A Review on Analysis and Design of Vehicle Chassis and its Materials

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Abstract— In this paper, effect is been made to review few researches made in the earlier years. In general, the chassis is the base frame of a car, motorcycle, carriage or heavy vehicle. In this paper at attempt is made to view the research paper being published earlier on the analysis of chassis, the technique used to analyse it and also to analysis the material used for producing the chassis. A number of analytical and experimental technique are available used for the analysis of the chassis and the material which is used for manufacturing the chassis. In several chassis structure Steel forms are commonly used material for producing chassis but overtime aluminum has acquired its use. Hence, the chassis is considered as the most vital component of the any vehicle as it holds all the parts and components together. Further, meshing and analysis is done on HYPERMESH and ANSYS. There are many factors which are to be consider while designing any chassis like, material selection, strength, stiffness and weight.

Index Terms— Chassis, Automotive Vehicles, Finite Element Analysis.

1 INTRODUCTION

A chassis consists of an internal framework that supports the complete vehicle, and gives a structural support to it. It is similar to an animal's skeleton. In recent few years ON- Road vehicles have changed drastically based on design and several other functional aspects. A chassis serves as the basic foundation which gives strength to the body and on which all the parts of a machine rest. An example of a chassis is the base structure of a car. That mass or weight reduction is an important issue in automotive industry. Chassis is a prominent structure for a body, which takes the loads during serious accidents, costly recalls; chassis too has an great impact on product image. If any failure occurs in chassis it will leads to collapse of whole vehicle system which cannot be replaced easily. The chassis structure must safely support the weight of the vehicle components and transmit loads that result from longitudinal, lateral and vertical accelerations that are experienced in racing environment without failure.

Functions of Chassis

- To carry load of the goods carried in the body.
- To withstand the forces caused due to the sudden braking or acceleration.
- To withstand the stresses caused due to the bad road condition.

2 LITERATURE REVIEW:

C. H. Neeraja a C. R. Sireesha and D. Jawaharlal [1] have carried out the research on modelled suspension frame for the two-wheelers. Modelling had being done on a 3D modeling software Pro/Engineer. To study the strength of a frame, structural analysis is carried out by applying the wheel forces. The aim of this analysis had being accomplished by finding an ultimate stress limit for the two-wheeler chassis. The analysis was carried out for four different materials, call as, alloy steel, magnesium, aluminum alloy A360 and carbon fiber reinforced fiber to understand which material is best for two-wheeler chassis and can deliver a very good strength. Analysis is done on the 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.

Table 1: For Alloy Steel

	Results	Permissable
Displacement	$0.297e^{-3}$	
Vonmises stress	2.383	325
	Frequency	Displacement
Mode 01	0.024473	0.922 e-3
Mode 02	0.025756	0.001876
Mode 03	0.026079	0.001991
Mode 04	0.02613	0.925 e-3
Mode 05	0.032796	0.004175

Table 2: For Magnesium alloy

	Results	Permissable
Displacement	$0.848e^{-3}$	
Vonmises stress	5.995	165
	Frequency	Displacement
Mode 01	0.04726	0.00167
Mode 02	0.014729	0.00167
Mode 03	0.021785	0.001547
Mode 04	0.021795	0.001547
Mode 05	0.023324	0.002075

Table 3: For Carbon fiber reinforced polymer

	Results	Permissable
Displacement	0.002413	
Vonmises stress	2.658	83
	Frequency	Displacement
Mode 01	0.01383	0.001667
Mode	0.014074	0.001666
Mode 03	0.014399	0.002029
Mode 04	0.014559	0.002031
Mode 05	0.021519	0.001549

Hence as compared all the four materials be get to see the result and hence, stress obtained is same but the displacement is less for carbon fiber reinforced polymer compared to that of the other three materials. And this paper concludes that for the designing and manufacturing of chassis for the two-wheeler, Carbon fiber reinforced polymer is better material for suspension frame to achieve the required strength.

Fig. 1: Back Bone Frame.

Teo Han Fui, Roslan Abd. Rahman [2], in December 2007, works on the Statics and Dynamics, Structural Analysis of a 4.5 Ton Truck Chassis, he researched and determined the dynamic characteristic of the truck chassis, investigating the mounting locations of components on the truck chassis and observed the response of the truck chassis under static loading conditions. He found that the local bending vibration in the chassis of the truck occurs at the top hat cross member where the gearbox is mounted. And the mounting location of the engine and transmission system is about the symmetrical axis of the chassis first torsion mode where the effect of the first mode is less comparatively. However, the mounting of the suspension system on the truck chassis is slightly away from the nodal point of the first vertical bending mode of chassis. And found that this could help in sustaining the static loading on the truck chassis. For the linear static analysis, the stress distribution and deformation profile of the truck chassis subjected to two loading conditions: truck components loading and asymmetrical loading had been determined. It is also studied that due to the loading on the chassis, the maximum stress and deflection occurs at the mounted brackets joined of the suspension system and the maximum translation occurs where the symmetry and asymmetry load acts on the chassis studied. The result of the analysis and the research in this paper shows that the maximum stress occurring of the truck chassis is studied to be 490 Megapascals and the maximum translation to be 33.6 mm. These values are acceptable as compared to the yield strength of the chassis material and the tolerance allowed for the chassis.

S. Agostoni, A. Barbera, E. Leo, M. Pezzola, M. Vanali[3], he had worked to improve vibration performance of the scooter by 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.

FA Conle investigated the fatigue life of Volvo S80 Bi-Fuel using MSC/Fatigue Conle and Chu [4], the research is being done in this paper in the field of fatigue analysis and the local stress –strain approach in the complex vehicular structures. The paper concludes that the damage assessment should be flexible hence to handle several multiaxial fatigue damage criteria. And also a plasticity correction method of multiaxial neuber type should be used to translate the elastic local stress which can eliminate for the plastic stress-strain behavior. A critical plane search for the most damaging direction is necessary.

Abhishek Sharma, Pramod Kumar, Abdul Jabbar and Mohammad Mamoon Khan(2014)[5], have designed the heavy vehicle chassis and analyzed with the help of ANSYS-15.0. The TATA LPS EX chassis is used in the research for the structural analysis of the heavy vehicle chassis with three different alloys subjected having the same conditions of the steel chassis. Three-material used in this paper for the analysis of the chassis are grey cast iron, AISI 4130 alloy steel and ASTM A710 STEEL GRADE A (CLASS III). There are different shapes of the cross sections that were used for their work which are C, I and Box type cross sections. A three-dimensional solid Model was built in the CATIA V5 parametric. The result shows that AISI 4130 steel alloy shows better performance and lighter than all of the other metal alloys with providing strength as well.

Jakub Šmiraus1, Michal Richtář2, "Design of motorcycle active chassis geometry Change system"[6],he studied on the designing of the motorcycle and concluded that the system with steering geometry changes might be a pioneering idea in construction of the 21st century motorcycle chassis. The trail adjustment along with changes in wheelbase and ground clearance of the bike open up many options in the field of negative effects regulation resulting from the dynamic characteris-

tics of motorcycle motion. Such a solution for motorcycle suspension with variable geometry dependent on driving conditions was designed in the thesis by Jakub Šmiraus and constructed at the Institute of Transport VŠB - Technical university of Ostrava under tutelage of MSc Michal Richtář. 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.

In June 2012 Haval Kamal Asker1, ThakerSalih Dawood1and Arkan Fawzi [7], had made research and worked on the Stress Analysis of a Standard Truck Chassis during ramping on block using finite element method and he focused on the intensity and the strength of the frame play a big role in the truck's design. He had been studing and analyzing using the Ansys package software. Also, vibration modes and the deflection in the members of the chassis have been analyzed during the loading conditions. And analysis is being done for a specific material in this paper as given below.

Table:1 Properties of truck chassis material used.

Modulus elasticity E (Pa)	**207 * 109**
Density ρ (kg/m3)	7800
Poisson ratio	0.3
Yield strength (MPa)	550
Tensile strength (MPa)	620

As the material has the proper density as compared to another material, for manufacturing of chassis and frame, and it was the best suited for the process of manufacturing. As a result, in this paper it is confirmed that the analysis made can be used to predict the bending and torsion stresses of frames when a vehicle ramp a block.

Capitalize all the words in a paper title. For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [7].

4 Conclusion

In the review most of cases are under study-

- It is observed that most of the existing researchers utilized common FEA package ANSYS, while very less used packages are ABAQUS, NASTRAN, HYPERVIEW.
- 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.
- After a careful analysis of various research studies conducted so far it has been found that sufficient studies have not been conducted on variable section concept and trailer chassis.
- To predict life of a chassis there is need to research for the base material for the load variation and impacting static as well as in dynamic.
- In order to fulfill the gap, future research studies and analysis should be conducted on variable section chassis and trailer chassis concept and also the material to be used in automobile.

References

[1] CH.Neeraja, C.R.Sireesha and D. Jawaharlal, "Structural Analysis of Two Wheeler Suspension Frame",International Journal of Engineering Research&Technology,Vol.1 Issue 6,August -2012.

[2] Teo Han Fui, Roslan Abd. Rahman, Faculty of Mechanical Engineering, University Teknologi Malaysia, "Statics and Dynamics Structural Analysis of a 4.5 Ton Truck Chassis"December,2007

[3] S. Agostoni, A. Barbera, E. Leo, M. Pezzola, M. Vanali, "investigation on motorvehicle structural vibrations Caused by engine unbalances",Proceedings of the SEM Annual Conference June 1-4, 2009 Albuquerque New Mexico USA

[4] Conle, F.A. and Chu, C.C., 1997, "Fatigue Analysis andthe Local Stress-strain Approach in Complex VehicularStructures",International Journal of Fatigue.

[5] Abhishek Sharma, Pramod Kumar, Abdul Jabbar and Mohammad Mamoon Khan, "Structural Analysis of a Heavy Vehicle Chassis Made of Different Alloys by Different Cross Sections", International Journal of Engineering Research & Technology (IJERT), Vol. 3 Issue 6, June – 2014, pp.1778-1785.

[6] Jakub Šmiraus1, Michal Richtář2, "Design of motorcyle active chassis geometry Change system".Number 5, Volume VI, December 2011.

[7] Haval Kamal Asker1 And Arkan Fawzi, "Stress Analysis Of Standard Truck Chassis During Ramping On Block Using Finite Element Method", JUNE 2012.