STRUCTRAL ANALYSIS OF A TWO WHEELED SUSPENSION FRAME BY USING STEEL WITH BAMBOO AND CARBON EPOXY

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ABSTRACT: The frame is an important part in a two wheeler and it carries the load acting on the vehicle. In frame different types of failure occurs due to different loading conditions. So it must be strong enough to resist the shock loads, vibration and other stresses. This project aims in the design and analysis of two wheeler suspension frame. Three models of suspension frames are designed for pipe type, rectangular type and oval type cross sections. Structural analysis and Modal analysis are done for frame using two materials, steel and carbon epoxy to find the strength of two models. Comparison is done by two FEA analyses, and also we can find the best cross section and material for suspension frame. Design is carried out in CATIA. Analysis is done on ANSYS.

Keywords: Suspension Frame, SOLIDWORKS, FEA

I. Introduction

C. H. Neeraja et.al. She have modeled a suspension frame of two wheeler in Pro/Engineer. They have done structural and modal analysis on suspension frame using four materials Steel, Aluminum, Alloy A360, Magnesium and carbon fiber reinforced polymer. By observing the results, for all the materials the stress values are less than their respective permissible yield stress values. They concluded that the design was safe. This study helps to validate our design. By the analysis, for all the materials the stress values are less than their respective permissible yield stress values. So the design is safe. 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 they conclude that, CFRP is better material for suspension frame.

Anand Aggarwal He has modified the design and performed structural analysis on it by using steel. They concluded that modified design has the strength and simpler to manufacture. This study helps in using a sheet metal in the suspension bracket of the frame which prevents the torsional loads. Structural analysis is aimed towards decreasing the weight while maintaining structural integrity and strength. It may be a cross field functionality such as civil dams, bridges, flyovers, power transmission towers OR components related to one engineering discipline like automotive where much physical testing is done along with computer simulations to arrive at results. Field data and past records for failure are also very essential as without these there is no historical data supporting the performance of the products. While all the above information is hardly available at one place, effort has been made to analyze a structural component by changing its design keeping stress within limits**.** As is clear from the analysis, making a small change to the design could save manufacturing time and costs.

Gaurav vasantrao bhunte et.al. He overviews the different analytical and experimental techniques developed for analysis of the automobile frame. They concluded that to predict the life of the chassis, there must be results which are based on load variation and impact. This study helps to what type of analysis is to be carried on two wheeler frame.In the review most of cases are under study and the work carried out do not provide sustainable progress in analysis of the chassis and differentiation between load analysis results to predict life of it. So it is necessary to continue further study in the analysis and evaluation of the chassis to provide the path finder a way. To predict life of a chassis there is need to have the results which are based on the load variation and impact in static as well as in dynamic.

Karaoglu et.al. He investigated of truck chassis of stress analysis with riveted joints by using FEM. By observing the results, by increasing the side member thickness locally, then stresses on the side member can be reduced.This helps in designing the frame with increasing the side member thickness.

Mrs. Bagal Nilesh N et.al. She has modeled a chassis using a combination of steel and bamboo to reduce weight as well as cost of the chassis**.** After fitment of bamboo columns, the weight of chassis is 13.40 Kg Hence, reduction in weight is about 2.071 Kg so, by using bamboo specimen in the frame we can reduce the cost as well as weight of the overall structure. This study helps in using the steel and bamboo as the material for the suspension frame.For protection from water a layer of liquid cement is applied so that water should not react with bamboo specimen. The bamboo used in chassis where the stresses are within the permissible limit. The chassis use for the project is PULSAR 180 having weight 15.471 Kg without use of bamboo and by using bamboo reduction in weight up to 13.40 Kg is obtained.

A.Moaaz et.al. He reviewed some of the previously conducted work on vehicle structural design, analysis and optimization is surveyed. An important aspect of chassis design and analysis is the stress distribution and fatigue life of prediction process. Fatigue is one of the most important parameters to consider when designing.The review of some of the analytical and numerical techniques related to vehicle structural design, analysis and optimization is surveyed . It is found that the chassis analysis mainly consists of stress analysis to predict the weak points and fatigue analysis to predict the life of the chassis. Several state of the art papers and even books on chassis stress analysis have been presented in the recently years. In this study, stress analysis is considered which helps to predict weak point.

Kutay Yilmazçoban et.al. He did FEA optimization of chassis, mainly focused on reducing the weight of the chassis for using three different thickness (4mm, 5mm and 6mm), finally concluded that less thickness i.e., 4mm thickness is better because the stress and displacement are better than remaining two thickness.To reduce the expenses of the chassis of the trucks, the frame’s structure design should be changed or the thickness should be decreased. In this study, for manufacturing reliable and inexpensive middle tonnage truck chassis, used chassis structures by some manufacturers are optimized by the thicknesses of the profiles. This study showed that the thinner chassis profiles can be reliably used in the truck chassis sections with the help of structural finite element analysis. This helps in designing the frame with the less thickness.

Haval Kamal Asker et.al. He did stress analysis by FEA of standard truck chassis during ramping on block. This study helps in focusing on strength and intensity of frame which play a vital role . The modal analysis for vehicle that considers the elastic characteristic of frame was applied to the rear frame of articulated dump truck, and the result express the behavior of the chassis during ramping block in the both wheels ramp the block and zigzag wheels ramp the block. As a result, it was confirmed that this analysis can be used to predict the bending and torsion stresses of frames when a vehicle ramp a block. Numerical simulation result shows that the critical point of stress occurred when the truck zigzagramp the block. The big effect was given to the case of zigzag wheels of the dump truck ramp the block because there was great difference in the torsion stress values in both two case studies.

O Kurdi et.al. He works on the Stress Analysis of heavy duty truck chassis. This study mainly focus on the important steps in development of new truck chassis is prediction of fatigue life span and durability loading of the chassis frame. Numerical simulation result shows that the critical point of stress occurred at opening of chassis which is contacted with bolt. The magnitude of highest stress is critical because the value of SF is below than the recommended value. Since fatigue failure started from the highest stress point, it can be concluded that this critical point is an initial to probable failure. Thus, it is important to take note to reduce stress magnitude at this point. The location of maximum deflection agrees well with the maximum location of simple beam loaded by uniform distribution force. By this study ,at critical point on the chassis frame stress magnitude is considered. **Teo Han Fui et.al.** He works on the static and dynamics, structural analysis of 4.5ton truck chassis. Under static loading conditions of truck chassis determined the dynamic characteristics and local bending vibrations occurs at top crown mention where the gear box is mounted on it. The first six natural frequencies of the truck chassis are below 100 Hz and vary from 12.68 to 61.64Hz. For the first four modes, the truck chassis experienced global vibration except for the fifth mode. The global vibrations of the truck chassis include torsion, lateral bending and vertical bending with 2 and 3 nodal points. The local bending vibration occurs at the top hat cross member where the gearbox is mounted on it. The mounting location of the engine and transmission system is along the symmetrical axis of the chassis’s first torsion mode where the effect of the first mode is less. However, the mounting of the suspension system on the truck chassis is slightly away from the nodal point of the first vertical bending mode. This might due to the configuration of 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. Maximum stress occurred at the mounting brackets of the suspension system while the maximum translation occurred at the location where the symmetry and asymmetry load is acting. The maximum stress of the truck chassis is 490 MPa while the maximum translation is33.6 mm. These values are acceptable as compared to the yield strength of the chassis material and the tolerance allowed for the chassis. . By this study some modifications are considered which helps in increasing the strength of the frame.

II. Methodology

II.I. Modeling of suspension frame

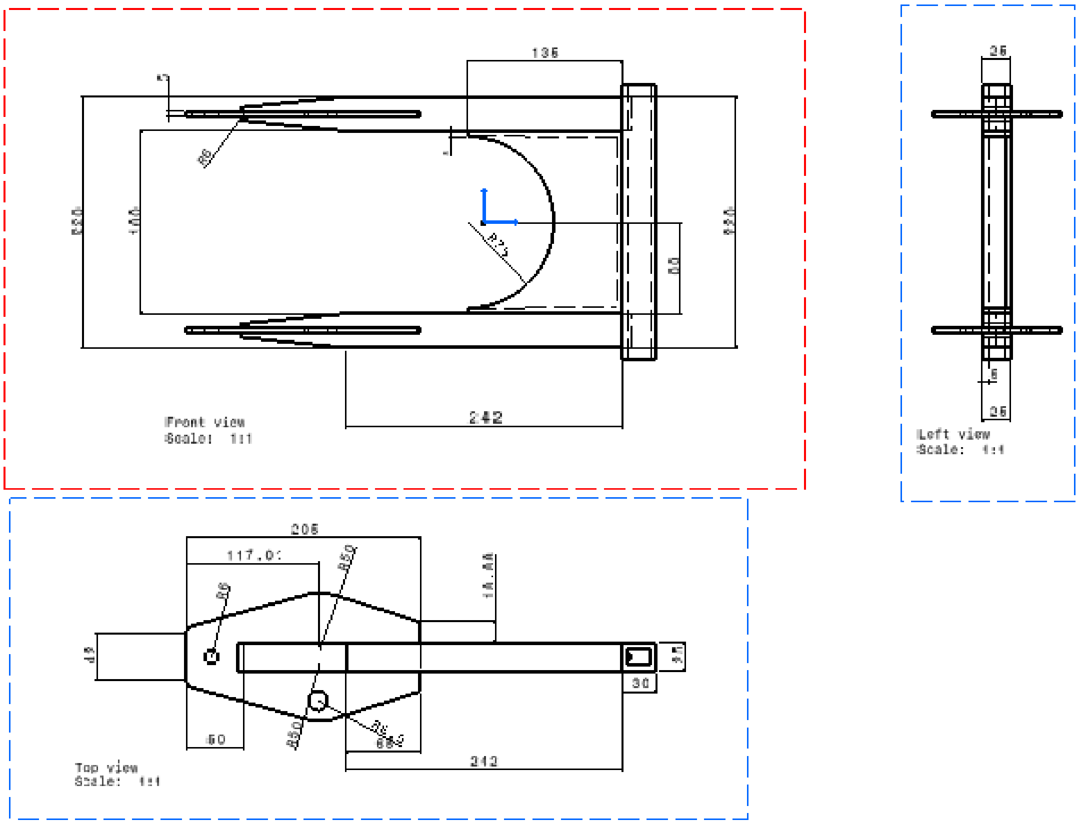

Fig.1. Sectional view of suspension frame

Fig.2.Suspension frame of circular modeled by using solid works

Fig.3. Suspension frame of oval modeled by using solid works

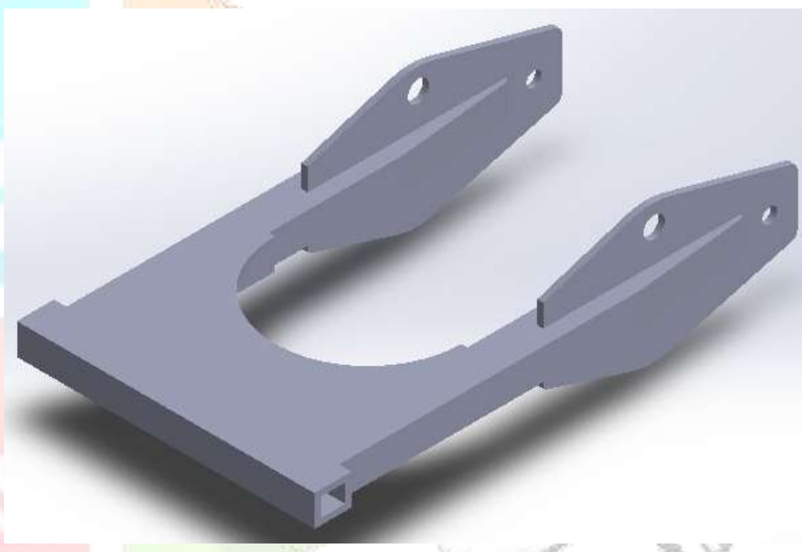

Fig.4.Suspension frame of rectangular modeled by using solid works

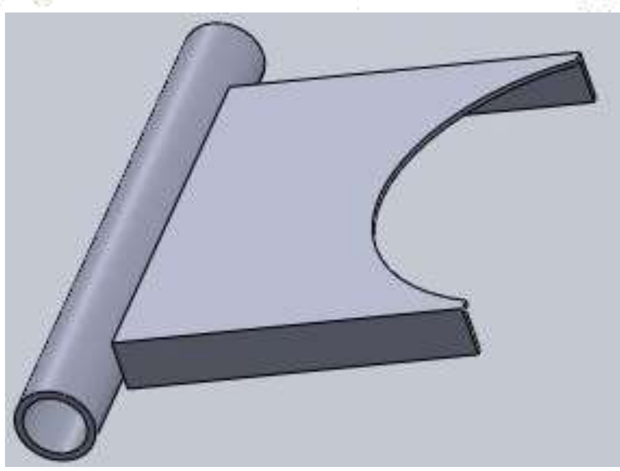

Fig.5. Suspension frame bracket

II.II. Meshing of suspension frame

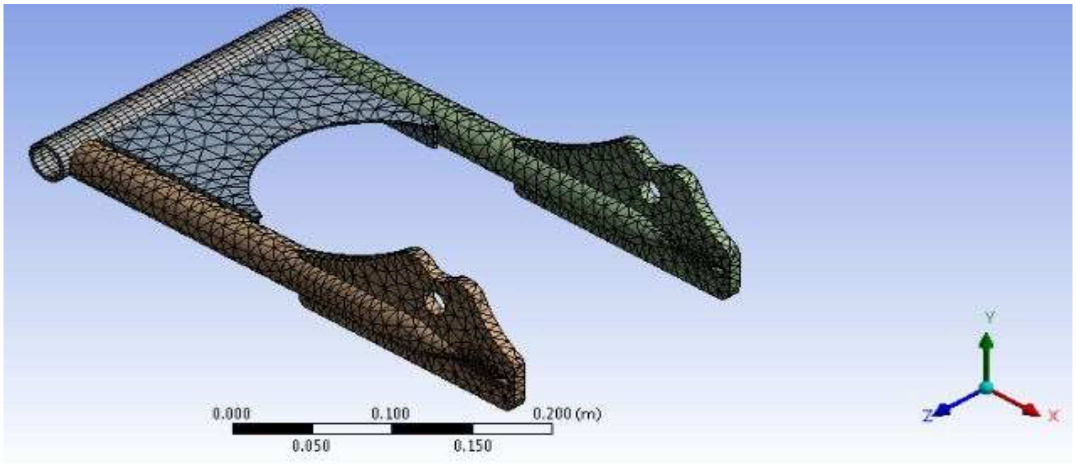

Fig.6. Isometric view of meshed model by using Hyper Mesh for circular cross section

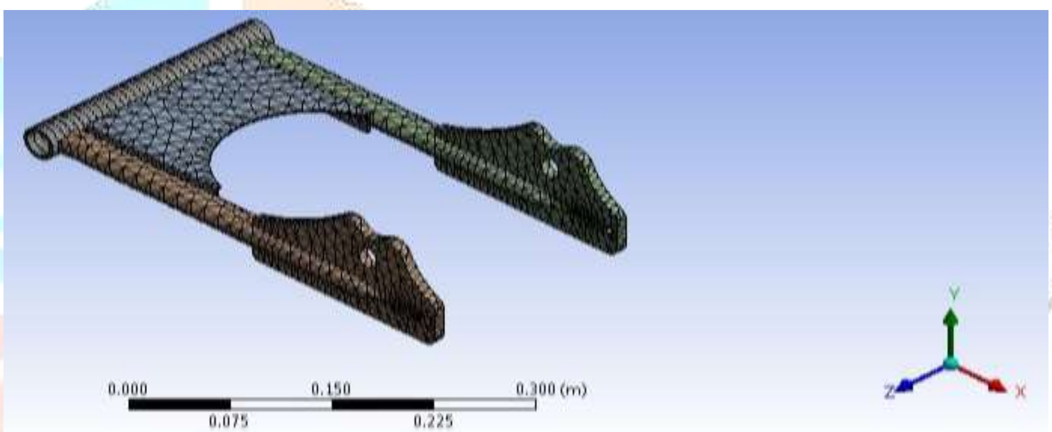

Fig.7. Isometric view of meshed model by using Hyper Mesh for oval cross section

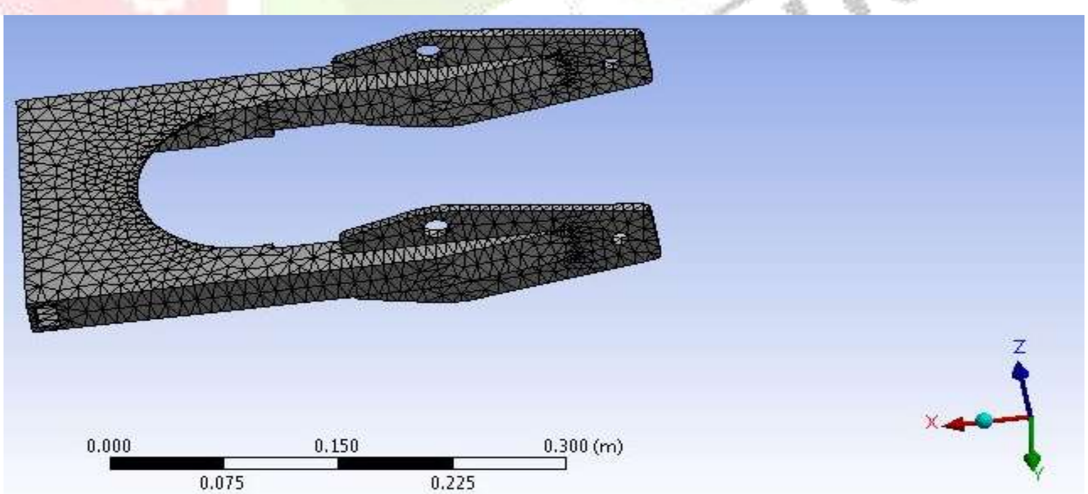

Fig.7. Isometric view of meshed model by using Hyper Mesh for rectangular cross section

II.III. Boundary Conditions on suspension frame

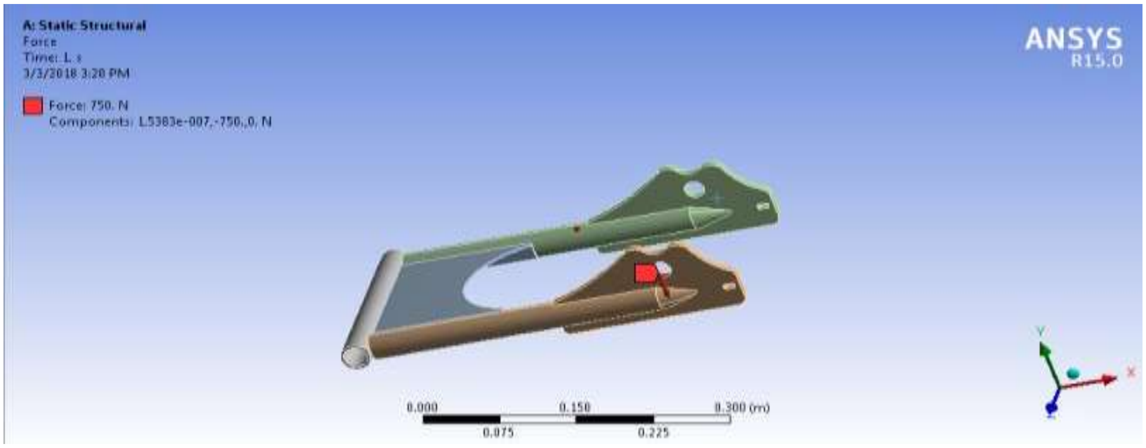

Fig.8. Boundary conditions

III. Results & Discussions

Static Structural analysis of suspension frame

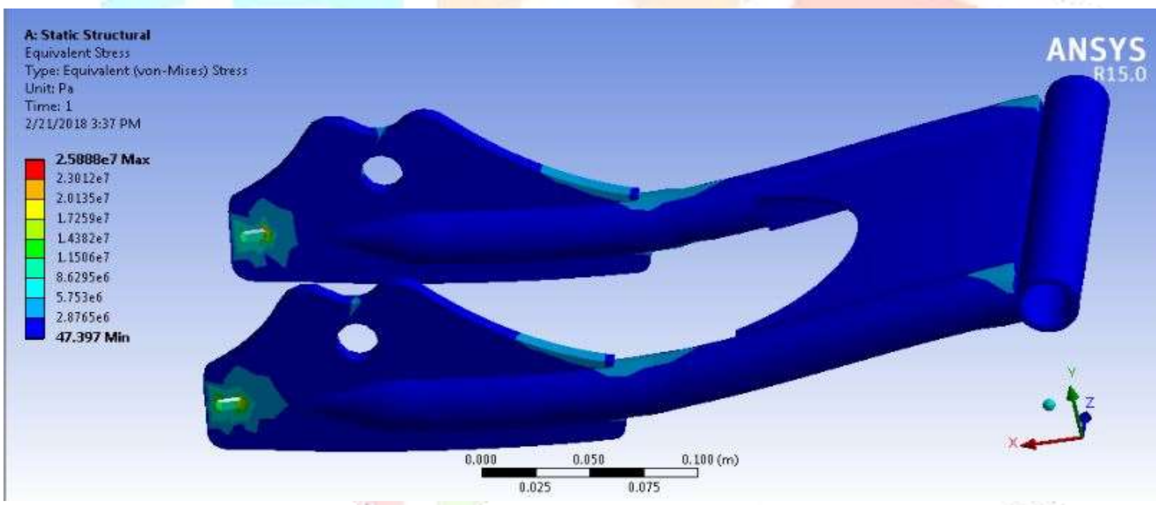

Fig.9. Von Mises stress in suspension frame for circular cross section by using steel with bamboo

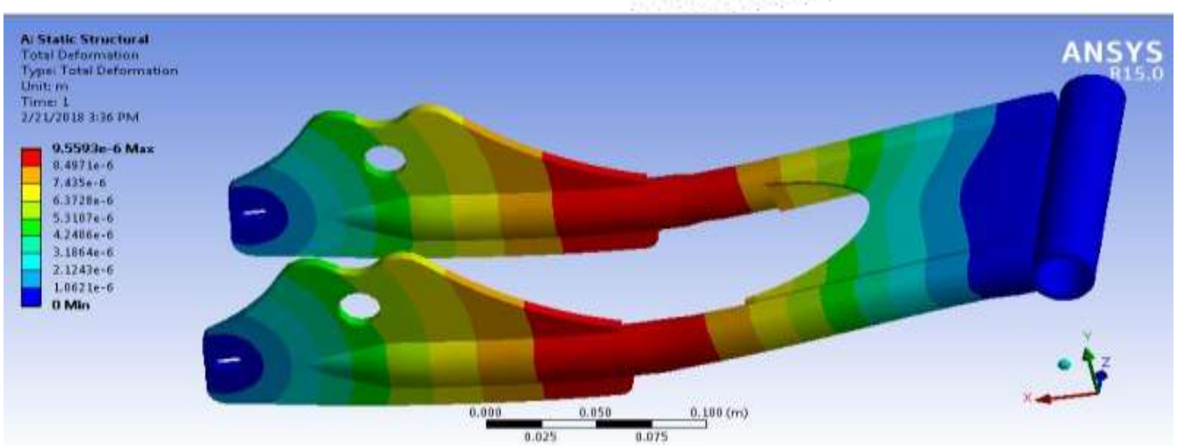

Fig.10.Total deformation in suspension frame for circular cross section by using steel with bamboo

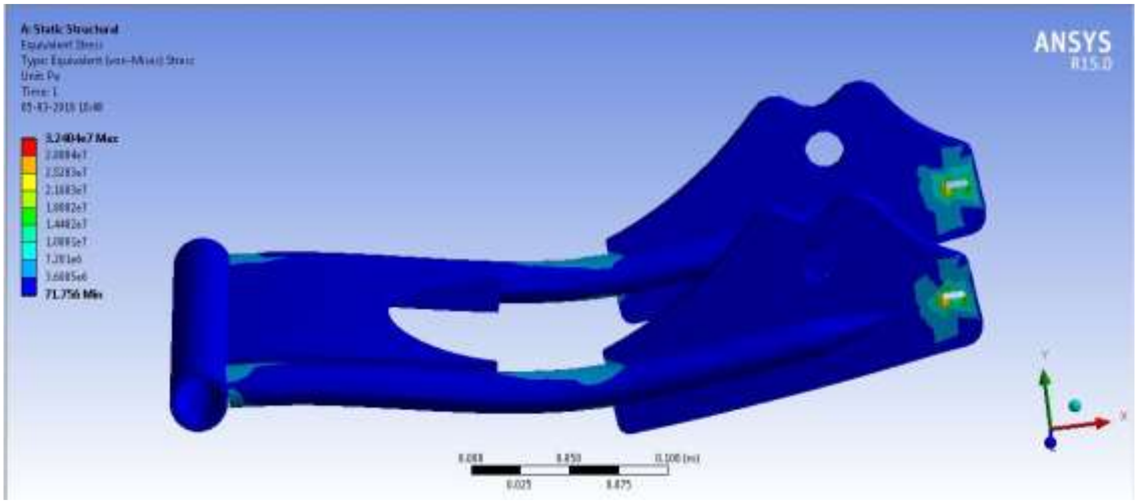

Fig.11. Von Mises stress in suspension frame for oval cross section by using steel with bamboo

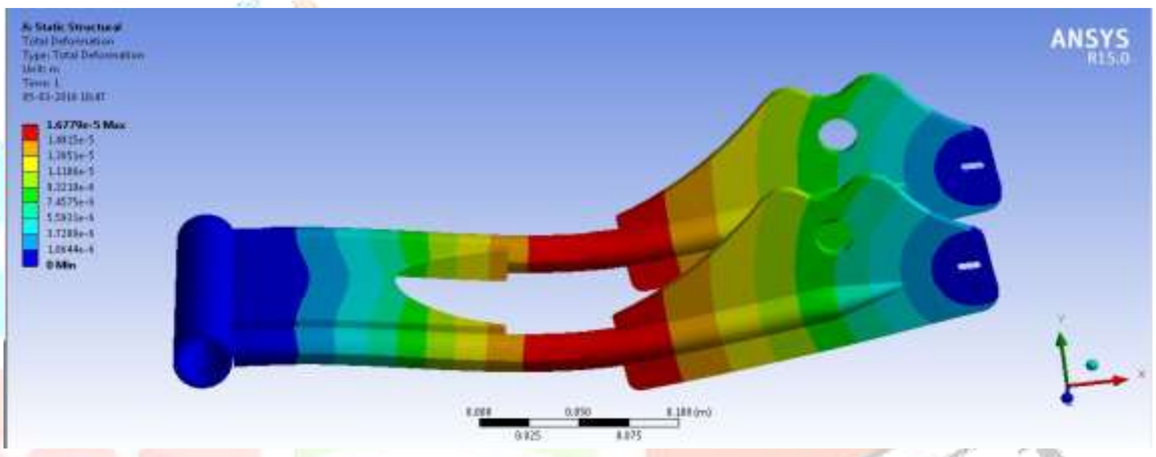

Fig.12. Total deformation in suspension frame for oval cross section by using steel with bamboo

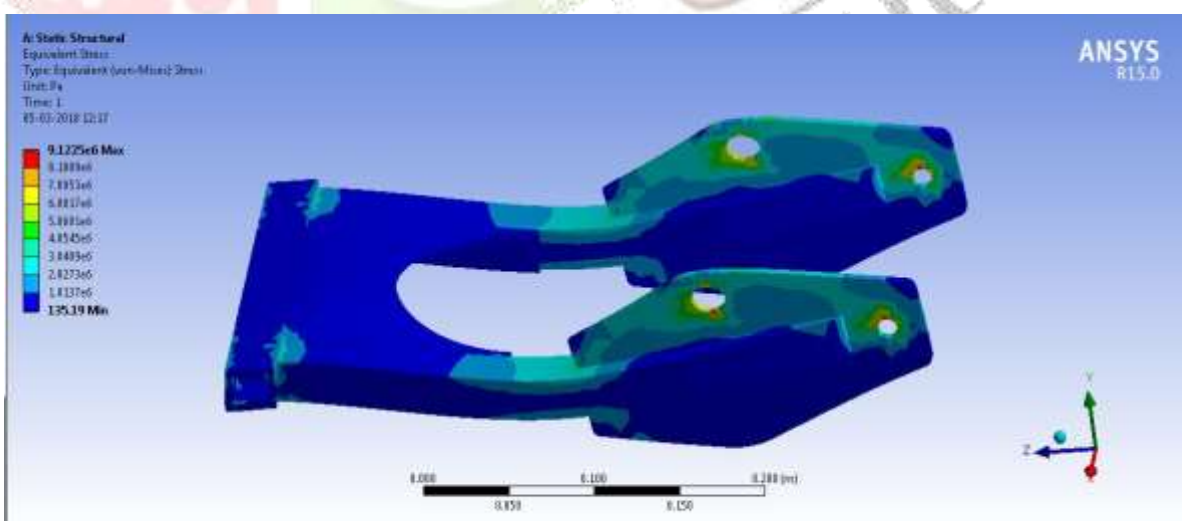

Fig.13. Von Mises stress in suspension frame for rectangular cross section by using steel with bamboo

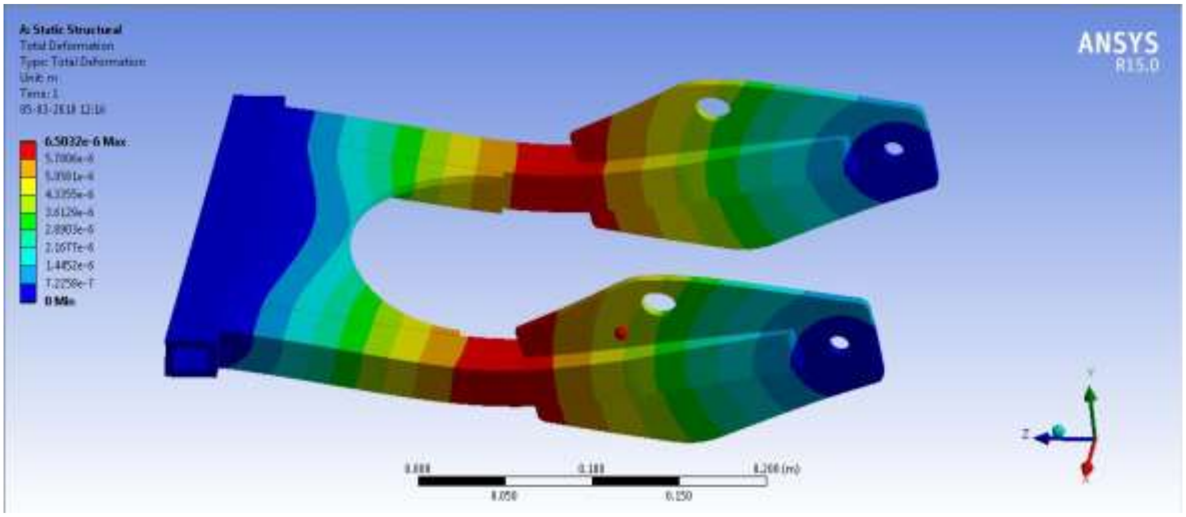

Fig.13. Total deformation in suspension frame for rectangular cross section by using steel with bamboo

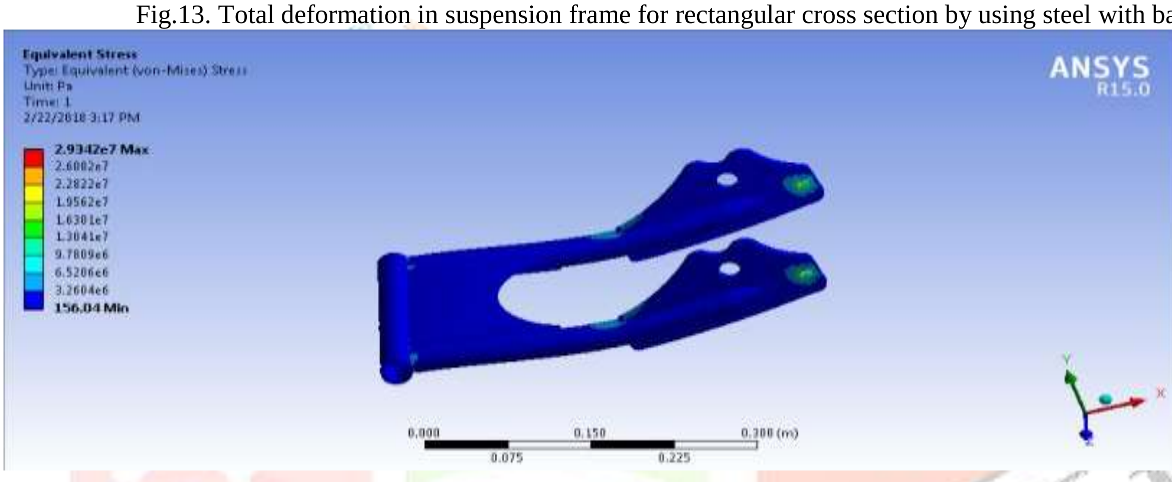

Fig.14.Von Mises stress in suspension frame for circular cross section by using carbon epoxy

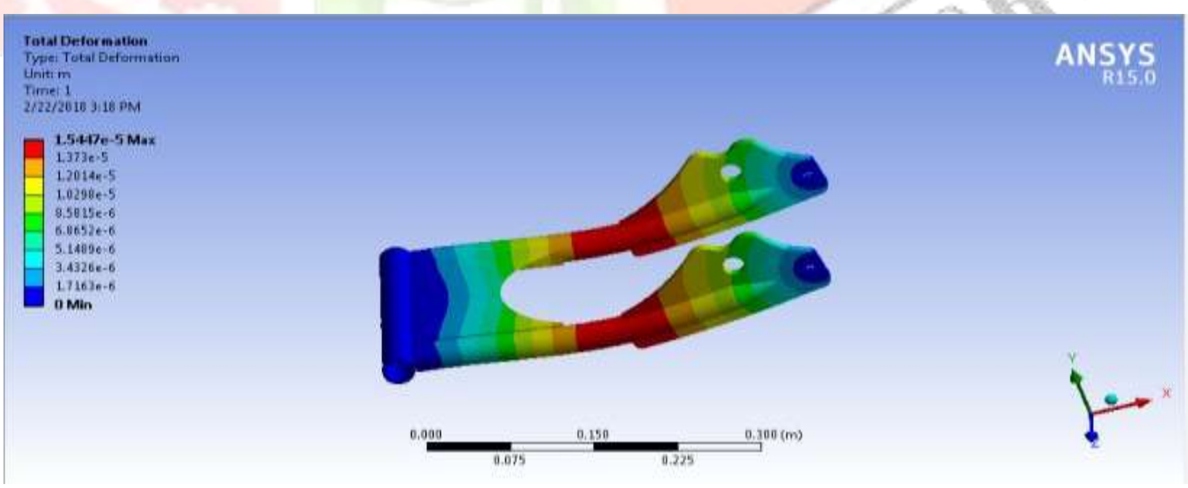

Fig.15. Total deformation in suspension frame for circular cross section by using carbon epoxy

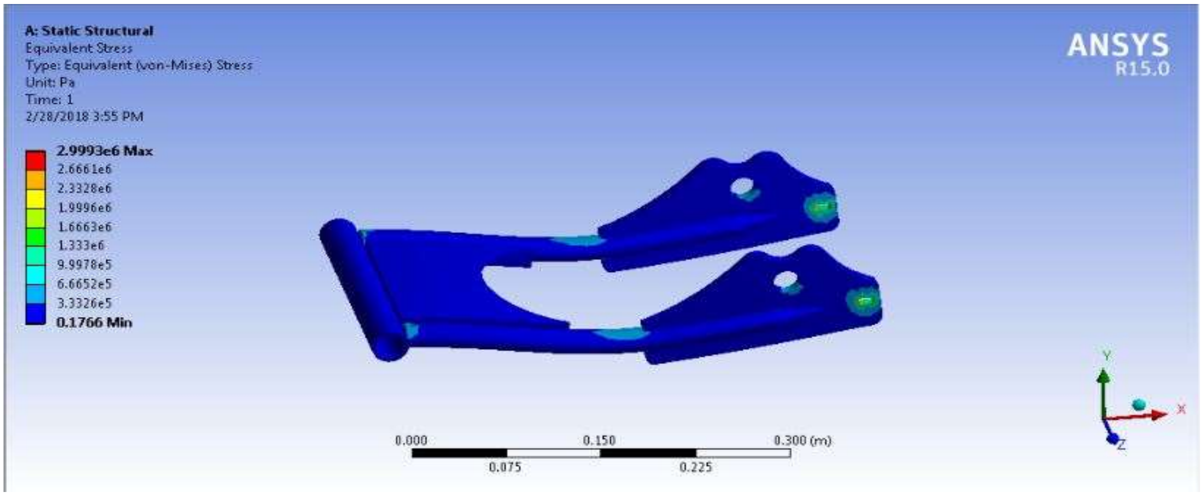

Fig.16. Von Mises stress in suspension frame for oval cross section by using carbon epoxy

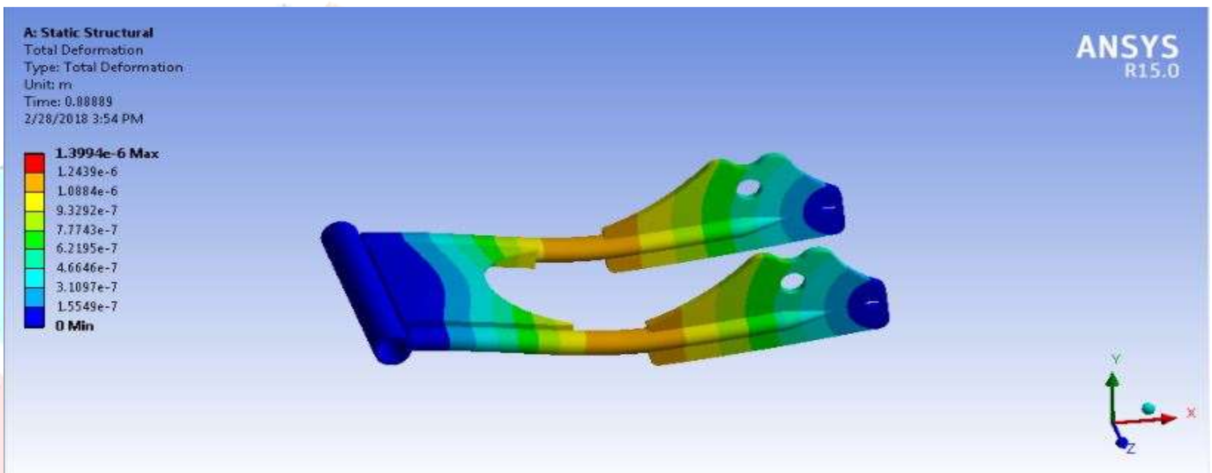

Fig. 17. Total deformation in suspension frame for oval cross section by using carbon epoxy

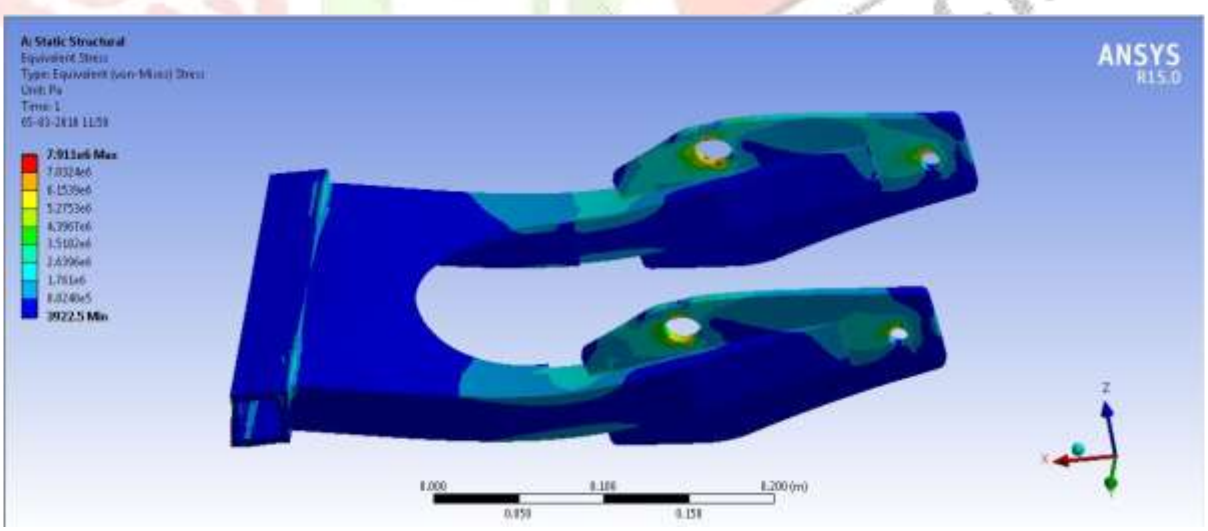

Fig.18. Von Mises stress in suspension frame for rectangular cross section by using carbon epoxy

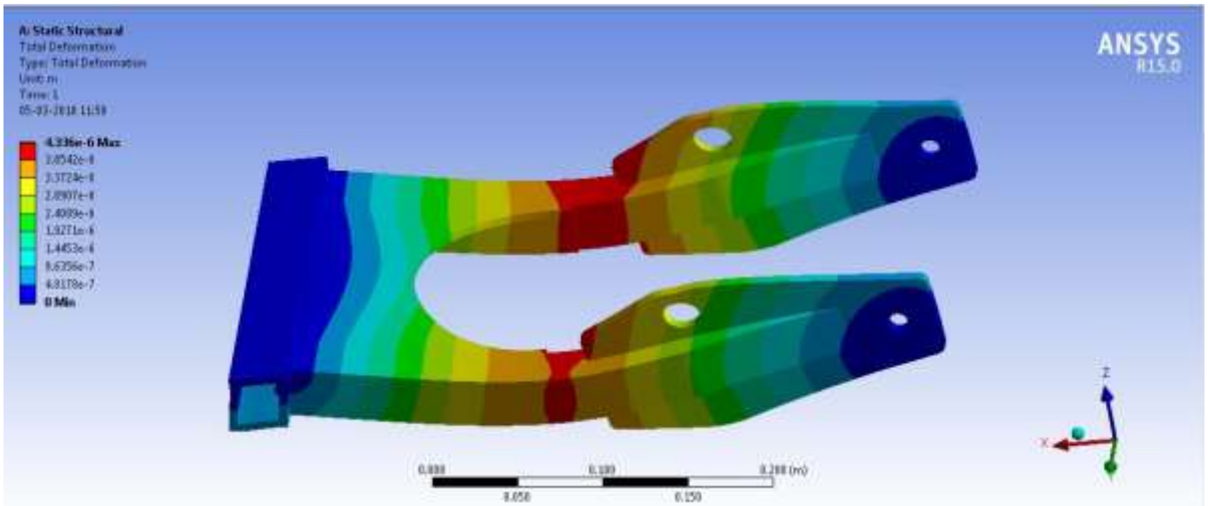

Fig.19.Total deformation in suspension frame for rectangular cross section by using carbon epoxy

Table1. Suspension frame with Steel with Bamboo as material

S.No	Model of suspension frame	Load applied (N)	Total deformation(m)		Von-mises stresses (Pa)	
			Max	Min	Max	Min
1	Circular Cross section	750	9.5593e-6	0	2.5888e7	47.397
2	Oval Cross section	750	1.6779e-5	0	3.2404e7	71.756
3	Rectangular Cross section	750	6.532e-6	0	9.1225e6	135.19

Table2.Suspension frame with Carbon Epoxy as material

S.No	Model of suspension frame	Load applied (N)	Total deformation(m)		Von-mises stresses(pa)	
			Max	Min	Max	Min
1	Circular Cross section	750	1.5447e-5	0	2.9342e7	156.04
2	Oval Cross section	750	1.3994e-5	0	2.9993e6	0.1766
3	Rectangular Cross section	750	4.336e-6	0	7.911e6	39225

IV. Conclusions & Future Scope

An attempt has been made to study the suspension frame used in two-wheeler. The work is carried out under elastic analysis. Design modifications are implemented by considering Optimization areas of frame i.e. area where frame is very rigid and where stresses are coming below are identified. Structural analysis on suspension frame using two materials Steel with Bamboo and Carbon epoxy is done.

By observing the results, for all the materials the stress values are less than their respective permissible yield stress values. After analysis it is found that after design modifications frame is safe. The weight of the frame was also reduced up to 30%.

Scope of Future Work

- In the given potential areas of weight reduction has been identified; hence these areas can be utilized for frame optimization.
- Frame was tested both for static and impact loading but more elaborative dynamic analysis could be done.

- Frame can be tested for stability criteria such as wobble, kickback vehicle can be tested for various road profile.
- Crash simulation of vehicle could be a good scope of future work.

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