Design And Structural Analysis of Composite Chassis For Tata Ace

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Abstract- *Chassis is a major component in a vehicle system. This work involved static analysis to determine key characteristics of a chassis. The static characteristics include identifying location of high stress area. Mathematical calculations were carried out to validate the static analysis. This paper presents the static load analysis of the chassis of TATA ace modelling using SOLIDWORKS software and analysis using ANSYS workbench and stress optimization using reinforcement technique of optimization. This has been carried out with limited modifications by adding stiffeners. The necessary design changes required to enhance the load carrying capacity of the vehicle has been recommended successfully.*

Keywords- Automobile Chassis, Geometry Model of Chassis, Solid Works, ANSYS, Static Load Condition.

I. INTRODUCTION

Automotive chassis is a skeletal frame on which various mechanical parts like engine, tires, axle assemblies, brakes, steering etc. are bolted. The chassis is considered to be the most significant component of an automobile. It is the most crucial element that gives strength and stability to the vehicle under different conditions. Automobile frames provide strength and flexibility to the automobile. The backbone of any automobile, it is the supporting frame to which the body of an engine, axle assemblies are affixed. The main function of the chassis is not only support the components and payload mounted upon it including engine, body, passengers and luggage, but also to maintain the desired relationship between the suspension and steering mechanism mounting points. The chassis is subjected to stress, bending moment and vibrations due to road roughness and components that mounted on it. When the truck travels along the road, Stress acting on chassis is varies with the displacement, the behaviour of the chassis that always subjected tostress (moving or not),to overcome this failure chassis requires appropriate strength, stiffness and fatigue properties of the components to be able to stand these loads or stresses. Modal updating technique also important in order to create a good model for analysis.

1.1 Applications of Chassis:

- The rectangular, usually steel frame, supported on springs and attached to the axles, that holds the body and motor of an automotive vehicle.
- The landing gear of an aircraft, including the wheels, skids, floats, and other structures that support the aircraft on land or water. The frame on which a gun carriage moves forward and backward.
- The framework to which the components of a radio, television, or other electronic equipment are attached.

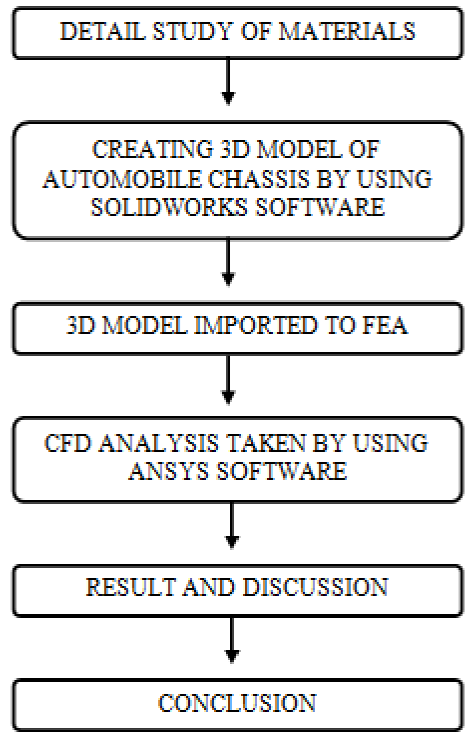
1.2 OBJECTIVES:

- To analyse the automobile chassis geometry using ANSYS software.
- To propose the non-metals (FRP material) for chassis model and analyse its mechanical behaviour.
- The E-Glass Fibre Reinforced Polymer (E – GFRP) has been proposed and results compared with existing material structural steel.

II. LITERATURE REVIEW

Patel et al have investigated and optimized a chassis design for Weight reduction of TATA 2516TC chassis frame using Pro-Mechanical. Thy first find out the assembly weight, maximum stress, strain and displacement for the existing section of chassis by using ANSYS Software after then they modified the dimensions of existing C-sections and again find all and concluded that the existing “C” sections is better than all the sections with respect to the Stress, Displacement, Strain and Shear stress except the weight. For the weight consideration modified “C” section has less weight than the all sections which are studying in this paper. Finally By the use of modified “C” section, 105.50 Kg (11 %) weight is saved per chassis assembly and in same manner cost may also be reduced approximately 11%.**Murali et al** have investigated the critical point which has the highest stress using Finite Element Method (FEM). This critical point is one of the factors that may cause the fatigue failure. For the modifications and analysis, the existing truck chassis were added with stiffeners. Initially the thickness of the model, where the maximum deflection occurs in bending analysis was increased to certain value with acceptable limit. And one more cross beam was added at the centre of the wheel base to add stiffness to the model. **B. RamanaNaik and C. Shashikanth** have objective to analyse an automobile chassis for a 10 tonne vehicle. The modelling is done using Pro-E, and analysis is done using ANSYS. The overhangs of the chassis are calculated for the stresses and deflections analytically and are compared with the results obtained with the analysis software. Modal Analysis is also done to find the natural frequency of the chassis and seen that it is above than its excitation frequency. This frequency is more than 4 times the highest frequency of the excitation (i.e. 33 Hz) hence the chassis can faithfully transmit the input excitation to the vehicle body without any amplification.**Vijay Kumar V. Patel and Prof. R. I. Patel** have investigated and optimized a chassis design of EICHER E2 (or 11.10) for Weight Reduction same manner as done by S. Prabakaran and K. Gunasekar but they used Pro-E softer for modelling and find the same results.**Potdar et al** used approximate dimensions to model the N1 type TATA Ace chassis. Software used was CATIA V5 for modelling and ANSYS Workbench for analysis. Concluded that the deflection due to bending of the Chassis Members can be evaluated using Static Finite Element Analysis instead of conventional time consuming calculations. The overall bending stiffness of the Chassis is 13724 N/m which is under 22000N/m, permissible range for N1 Vehicle Category.**Kamlesh Y. Patil and Eknath R. Deore** have studies the Ladder Chassis frame of TATA 912 Diesel Bus and The model of the chassis was created in Pro-E and analysed with ANSYS for Various Cross Sections for same load conditions. They observed that the Rectangular Box (Hollow) section is more strength full than the conventional steel alloy chassis with C and I design specifications. The Rectangular Box (Hollow) section is having least deflection i.e., 2.683 mm and stress is 127 N/mm2 in all the three type of chassis of different cross section.

III. WORKING METHODOLOGY



A comparison between the results obtained based on existing material and the results obtained from the ANSYS 14.0. Work bench has been carried out.In conventional approach conception ideas are converted into sketches or engineering drawing. With the help of this drawings the prototypes i.e. product which looks same as that of final product are made. It is launched in the market after testing of prototype which gives acceptable results. The thing is, product is launched after doing many practical testing and many trial and error procedures which consumes more time and cost too.

In CAE approach some steps are same as that of conventional method. Here also ideas, concepts are converted into engineering drawing, but it is then modelled on computer. Geometric model of product is made using solid work software like CAD which enables better visualization of simple as well as complex models. These models then further used for computerized analysis by using different CAE tools (FEA/CFD software's) depending upon the application before the prototype is been made to check whether the components are going to work according to its intended function. After that once appropriate results are obtained the final practical testing is carried out.

IV. MATERIAL SELECTION

Glass fibre has roughly comparable mechanical properties to other fibres such as polymers and carbon fibre. Although not as strong or as rigid as carbon fibre, it is much cheaper and significantly less brittle when used in composites. Glass fibres are therefore used as a reinforcing agent for many polymer products; to form a very strong and relatively lightweight fibre-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), also popularly known as "fiberglass". This material contains little or no air or gas, is denser, and is a much poorer thermal insulator than is glass wool.Glass fibre is formed when thin strands of silica-based or other formulation glass are extruded into many fibres with small diameters suitable for textile processing. The technique of heating and drawing glass into fine fibres has been known for millennia; however, the use of these fibres for textile applications is more recent.

Properties of GFRP:

Young's modulus – 39.3 GPa
Density – 2630 kg/m^3
Poisson's ratio –0.33

V. MODELLING AND SIMULATION

Computer- aided design systems are powerful tools and in the mechanical design and geometric modelling of products and components. The chassis geometry model has been modelled by using CAD application SOLIDWORKS. Solid works is feature based. Geometry is composed of a series of easy to understand features. A feature is the smallest building block in a part model.

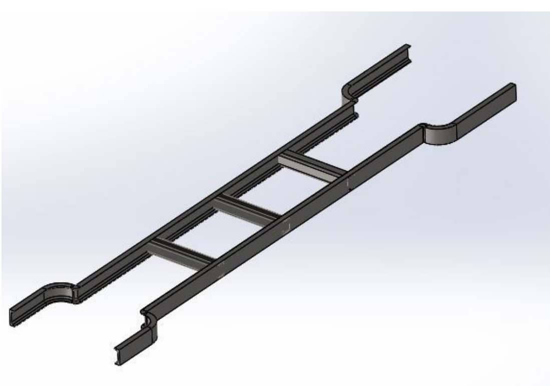


Figure 1. Chassis Design in Solid works

Using IGES, a CAD user can exchange product data models in the form of circuit diagrams, wireframe, and freeform surface or solid modelling representations. Applications supported by IGES include traditional engineering drawings, models for analysis, and other manufacturing functions. For simulation, the ANSYS application has been used and analyse the mechanical behaviour of chassis.

Figure 1 represents CAD model of chassis whereas figure 2 represents boundary conditions.

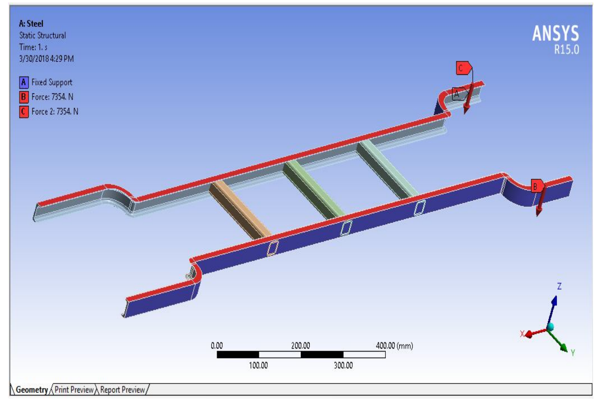


Figure 2. Boundary Condition of Chassis Geometry

5.1 Result and Discussion:

Results for structural steel:

Figure 3 to figure 5 represents the structural results of structural steel material and tabulated in table 1.

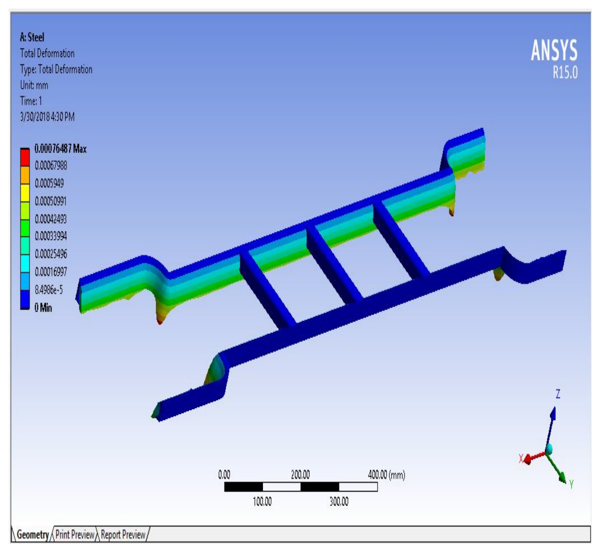


Figure 3. Total Deformation for Structural Steel Material

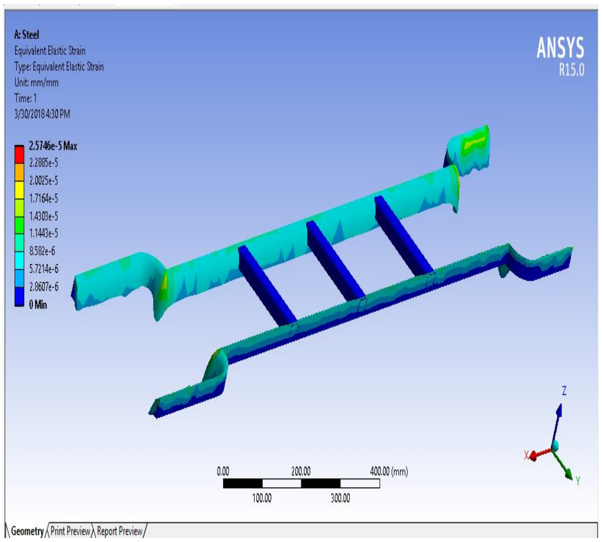


Figure 4. Equivalent Elastic Strain (Structural Steel)

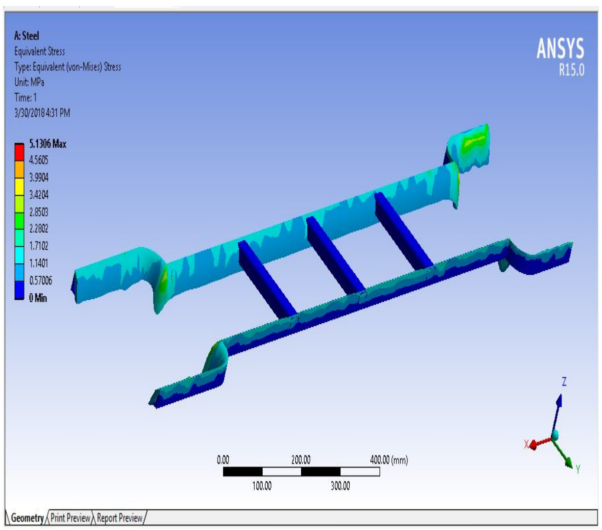


Figure 5. Equivalent (Voin- Mises) Stress(Structural Steel)

Table 1 –Observation of Mechanical Behaviour for Structural Steel

Structural Steel	Maximum	Minimum
Total Deformation (mm)	0.00076487	8.49865e-5
Elastic Strain	2.5746e-5	2.8607e-6
Elastic Stress (MPa)	5.1306	0.57006

Results for GFRP:

Figure 6 to figure 8 represents the structural results of E-Glass Fibre Reinforced Polymer material and tabulated in table 2.

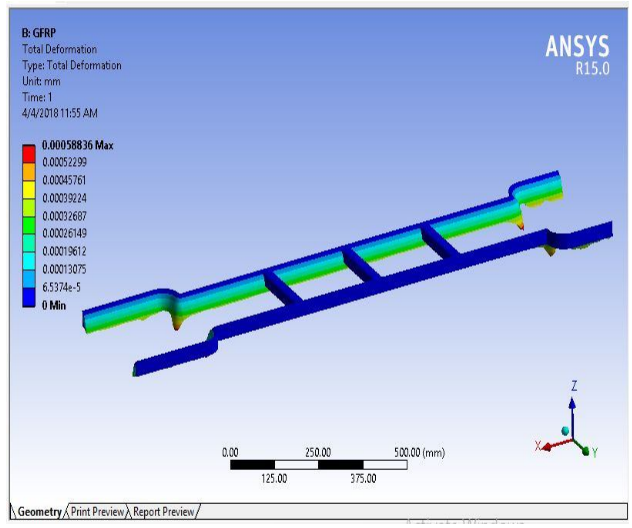


Figure 6. Total Deformation for GFRP Material

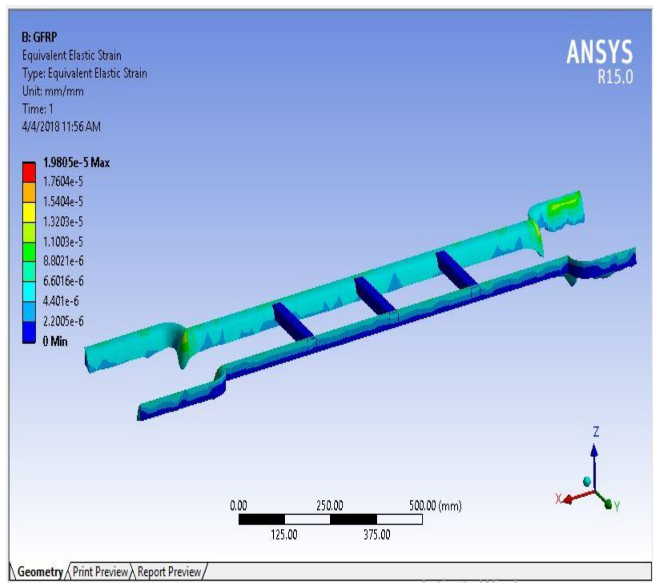


Figure 7. Equivalent Elastic Strain (GFRP)

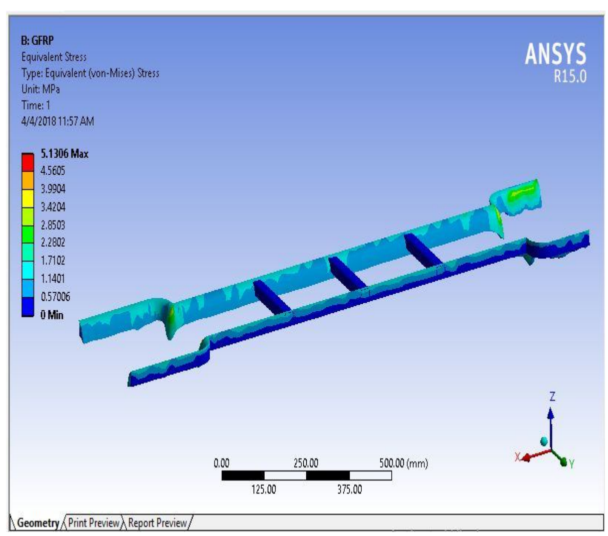


Figure 8. Equivalent (Voin- Mises) Stress (GFRP)

Table 1 – Observation of Mechanical Behaviour for GFRP

E- GFRP	Maximum	Minimum
Total Deformation (mm)	0.00058836	6.5374e- 5
Elastic Strain	1.9805e-5	2.2005e-5
Elastic Stress (MPa)	5.1306	0.57006

VI. CONCLUSION

In this paper we have designed a chassis used in heavy vehicles. Present used material for chassis is steel. We are replacing the material with composite materials E Glass Epoxy. Since the density of composite materials is less than that of steel, the weight of chassis reduces using composite materials than steel.

- In results, total deformation of steel is 0.00076487mm whereas for GFRP is 0.00058836 mm on applying load 7354 N.
- The elastic strain of steel is $2.5746e^{-5}$and elastic strain is $1.9805e^{-5}$for the load of 7354 N.
- The stress attains for chassis with steel and E-GFRP material is 5.1306 MPa.

When we compare the resultsfor allthree materials, the stress value is less for E Glass Epoxy and also its weight is less compared with other two materials. So we can conclude that using E Glass Epoxy is better.

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