NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 3, ISSUE3, MAR.-2016

# A REVIEW OF VIBRATION ANALYSIS OF SCOOTER CHASSIS

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## ABSTRACT

Implemented paper made an effort to review the investigations that have been made on the different analysis technique automobile chassis. That analysis may be, static analysis or dynamic analysis. A number of analytical and experimental techniques are available for the analysis of the automobile chassis. Determination of the different analysis around different conditions in an automobile chassis has been reported in literature. An attempt has been made in the paper to review various techniques developed for the analysis of scooter chassis and results of that analysis can be used for further studies. Therefore the chassis is considered as the most vital component of the any two wheelers as it holds all the parts and components together. The operation of any mechanical system will always results in vibration. Our goal is to minimize the effect of these vibrations, because while it is undesirable, vibration is unavoidable. In this, we are going to model a scooter chassis in CATIA V5R19. Dimensions will be found out through reverse engineering (hand calculation on actual model). Design constraints are listed based on actual working conditions. Further, meshing and analysis is done on HYPERMESH and ANSYS. Optimization is carried out. The dynamic characteristics of scooter chassis such as the natural frequency and mode shape will determine by using finite element (FE) method. Al material will replace the conventional MS material. Chassis will be fabricated based on optimum results. Design will be tested and results are verified with numerical data.

**KEYWORDS:** Vibration Analysis of a Scooter,

## INTRODUCTION

A chassis consists of an internal framework that supports a complete vehicle. It is analogous to an animal's skeleton. Two wheeler chassis is the under part of a motor vehicle, consisting of the frame with the wheels and machinery. In the case of vehicles, the term chassis means the frame plus the running gear like driveshaft, transmission, differential, engine, and suspension. A body, which is usually, does not necessary for integrity of the structure. The complete vehicle is built on the chassis.
A chassis consists of an internal framework that supports a man-made object. It is analogous to an animal's skeleton. An example of a chassis is the under part of a motor vehicle. That mass or weight reduction is an important issue in automotive industry. Chassis is a prominent structure for a moped body, which takes the loads during serious accidents, costly recalls; chassis also has an impact on product image. There is a great potential for optimizing weight of chassis by using alternate material without affecting its structural behavior.

A chassis serves as the basic foundation on which all the parts of a machine rest. In any two wheelers, the chassis acts as a skeleton on which the engine, gearbox, driveshaft, transmission, driveshaft, differential, and suspension are mounted. The chassis should be structurally sound in every way and support the body over the expected life of the two wheeler and may be beyond expected.
The engine generally sits inside the frame, the rear swing arm is attached by a pivot bolt and the front forks are attached to the front of the frame. The chassis also helps to protect the more sensitive parts of the motorcycle in any mishap.

**Chassis several things:**

i. Be structurally sound in every way over the expected life of the vehicle and beyond. This means nothing will ever break under normal conditions.
ii. Maintain the suspension mounting locations so that handling is safe and consistent under high cornering and bump loads.
iii. Support the body panels and other passenger components so that everything feels solid and has a long, reliable life.
iv. Protect the occupants from external intrusion.
v. Help the wheels align on a single straight line.

Different chassis designs have their own strengths and weaknesses. Every chassis is a compromise between component size, weight, vehicle intent, complexity, and ultimate cost. And even within a basic design method, stiffness and strength can vary significantly, depending on the details. There is no well proven method for construction of every two wheeler, because each vehicle presents a different set of problems.
Even though aluminum is the lightest material but it is proven well that it is more flexible compared to steel. In fact, the ratio of stiffness to weight is almost same as that of steel, so an aluminum chassis must weigh the same as a steel one to achieve the same stiffness. Aluminum has an advantage only where there may be very thin sections where buckling is possible.
Chassis design works around three major aspects of the motorcycle, the rider, engine and suspension. The suspension mounting points are fixed in space and are determined by the geometry of the suspension. The engine is a large component in the vehicle with a fixed size, and needs to be located as close to the rear of the vehicle as possible for proper weight distribution. The rider is the largest lumped mass in the vehicle, with special ergonomic requirements for comfort and drivability.
These three items directly govern chassis design and must be accounted for before any subsystem design can begin. A good chassis design encompasses all of these aspects in an efficient way, providing a stable and sound foundation for all vehicle components.

## VIBRATIONS IN MOTORCYCLE

The motorcycle is assumed to run straight on a flat, level road surface at a certain velocity. The rider is thought to be a rigid body fixed to the rear frame, which can exert no control on the motorcycle. For simplicity's sake, the motorcycle is considered to have rigid suspension; from a kinematics point of view it is a spatial system whose motion can be described by means of the following four coordinates:

- The steering angle;
- The roll angle;
- The yaw angle;
- The lateral displacement of the mass centre.

## LITERATURE REVIEW

**Carfagni, Monica. "Virtual Scooter Prototype In The Design For Comfort.". :**An innovative analytical model of a two wheeler for the simulation of a comfort test bench has been developed within this research in order to predict the reaction forces transmitted between the vehicle and the rider in the interface points. This goal has been accomplished by using a FEM modeling of a two wheeler (180cc, 2 strokes) mainframe and its accessories, validated experimentally through a modal eigen values and shapes comparison (MAC). Moreover the multi body system of the rear suspension was developed and its dynamic behavior was validated experimentally (since a test bench was realized).
Each vehicle component has been modeled and validated, reaching high levels of detail of the overall assembly, having considered all the most significant physic phenomena. Following correctly the modeling procedures, developed during this research, for all the scooter components (front and rear suspension, slider-crank mechanism, main frame), it is possible to 'virtually' test the comfort bench, without performing any experimental activity, excepting those strongly needed to define the components' physic parameters (stiffness's, damping, mass and inertia properties), not provided by the OEMs.

**S. Agostoni, A. Barbera, E. Leo, M. Pezzola, M. Vanali, "investigation on motorvehicle structural vibrations Caused by engine unbalances",:** Objective of this paper, is to improve vibration performance of the scooter. An experiment done while carrying out this research is for finding out local vibration modes. Methodology developed will be able to identify the local vibration modes allow to find if/when/how chassis components' resonances are excited. By implementing this method structural modifications have been studied for various type of chassis models. New handlebar innovation multi DOF mass damper vibration results are optimized. In this paper foot plate geometry is been modified for reduction of nodal displacement of footrest beam binding. In this research chassis has been developed with the sole aim of improving rider comfort. And attention is been directly given to handle bar, component related directly to driver.

**Neeraja, C. H., C. R. Sireesha, and D. Jawaharlal. "Structural Analysis of Two Wheeler Suspension Frame." :**The research is been carried out to model a frame using 3D modeling software Pro/Engineer. To validate the strength of a frame, Structural analysis is carried out by applying the wheel forces. The aim of this analysis is been accomplished by finding an ultimate stress limit for the two wheeler chassis. Analysis is been carried out for four different materials alloy steel, magnesium, aluminum alloy A360 and carbon fiber reinforced fiber to understand which material is best for two wheeler chassis. Model analysis is also done to determine different mode shapes for large number of modes. Analysis is done in ANSYS software. By having looked at the results, for different materials and stress values found to be in limit and less than permissible limits confirming to safety of passenger. By comparing the results for four materials, stress obtained is same and displacement is less for carbon fiber reinforced polymer than other three materials. So we conclude that for our design, CFRP is better material for suspension frame.
**Li-rui, Wang, and Yang Xiao-long. "Simulation and Improvement of Vehicle Frame Using FEM.":** To develop and improve the chassis design and optimize a two wheeler particularly scooter frame this research paper is been written. In this paper illustration of modeling and simulation of a developed new type of vehicle frame. While carrying out this research two giant software's used are UG NX6.0 and simulation of the frame was done by

using ANSYS 12.0 based on the results obtained from simulation. In this study component was designed to strengthen the frame based on simulation results design was made final. This paper gives system analysis using ANSYS 12.0 and hyper works for validating the model in static as well as in dynamic conditions keeping safety precautions in mind.
Based on the solutions, new component was designed to strengthen the frame. After improvements stated above, all statistics, including displacement, stress and load distribution are within the specified limit as compared to international standards. The model is appropriate for the two wheeler foray to join the competition.

**Jakub Šmiraus1, Michal Richtář2, "Design of motorcyle active chassis geometry Change system".** Modern motorcycles have a number of electronic systems supporting their driving stability. These are usually adopted solutions used in automobiles. However, the idea of trying to affect the driving stability with the use of up-to-now changeless parameters such as wheelbase or trail is quite new. Such an innovative solution of motorcycle suspension with variable geometry dependent on driving conditions was designed in thesis by Jakub Šmiraus and constructed at the Institute of Transport VŠB - Technical university of Ostrava under tutelage of MSc Michal Richtář.
With the introduction of composite materials and latest aluminum alloys, there come the possibilities of suspension construction with variable values of steering axis angle or wheelbase. The main idea in the construction of the designed suspension is to smoothly change the parameters of the chassis during the drive. This would be done manually by the driver in the first generation and automatically, depending on the optimal chassis setup, in the following one. In the future generations, the whole system could be fully automated, in which case it could collaborate without difficulty with the above mentioned already utilized stability and assistance systems

**Rajput, Yogendra S., et al. "A Vibration Analysis Of Vehicle Frame.":**The present study deals with Importance in the development of off-road racing vehicle for the SAEINDIA's BAJA competition has raised the value of dynamic analysis under severe uneven loading. The dynamic analysis is carried out by the finite element method simulation thereby predicting failure modes of the vehicle frame under vibration analysis. This work investigates the vibration characteristics of the frame including the natural frequencies and mode shapes.
The results developed states that the frame's dynamic behavior caused by change in usage with finite element method using ANSyS. Frequency modes of the frame that determine its dynamic behavior are below100 Hz and vary from 26.156 to 56.254 Hz. For the first two modes, the frame experienced longitudinal vibration on the roof pillars. The vibrations of the vehicle frame include longitudinal, transverse and torsion at different nodal points. The local bending vibration occurs at the top hat cross member where the engine is mounted on it.

**Nissar Ahamed, Brahmananda Reddy.K, "Determination of Fundamental Natural Frequencies of the Motorcycle Chassis".:** Vibration of the motorcycle affects the ride quality and the safety of the parts and passengers. Chassis and the handlebar of the motorcycle play an important role in the vibration of the motorcycle. Hence, as a primary step, the modal analysis of a chassis, handlebar and the assembly of the motorcycle have been studied in this work. The outcome of this analysis is the data obtained regarding the vibration behaviour of the motorcycle chassis, handlebar and the assembly, The modal analysis also identified the region of maximum displacement in the components analyzed. The results pertaining to the natural frequency of vibration of the two wheeler chassis, assembly lie abd handlebar in the valid range of vibration. The modal analysis of the assembly indicates that

maximum displacement takes place at the bottom portions of the chassis, because of this reason there is chances of maximum displacement causing instability of the total assembly.

## CONCLUSION

In this paper the primary features of to collect the literature survey of research work, and referring different books and earlier research works published in reputed journals for the dissertation work from the literature review it is observed that mass or weight reduction is an important issue in automotive industry. Chassis is a prominent structure for a moped body, which takes the loads during serious accidents, costly recalls; chassis also has an impact on product image. There is a great potential for optimizing weight of chassis by using alternate material without affecting its structural behavior. The design and analysis of model, conditions required for applying various constraints and how the loads are to be applied is briefed about in the technical papers referred. From these literature surveys, the properties of various alternate materials like carbon fiber, aluminum alloy, titanium have been studied and been compared with conventional mild steel. Also it is observed that the work has not been carried out for weight optimization of complete chassis, only chassis components weight has been optimized by using software simulations. So, there is scope to optimize the weight of chassis by using alternate material while maintaining its strength and finally suggest the best alternate material for the chassis.

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