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Design and Analysis of TATA 2518 TC Chassis Frame

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***Abstract*: Chassis Frame structure is an important supporting member for various mechanical components of any vehicle, hence its study is very important factor for any automotive hub. The truck chassis form the backbone of truck and its main function is to safely carry the maximum load whether the vehicle is in static or dynamic condition. The chassis frame has to bear the stressesand deformation, fatigue failure with welding cracks. This paper presents the study of the stress developed in chassis as well as deformation of chassis frame by material optimization. The model of the chassis has been developed in CATIA V5.Static structural analysis had done in ANSYS WORKBENCH 17.2 for existing material and new material and result is tabulated.**

***Keywords*: Heavy truck chassis frame, CATIA, ANSYS, Von-Mieses stress, Total deformation.**

1. Introduction

The chassis is considered to be one of the significant skeletons of an automobile. It is the frame which holds both the vehicle body and the mechanical components like the engine and the drive train, axle assemblies including the wheels, suspension parts, brakes, steering components, etc., are mechanically linked to the chassis. Thus chassis provides strength needed for supporting the different vehicular components as well as the payload and helps to keep the automobile rigid and stiff under various loading conditions. Hence it also play a major role in overall safety of an vehicle. Furthermore, it ensures low levels of noise, vibrations and harshness throughout the automobile. Chassis should be rigid enough to withstand the shock, twist, vibration and other stresses. Along the strength, an important consideration in chassis design is to have adequate bending and torsional stiffness for better handling characteristics. So, strength and stiffness are two important criteria for the design of chassis. The major challenge in today's vehicle industry is to overcome the increasing demands for higher performance, lower weight, and longer life of components, all this at a reasonable cost and in a short period of time. Since the truck chassis is a major component in the vehicle system, it is often identified for refinement. There are many industrial sectors using this truck for their transportations such as the logistics, agricultures, factories and other industries. The automobile chassis is tasked with holding all the components together while driving, and transferring vertical and lateral loads, caused by accelerations, on the chassis through the wheels. The automotive chassis provides the strength necessary to support a vehicle's components and the payload placed upon it. The body of the vehicle encloses the mechanical components and passenger compartment. The components which make up the chassis are held together in proper relation to each other by the frame.

The side members, or rails, are the heaviest part of the frame. The side members are shaped to accommodate the body and support the weight. They are narrow toward the front of the vehicle to permit a shorter turning radius for the wheels, and then widen under the main part of the body where the body is secured to the frame. Trucks and trailers commonly have frames with straight side members to accommodate several designs of bodies and to give the vehicle added strength to withstand heavier loads. The cross members are fixed to the side members to prevent weaving and twisting of the frame. The number, size, and arrangement of the cross members depend on the type of vehicle for which the frame was designed. Usually, a front cross member supports the radiator and the front of the engine. The rear cross members furnish support for the fuel tanks and rear trunk on passenger cars and the tow bar connections for trucks. Additional cross members are added to the frame to support the rear of the engine or power train components. The gusset plates are angular pieces of metal used for additional reinforcement on heavy-duty truck frames. With this type of frame construction, the body structure only needs to be strong and rigid enough to contain the weight of the cargo and resist any dynamic loads associated with cargo handling and cargo movement during vehicle operation and to absorb shocks and vibrations transferred from the frame. In some cases, particularly under severe operating conditions, the body structure may be subjected to some torsional loads that are not absorbed completely by the frame. We designed a CAD model of the chassis on the 3D modelling software. Using this design software allowed the team to visualize the design in 3-D space and reduce errors in fabrication. In this project, 'CATIA' V5 is the software used for the modelling of the chassis and analysis has done with the help of ANSYS software. Our paper has Stress analysis as a key characteristic of a chassis. Paper mainly focussed on material optimization of an TATA 2518TC Model chassis based Von-Meises stress, maximum principle stress, and total deformation.

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2. Literature survey

Mr. akash singh patel, Mr. atul shrivastava (2016) has studied "Modeling, Analysis & Optimization of TATA 2518 TC Truck Chassis Frame using CAE Tools," Structure Steel ST37 Grey cast iron AISI 4130 steel alloy ASTM A710 Steel chassis material in various cross sections like C, I and Box Section. After analysis a comparison is made between existing structure steel chassis and alloy steel materials in terms of deformation and stresses, to select the best one [1].

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 (C, I and Box sections) 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%. From the results, modified "C" sections are used as an optimized section [2].

A. *Problem statement*

We study the different research paper and we notice that, the many problems is in chassis like weight, stress-strain, deformation and their cross-section of chassis. So, our work is to design and analysis of the chassis to change their cross-section and checking the stress-stain and deformation.

B. *Vehicle specification*

Table 1
Vehicle Specification

Properties	Values
Total length of chassis	9010 mm
Width of chassis	2440 mm
Wheel base	4880 mm
Front overhang	1260 mm
Rear overhang	2115 mm
Ground Clearance	250 mm
Capacity (GVW)	25 ton
Kerb Weight	5750 kgs
Payload	19250 kgs

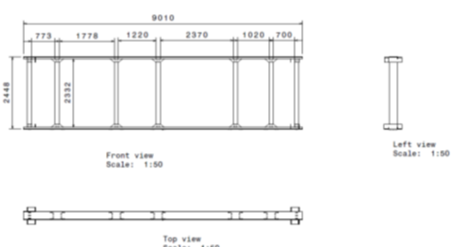

Fig. 1. Vehicle specification

C. *Material selection*

ASTM A302 grade B is a type of ASTM A302 alloy steel. Cited properties are appropriate for the as fabricated (no temper or treatment) condition. It has the lowest ductility compared to the other variants of ASTM A302 alloy steel [3].

Table 2
ASTM-A302 Material Properties

Properties	Values
Modulus of elasticity (MPa)	190 GPa
Hardness, Brinell	190
Tensile Strength, Ultimate	620 MPa
Tensile Strength, Yield	320 MPa
Elongation at Break (In 50 mm)	20%
Poisson's Ratio (Typical For Steel)	0.27-0.30
Machinability	45%

D. *Calculation*

The overall length of C-Section:
Channels with Height (H) = 285 mm,
Width (B) = 65mm,
Thickness (t) = 7 mm

1) Basic calculation for chassis frame

Model No. = LPT 2518 TC (TATA)
Capacity of Truck = 25 ton (Kerb Weight+ Payload)
= 25000 kg = 245250 N
Capacity of Truck with 1.25% = 245250 *1.25 N = 306562 N
Total Load acting on the Chassis = 306562 N
285mm x 65mm x 7mm
The two beams are used in this chassis so the half load acting.
Load acting on the single frame = Total load acting on the chassis / 2
= 306562 /2
=153281 N / Beam

2) Loading conditions

Load acting on Entire span of the beam is 153281 N.
Length of the Beam is 9010 mm.
Uniformly Distributed Load is 153281 / 9010 = 17.0 N/mm

3. 3-D CAD modelling

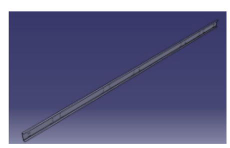

Fig. 2. Side member

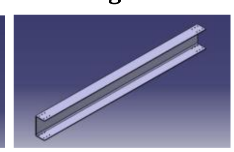

Fig. 3. Cross member

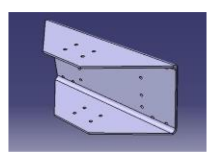

Fig. 4. Strip

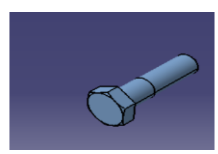

Fig.5. Nut

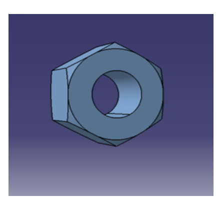

Fig. 6. Bolt

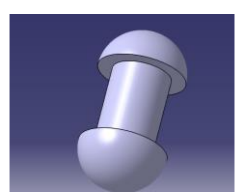

Fig. 7. Rivet

4. Structural analysis of AISI-4130

A. Meshing

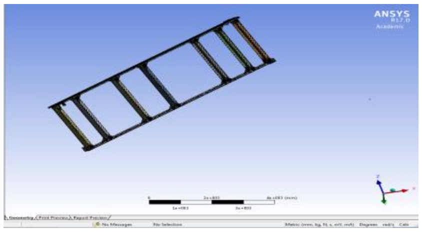

Fig. 8. Meshing

B. Maximum principal stress

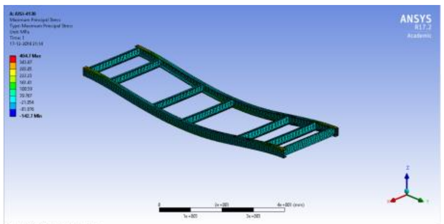

Fig. 9. Maximum Principal Stress

C. Equivalent (von-Mises) stress

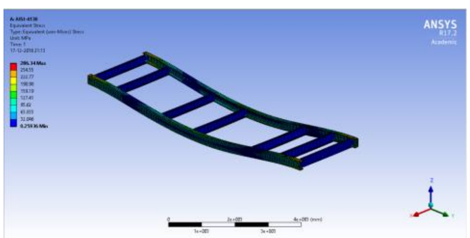

Fig. 10. Equivalent (von-Mises) Stress

D. Total deformation

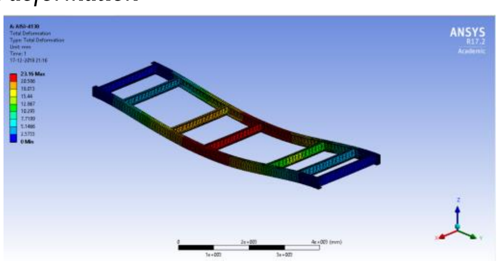

Fig. 11. Total Deformation

5. Structural Analysis of ASTM-A302

A. Maximum principal stress

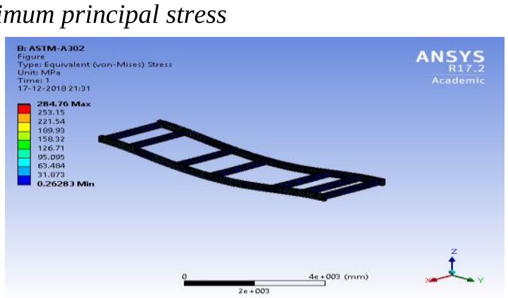

Fig. 12. Maximum Principal Stress

B. Equivalent (von-Mises) stress

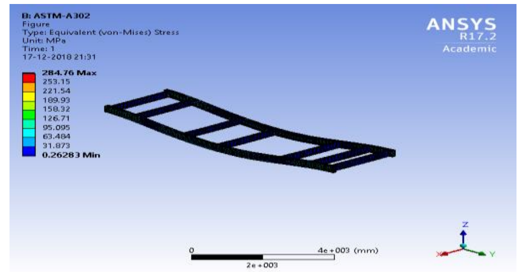

Fig. 13. Equivalent (von-Mises) Stress

C. Total deformation

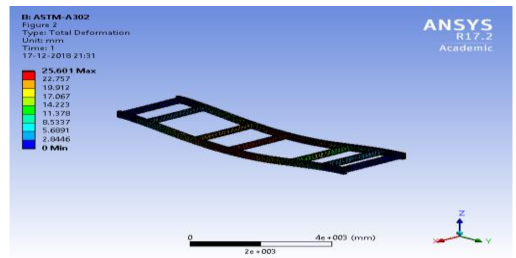

Fig. 14. Total Deformation

6. Result Table

Table 3
Result

Material	AISI-4130 (Std.)	ASTM-A302
Maximum Principal stress	404.7	400.23
Equivalent (von-Mises) Stress	286.34	284.76
Total Deformation	23.16	25.601

7. Conclusion

In this analysis on C-cross section ladder chassis using material (ASTM-A302) is done. By this analysis we confirmed that materials show approximately similar von mises stress, maximum shear stress & AISI-4130 (Std.) shows frequently less deformation when compared to ASTM-A302, the difference is acceptable and safe.

References

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