limit a decrease in weight of 73%~80%, common recurrence of PCHVC overwhelming vehicle case are 32%~54% higher than substantial vehicle steel body and 66~78% stiffer than the substantial vehicle steel skeleton.

### III. METHODOLOGY

The finite element method is a numerical technique for solving engineering problems. It is a powerful analysis tool used to solve simple as well as complicated problems. 1. Create 3D CAD model: The 3D modelling of the chassis is done using CATIA V5 software and saved in a IGES format. 2. Importing: Import the CAD geometry to the FEA package ANSYS 19.0 3. Material properties: The material properties are defined in the FEA package.

	UNITS	AISI 4130	ASTM A710	AISI 317
E	G.Pa	205	210	193
Poission raio		0.29	0.29	0.27
Density	Kg/m3	7850	7850	7890

Meshing: In this operation the CAD geometry is divided into large number of small pieces called mesh. The auto generate mesh feature of ANSYS 19.0 is used in this research due to the limited resources at the disposal of the researcher. Defining boundary conditions: The loads are applied and the position of the load is defined. The constraints and the supports provided are used as input. Solve: The FEA package ANSYS 19.0 solves the model with the given mesh and loads for static, dynamic and harmonic analysis. Post processing: The reviewing of the results and the solutions are carried out in ANSYS 19.0 itself. The results are viewed in various formats such as graph, values and animations.

#### CATIA MODEL

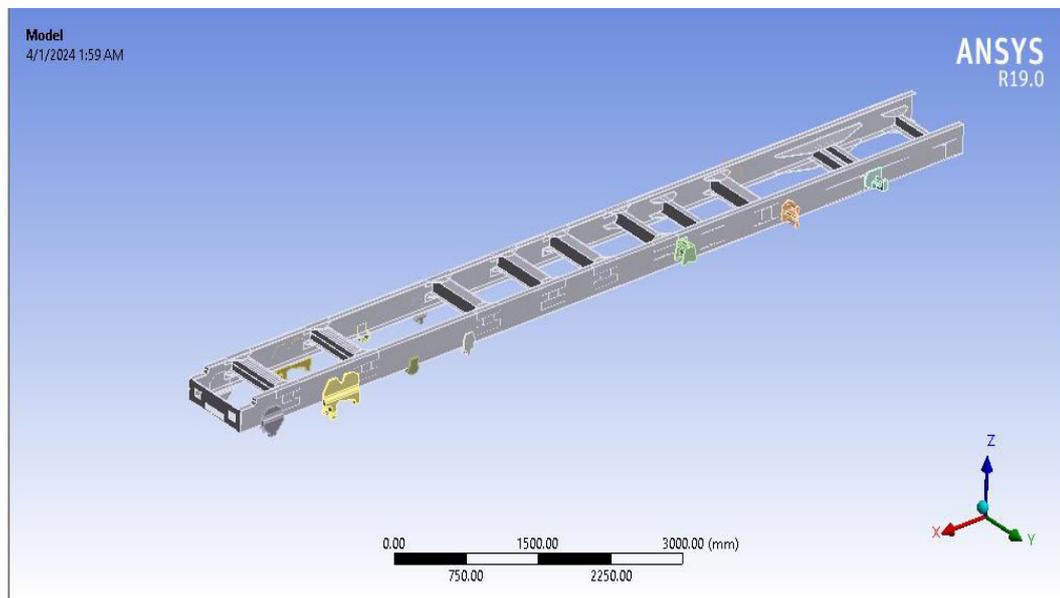


Fig1: Ladder Chassis

IV. EXPERIMENTAL RESULT

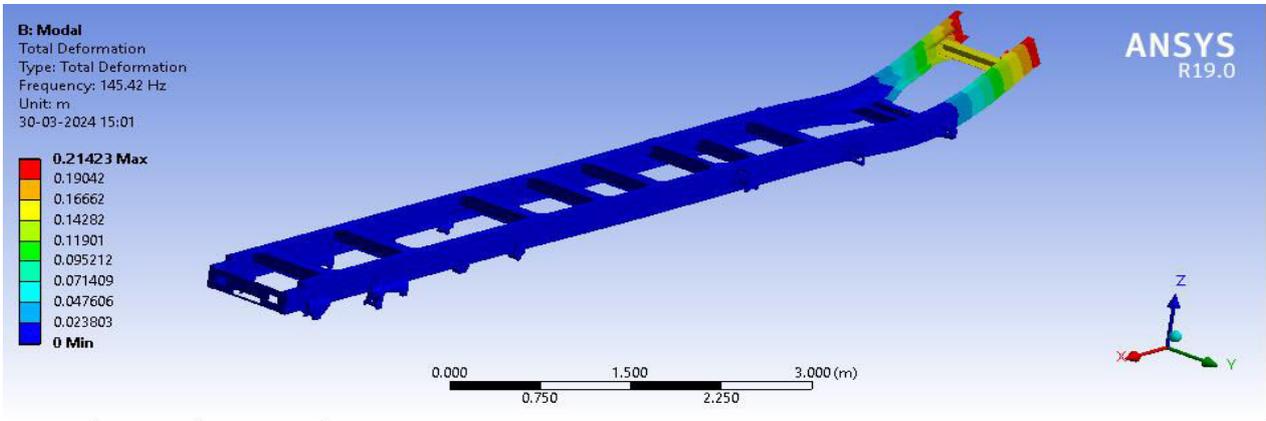


Fig 2 : mode 1 natural frequency 145.4 Hz

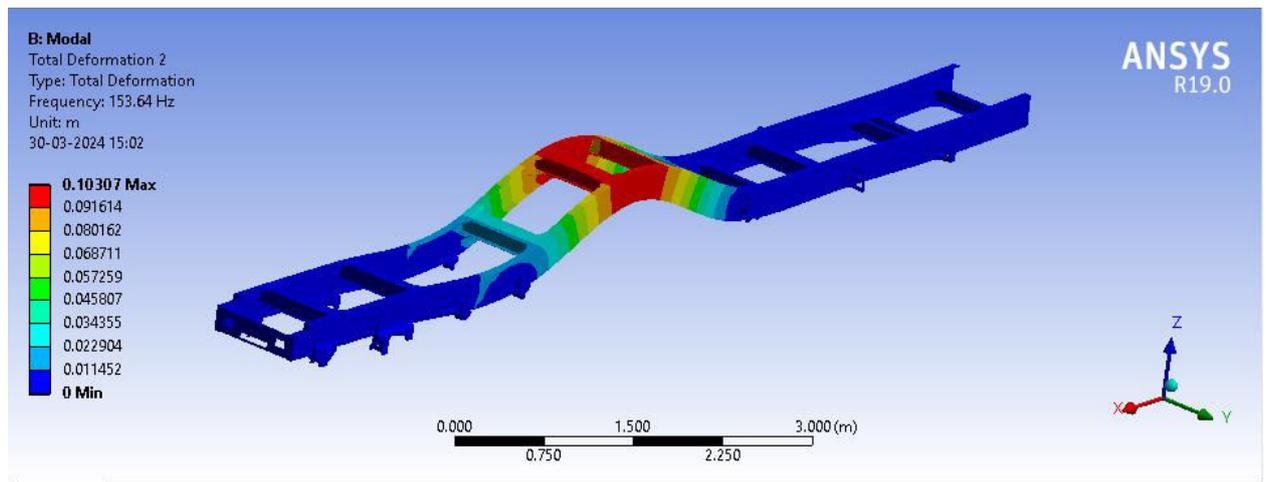


Fig 3: Mode2 natural frequency 153.64Hz

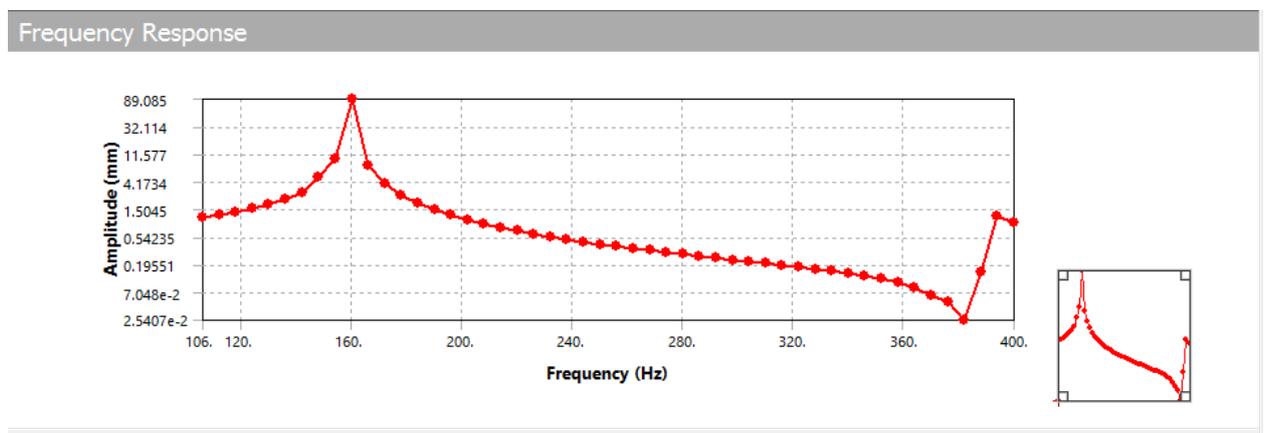


Fig 4: harmonic analysis of chassis

### V. SINGLE TUNED MASS DAMPER

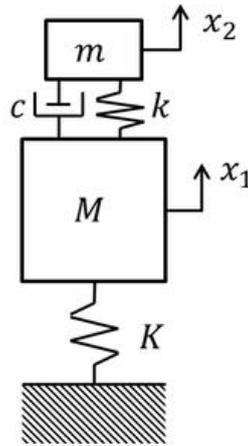


Fig 4: single tuned mass damper

A single tuned mass damper reduces mechanical vibrations in systems to prevent damage. It matches its natural frequency to the excitation frequency, stabilizing displacements caused by harmonic vibrations.

### VI. TUNED MASS DAMPER DESIGN

Mass of truck Chassis = 0.85 tones.

Adding mass for tune mass damper is 3 % of total mass of chassis.

Adding mass=0.03 X 0.85=25.5 Kg

First natural frequency of chassis is noted as 160 Hz, according this stiffness is calculated using below.

$$f_n = \frac{1}{2\pi} \sqrt{\frac{K}{Mt}}$$

Stiffness K is calculated as 25715.099 N/m

### VII. DESIGN MODIFICATION OF CHASSIS

The tuned mass damper, combining spring and damper systems, reduces mechanical vibrations. Identified through modal analysis at 160Hz, high chassis amplitude necessitates its use. Widely applied in mechanical and civil engineering, TMDs consist of mass, spring, and dashpot components for vibration control. They vary in size and configurations like pendulum or liquid dampers are also used for mitigation.

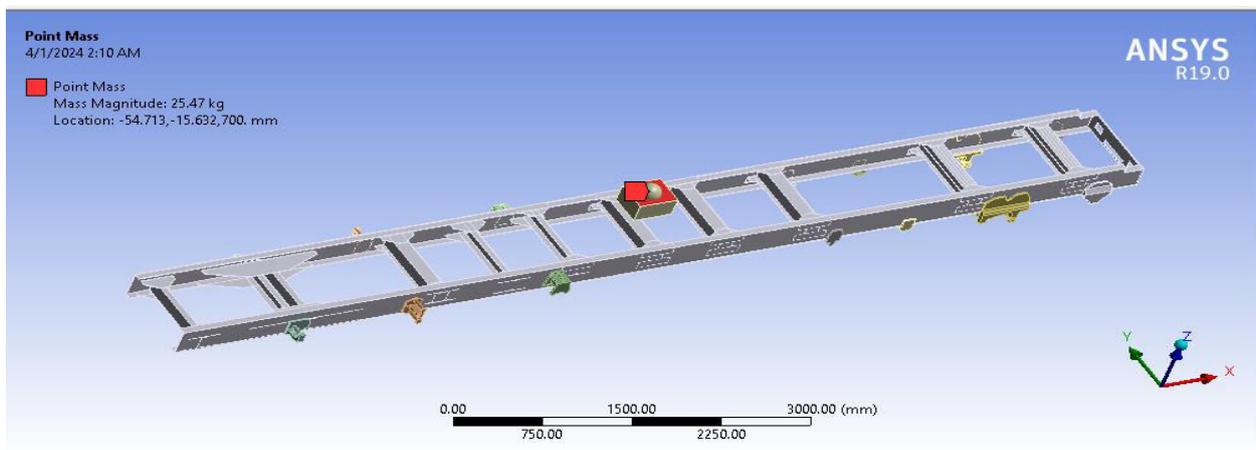
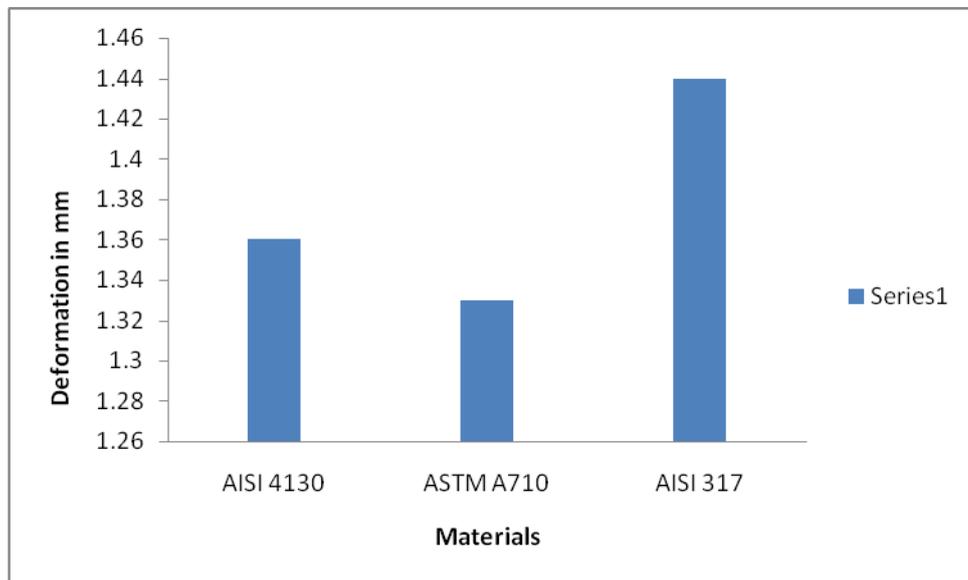


Fig 5: Design modification of chassis

VIII. FINAL RESULTS

		AISI 4130	ASTM A710	AISI 317
deformation	mm	1.36	1.33	1.44
stress	M.Pa	225.06	225.06	227.3
Strain		0.0016	0.00164	0.0018

Table-2 results of the static analysis



GRAPH :Deformation for different Materials

	Mode	<input checked="" type="checkbox"/> Frequency [Hz]
1	1.	145.42
2	2.	153.64
3	3.	206.38
4	4.	218.83
5	5.	225.95
6	6.	353.87

Table-3 results of the modal analysis

IX. CONCLUSION

In this work numerical analysis is conducted on the vehicle framework. Catia v5 version software program is accustomed to create the particular model and it also was brought in into analysis software ANSYS. static, Modal, Harmonic test provides performed on the chassis. Within order to conduct anxiety and vibration analysis in the existing truck chassis, finite element method is used to assess the static in addition to dynamic structural behaviours of truck chassis. The stress/strain distribution and natural frequencies were calculated over the chassis. Maximum tension and

strain levels are usually found in front section regarding chassis, where engine and transmission are installed. in the structural analysis, the chassis has minimum deformation and stresses for A710 materials. And it was selected for optimum materials, based on this modal. Harmonic and tune mass damper analysis are performed. Tune mass damper is helped to reduce the vibration amplitude.

#### REFERENCES

- Hulsey, K. C. <http://www.khulsey.com>
- Suhir, E.; Burke, R. Analysis and Optimization of The Dynamic Response of a Rectangular Plate to a Shock Load Acting On Its Support Contour, With Application To A Portable Electronic Packages. // Proceedings of The 44th Electronic Components and Technology Conference, Washington, 1994, pp. 1037-1049.
- Xue, X.; Schmid, F.; Smith, R. A. Analysis of the structural characteristics of an intermediate rail vehicle and their effect on vehicle crash performance. // Proc. Instn. Mech. Engrs., Part F, Journal of Rail and Rapid Transit, 221, (2007), pp. 339-352.
- Veloso, V.; Magalhães, H. S.; Bicalho, G. I.; Palma, E. S. Failure investigation and stress analysis of a longitudinal stringer of an automobile chassis. // Journal of Engineering Failure Analysis. 16, 5(2009), pp. 1696-1702.
- Liu, Z. S.; Lu, C.; Wang, Y. Y.; Lee, H. P.; Koh, Y. K.; Lee, K. S. Prediction of noise inside tracked vehicles. // Journal of Applied Acoustics. 67, 1(2006), pp. 74-91.
- Muhammadnor, M. A.; Rashid, H.; Faizul, W. M. Stress Analysis of a Low Loader Chassis. // Procedia Engineering. 41, (2012), pp. 995-1001.
- Cosme, C.; Ghasemi, A.; Gandevia, J. Application of Computer Aided Engineering in the Design of Heavy-Duty Truck Frames. // SAE Paper 1999-01-3760, International Truck & Bus Meeting & Exposition, Detroit, Michigan, 1999.
- Xu, H. J.; Liu, Y.Q.; Zhong, W. Three Dimensional Finite Element Simulation of Medium Thick Plate Metal Forming and Springback. // Finite Elements in Analysis and Design. 51, (2012), pp. 49-58.
- Taheri-Behrooz, F.; Esmaeel, R. A.; Taheri, F. Response of Perforated Composite Tubes Subjected to Axial Compressive Loading. // Thin-Walled Structures. 50, 1(2011), pp. 174-181. pp. 195-205.
- Sane, S. S.; Jadhav, G.; Anandraj, H. Stress Analysis of Light Commercial Vehicle Chassis by FEM. // Piaggio Vehicle Pte. Ltd pune. Stress Analysis of Heavy Duty Truck Chassis using Finite Element Method, Phil. Trans. Roy. Soc. London, vol. A247, (1955), pp. 529-551.
- Guo, Y. Q.; Chen, W. Q.; Pao, Y. H. Dynamic analysis of space frames: The method of reverberation-ray matrix and the orthogonality of normal modes. // Journal of Sound and Vibration. 317, 3-5(2008), pp. 716-738.
- Kim, V.; Lee, V. Elastic Foundation Effects on the Dynamic Response of Engine Mount Systems. // Proceedings of the Institution of Mechanical Engineers, 214(D), 2000, pp. 43-53.
- Kotari, S.; Gopinath, V. Static and Dynamic Analysis on Tatra Chassis. // International Journal of Modern Engineering Research (IJMER). 2, 1(2002), pp. 086-094.
- Marzbanrad, J.; Alijanpour, M.; Saeidkiasat, M. Design and analysis of an automotive bumper beam in low-speed frontal crashes. // Thin-Walled Structures. 47, (2009), pp. 902-911.
- Rao, S. S. Mechanical Vibration, 4th Edition, Pearson education press, 2004.
- Sani, M. S. M.; Arbain, M. T.; Noor, M. M.; Ming, G. L.; Zohari, M. H.; Nizwan, C. K. E.; Mon, T. T. Stress Analysis and Modal Transient Response of Car Chassis. // International Conference on Advance Mechanical Engineering (ICAME09), Selangor, 2009.
- Lu, Y.; Yang, S.; Li, S.; Chen, L. Numerical and experimental investigation on stochastic dynamic load of a heavy duty vehicle. // Applied Mathematical Modelling. 34, 10(2010), pp. 2698-2710.
- Afkar, A.; Mahmoodi, M.; Paykani, A. Geometry optimization of double wishbone suspension system via genetic algorithm for handling improvement. // Journal of Vibroengineering. 14, 2(2012), p. 827, ISSN 1392-8716.
- Hayashi, S.; Kano, S. Optimization method for mount layout and mount specifications of vehicle sub-frame. // Society of Automotive Engineering of Japan INC. 15, 1(1994), pp. 27-33.
- Massa, F.; Lallemand, B.; Tison, T. Fuzzy multiobjective optimization of mechanical structures. // Computer Methods in Applied Mechanics and Engineering. 198, 5-6(2009), pp. 631-643.
- K. S. S. Gurudatta, V. Harikiran, M. V. D. K. Raju, B. Rama Krishna & I. Jagadeesh // Design and CFD Analysis of Drone thrust with duct



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