Review on Structural Analysis of Suspension Pin used in Automobile Chassis

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Abstract— Suspension pin is a component for chassis of commercial vehicle used for shifting fork mounting. The current work studies the various researches conducted in optimizing design and material of automobile chassis using numerical and experimental techniques. The study also includes manufacturing process involved, stresses and application of FEA software in analysis of automobile chassis.

Keywords: Automobile Chassis, Structural Analysis, Design Optimization

I. Introduction

The proposition of the chassis of the car is to maintain the shape of the vehicle and to support the various loads which are applied to it. The structure usually accounts for a large part of the development and production costs of the new vehicle program and many different structural concepts are available to the designer. Choosing the best is essential to guarantee acceptable structural performance under other design constraints such as cost, volume and production method, product application and many more.

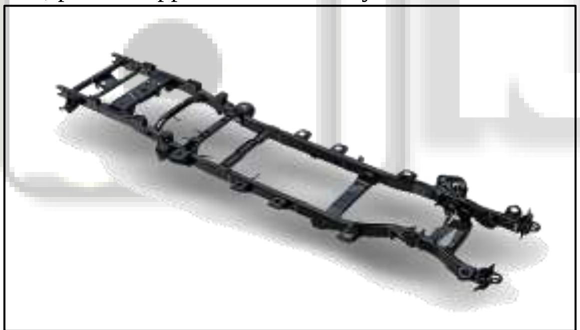

Fig. 1: A ladder chassis frame

II. Literature review

Madan Mohan Reddy and Lakshmi Kanta Reddy (2014) [1] studied the modeling and analysis of the container frame using the FEM to improve load capacity and reduce frame failure with bending by adding stiffeners. The rectangular stiffeners is positioned between the crosspieces and fixed to the chassis by bolts. The results of the Ansys-14 analysis show that there is a reduction in the von miss stress in the chassis with stiffening up to 37.11% compared to without stiffening, while the intensity of the stress is reduced to 36.23% and the reduction reduced by 36.16%.

Bhat KA, Untawale SP, Katore HV (2014) [2] has redesigned the tractor chassis. The existing trolley frame uses a "C" cross section and the material used is mild steel. The total capacity of the trolley is 60KN, but the dead weight of the trolley and other accessories is 13 KN. The redesign is carried out by changing the cross section from "C" to "I" without changing the material and dimensions. Modifying the section resulted in safer strains than the previous section and a weight reduction of 31.79 kg, which ultimately reduced the cost of the frame.

Ketan Gajanan Nalawade, Ashish Sabu and Baskar P (2014) [3] performed static structural analysis and modal analysis of a TATA 407 truck chassis. Modeling is conducted in CATIA and finite element analysis is performed using the ANSYS seminar. After carrying out the analysis on the ladder frame with structural steel and E-Glass composite, the results obtained show that the maximum shear stress and the equivalent stress generated in the E glass are lower than the acceptable limit and the total deformation is also within the limit. It also shows that for the same load capacity, E glass is more suitable than steel and can therefore reduce weight from 60 to 68% and increase rigidity.

Abhishek Sharma, Pramod Kumar, Abdul Jabbar and Mohammad Mamoon Khan (2014) [4], designed the chassis of heavy vehicles and analyzed using ANSYS-15.0. The size of the TATA LPS 2515 EX chassis is used for the structural analysis of the chassis of heavy vehicles with three different alloys subject to the same conditions as the steel chassis. The three materials used for the frame are gray cast iron, AISI 4130 alloy steel and ASTM A710 STEEL GRADE A (CLASS III). There are different forms of sections used in this work, for example type C, I and Box sections. A solid three-dimensional model was built in the parametric model CATIA V5. The results show that the steel alloy AISI 4130 exhibits better and lighter performance than all the other metal alloys also offering resistance. The analysis of several cross sections shows that the section of the box channel is the best in terms of resistance with less deformation, but the weight of the frame is high compared to other cross sections, while the frame in section C is suitable for heavy trucks.

Swami K.I. and Tuljapure S.B. (2014) [5] studied static structural analysis of the truck chassis using the ANSYS software. Here, the frame of the Eicher 20.16 is of the ladder frame type that has two beams or beams of cross section in C and seven beams called beams of cross section in C. The results of the graph show that as and As the thickness increases of the lateral element, initially there is a slight decrease in the maximum value of the von miss stress, but then it starts to increase. Speed decreases just before the end and increases again at the end.

The structural analysis of the vehicle chassis with constraints of maximum shear stress and deformation of the chassis at maximum load using the Pro-e 4.0 software and the works of Altair Hyper was carried out by Abhishek Singh, Vishal Soni, Aditya Singh (2014) [6]. The vehicle chassis dimensions of a TATA LP 912 Diesel BS4 bus were taken for analysis with materials, i.e. the steel alloy subjected to the same load. The four different vehicle chassis have been modeled considering four different sections. Namely the cross sections of type C, I, rectangular box (empty) and rectangular box (intermediate). From the results, it has been observed that the rectangular (intermediate) section is more robust than traditional steel alloy frames with the design specifications of sections C, I and rectangular (hollow). The rectangular section of the housing showed the least bending in the four types of frame of different section.

Sandip Godse and DA Patel (2013) [7] present the document on the analysis of the static load of the TATA axle frame using the ANSYS workbench and the optimization of stresses using the optimization enhancement technique. This was done with limited modifications by adding stiffeners. They analyzed the existing framework using finite element analysis, the stress levels were equal to 37.04 N / mm2. After the modifications, the frame with an adequate reinforcement, the increase in thickness, the addition of stiffeners, the analysis of the finite elements was carried out and the stress levels of the frame were found at 22.97 N / mm2, which shows that the modified frame is capable of supporting loads beyond the previous payload.

Manpreet Singh Bajwa, Yatin Raturi and Amit Joshi (2013) [8] studied the analysis of the static load of the TATA ACE chassis using ANSYS Workbench and the verification was carried out using the mechanics of solid. Here, the frame is of the ladder frame type which comprises two lateral elements or longitudinal elements of cross section in C and five transverse elements called elements in cross section of the box. The chassis was modeled in CATIA V5R18 using most of the actual dimensions. The result shows that the static analysis and verification were successfully performed using solid mechanics.

Mohd Azizi Muhammad Nora, Helmi Rashida, Wan Mohd Faizul, Wan Mahyuddin, Mohd Azuan Mohd Azuan, Jamaluddin Mahmud (2012) [9] performs the stress analysis of a low load structure consisting of an I beams design application of a 35 ton trailer. Modeling is performed in CATIA V5R18. The results of the analysis revealed that the position of the maximum deflection and the maximum stress corresponds well to the maximum theoretical position of the single beam under a uniform load distribution. It also shows that the maximum stress is 571.4 Mpa on the A beam. This study revealed that there is a divergence between the theoretical results (2-D) and the numerical results (3-D FEA). It is observed that the maximum deflection is pointed between BC1 and BC2 with a magnitude of 7.79 mm.

Vijaykumar V. Patel, R. I. Patel (2012) [10] studied the ladder frame of Eicher E2 by means of static structural analyzes. For this study, the chassis was taken as a simply supported beam with a protrusion. Pro-E and Ansys software were used for this work. The study also involved the analytical calculation of the frame. The results of the software analysis and analytical calculation were compared and revealed that the stress value obtained from the software analysis was 10% higher and that the displacement was also 5.92% higher.

C. H. Neeraja to C. R. Sireesha and D. Jawaharlal [11] carried out research on the suspension frame modeled for two wheels. The modeling was performed on 3D Pro / Engineer modeling software. To study the resistance of a frame, a structural analysis is performed by applying the forces of the wheel. The purpose of this analysis had been achieved by finding a maximum stress limit for the two-wheel chassis. The analysis was conducted for four different materials, such as alloy steel, magnesium, aluminum alloy A360 and carbon fiber reinforced fiber to understand which material is best for the two-wheel frame and can offer excellent resistance. The analysis is performed on the ANSYS software. After examining the results, the different materials and stress values were limited and lower than the authorized limits to confirm passenger safety.

Teo Han Fui, Roslan Abd. Rahman [12], in December 2007, works on statics and dynamics, the structural analysis of a 4.5 tonne truck chassis, studied and determined the dynamic characteristics of the truck chassis, investigating the positions to mount the components on truck chassis and observe the response of the truck chassis under static load conditions. He found that local bending vibration in the truck chassis occurs on the top hat rail where the gearbox is mounted. And the mounting position of the engine and transmission system is around the symmetrical axis of the first chassis twisting mode where the effect of the first mode is less comparative. However, the mounting of the suspension system on the truck chassis is slightly away from the nodal point of the first vertical chassis flex mode. And he found that it could help keep the static load on the truck chassis. For the linear static analysis, the stress distribution and the deformation profile of the truck chassis under two load conditions were determined: the load of the truck components and the asymmetrical load were determined. It was also studied that due to the load on the frame, the maximum stress and bending occur at the level of the mounted supports joined to the suspension system and the maximum translation occurs when the load of symmetry and asymmetry acts on the frame studied. The result of the analysis and research in this article shows that the maximum stress that occurs on the truck chassis is designed to be 490 megapascals and the maximum translation to be 33.6 mm. These values are acceptable with respect to the yield strength of the frame material and the allowable tolerance for the frame.

S. Agostoni, A. Barbera, E. Leo, M. Pezzola, M. Vanali [13], he had worked to improve the vibratory performance of the scooter by an experiment carried out during this research to discover local modes of vibration. Developed methodology will be able to identify local vibration modes to find if / when / how the resonances of the chassis components are excited. By implementing this method, structural modifications have been studied for different types of chassis models. The new vibration results of the multi DOF mass shock absorber are optimized. In this paper, the geometry of the foot plate has been modified to reduce the nodal displacement of the fixation of the beam of the footrest. In this research chassis was developed with the sole purpose of improving driver comfort. And attention was paid directly to the handlebars, a component directly linked to the driver.

FA Conle studied the fatigue life of the Volvo S80 BiFuel using MSC / Fatigue Conle and Chu [14], the research is conducted in this article in the area of fatigue analysis and the constraint-local constraint approach in complex structures of vehicles. The document concludes that damage assessment should be flexible in order to take into account numerous criteria for multiaxial fatigue damage. In addition, a multiaxial neutral plasticity correction method must be used to translate local elastic stress which can eliminate the stress-strain behavior of the plastic. Critical research of the aircraft is needed in the most harmful direction.

Abhishek Sharma, Pramod Kumar, Abdul Jabbar and Mohammad Mamoon Khan (2014) [15], designed the heavy vehicle chassis and analyzed using ANSYS15.0. The TATA LPS EX chassis is used in research for the structural analysis of the chassis of heavy vehicles with three different alloys subject to the same conditions as the steel chassis. The three materials used in this article for frame analysis are gray cast iron, AISI 4130 alloy steel and ASTM A710 ACIER GRADE A (CLASS III). There are several forms of sections used for their work, which are type C, I and Box sections. A solid three-dimensional model was built in the CATIA V5 parametric model. The result shows that the AISI 4130 steel alloy performs better and is lighter than all other metal alloys offering strength.

Jakub Smiraus1, Michal Richtar2, [16] studied the design of the motorcycle and concluded that the steering geometry change system could be a pioneering idea in the construction of the 21st century motorcycle frame. Adjusting the route, as well as changing the wheelbase and the ground clearance of the bike, opens up many options in the area of adjusting the negative effects arising from the dynamic characteristics of the bike's movement. This solution for the suspension of motorcycles with variable geometry according to the driving conditions was conceived in the thesis of Jakub Smiraus and built at the institute of transport VŠB - Technical University of Ostrava under the direction of the master Michal Richtar.

Haval Kamal Asker1, ThakerSalih Dawood1 and Arkan Fawzi [17], had researched and worked on the stress analysis of a standard truck chassis during the block ramp using the finite element method and focused on the intensity and chassis resistance playing an important role in the design of trucks. He studied and analyzed using the Ansys package software. In addition, the vibration and deflection conditions in the chassis elements were analyzed during the loading conditions. And the analysis is done for a specific material in this document as shown below.

C. H. Neeraja and C. R. Sireesha and D. Jawaharlal [18] conducted research on the suspension frame modeled for the two wheels. The modeling was performed on 3D Pro / Engineer modeling software. To study the strength of a frame, a structural analysis is performed by applying the forces of the wheel. The purpose of this analysis had been achieved by finding a maximum stress limit for the two-wheeled chassis. The analysis was conducted for four different materials, called alloy steel, magnesium, A360 aluminum alloy and carbon fiber reinforced fiber to understand which material is best for a two-wheeled frame and can provide excellent strength. The analysis is performed on the ANSYS software.

Quantity	Results	Permissible
Displacement	0.297e-3	-
Vonmises stress	2.383	325

Table 1: Displacement and stress for alloy steel

Mode	Frequency Displacement	Frequency Displacement
Mode 01	.04726	.00167
Mode 02	.014729	.00167
Mode 03	.021785	.001547
Mode 04	.021795	.001547
Mode 05	.023324	.002075

Table 2: Frequency for alloy steel

Quantity	Results	Permissible
Displacement	0.002413	-
Vonmises stress	2.658	83

Table 3: Displacement and stress for Carbon fiber reinforced polymer

Mode	Frequency Displacement	Frequency Displacement
Mode 01	0.01383	0.001667
Mode 02	0.014074	0.001666
Mode 03	0.014399	0.002029
Mode 04	0.014559	0.002031
Mode 05	0.021519	0.001549

Table 4: Frequency for Carbon fiber reinforced polymer

Thus, compared to the four materials, you see the result and therefore the stress obtained is the same, but the displacement is less important for the polymer reinforced with carbon fiber than that of the other three materials. And this document concludes that for the design and manufacture of frames for the two-wheeled vehicle, carbon fiber reinforced polymer is the best material for the suspension frame to achieve the required strength.

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III. Conclusion

Various researches are conducted to determine stresses, its effects on chassis life and parameters effecting pressure, shear stress, and fatigue life of chassis. The findings have shown that magnitude of load applied, chassis geometry and material are major factors which determine the life of chassis. The study also discusses about application of suspension pin in vehicle chassis.

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