Structural Analysis of Toyota FZJ79LPickup

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Abstract: **The automotive chassis forms the structural backbone of a vehicle. The main function of the chassis is to support the components and payload placed upon it. When the vehicle travels along the road, the chassis is subjected to various stress distributions and displacement under various loading conditions.**

This paper deals with the total deformation and stress analysis of the Toyota FZJ79L pickup truck chassis when subjected to static load and frontal impact.

Keywords: **chassis, static loads, side impacts, ladder frame, Toyota pickup truck chassis**

I. INTRODUCTION

The design of chassis is completely based on the data gathered from previous publications and the objective is to design chassis that will use standard component. The CAD design of chassis was made in SOLIDWORKS 14. Analysis of deformation and stress is done using ANSYS 14.

The chassis is one of the main parts of the automobile; engine transmission, suspension, shafts steering and body are mounted on the chassis mounting points.

The chassis serves as a framework for supporting the body and different parts of the automobile. Also, it should be rigid enough to withstand the shock, twist, vibration and other stresses. Along with 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 thechassis.

II. DESIGN OF CHASSIS

Design of chassis is done in Solidworks 14 with the following dimensions

Overall length of chassis: 4880mm Sections used:

1. Hollow circularsection:
2. Csection
3. Hollow boxsection:
4. Isection:

A 2D model in top plane and frontplane was made with the given dimensions and using project curve command final path of box section was made. All other sections weremade as per given dimensions.

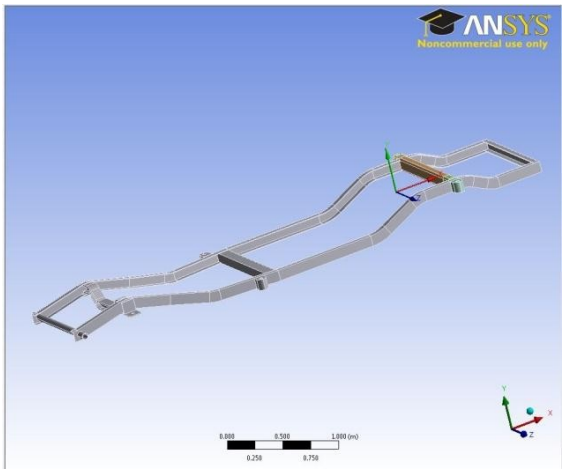

Fig. 1: CAD model in Ansys workbench14

III. MATERIAL USED

Material used for chassis was structural steel.

Density	7850 kg m^{-3}
Coefficient of Thermal Expansion	1.2e-005 C^{-1}
Specific Heat	434 J kg^{-1} C^{-1}
Thermal Conductivity	60.5 W m^{-1} C^{-1}
Resistivity	1.7e-007ohm m

IV. CALCULATIONS

1. Static condition:

When vehicle is standing or is in static condition; engine load and payload are acting on the chassis members in different portions.

Engine load: 7360 N Payload: 29283 N

2. Front impact force calculations: Deformation and stress analysis is done as follows:

Mass of the vehicle (m)-3200 Kg Now,

Force (F)= m*a

Where m=mass of the vehicle\

a = acceleration in m/s^2 a = v-u/t

taking t =22.5 seconds a =0.98 m/s^2 Therefore

Force=3160 N

V. DEFORMATION AND STRESS UNDER STATICCONDITION

Chassis file is imported in ANSYS WORKBENCH14 from Solidworks by saving it in IGES format.

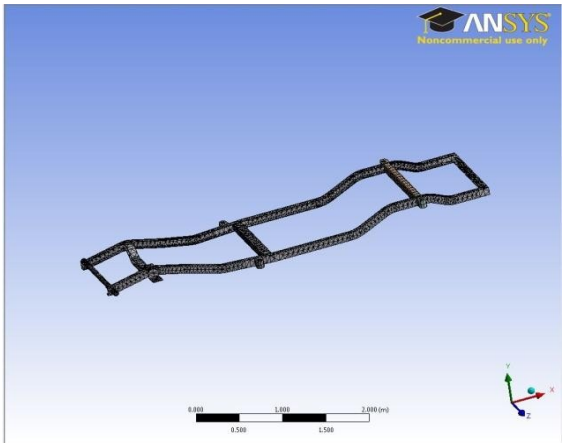

Fig 2: meshed model

All wheel mountings are made fixed to support for the structure to bear theload

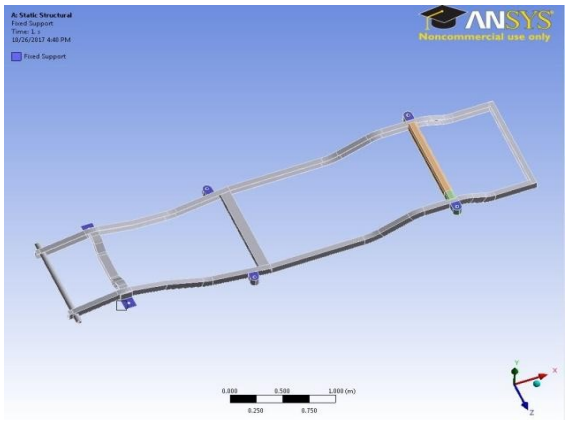

Fig.3: fixed supports at wheelmountings

Engine load is applied on the engine bracket.

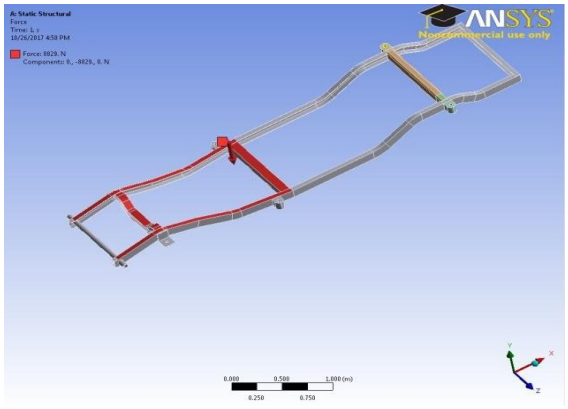

Fig.4: engine load.

Payload is applied separately on two horizontal members

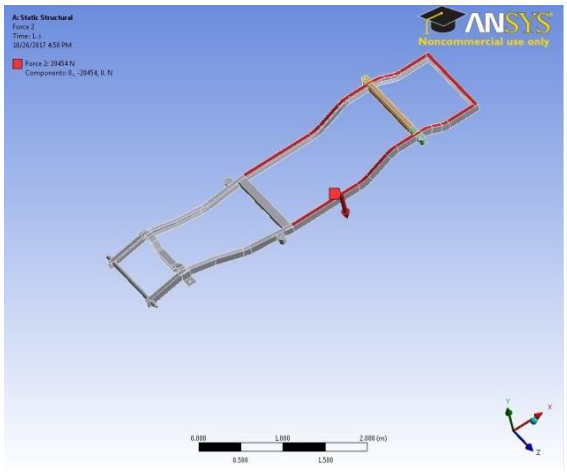

Fig. 5: Cargo load

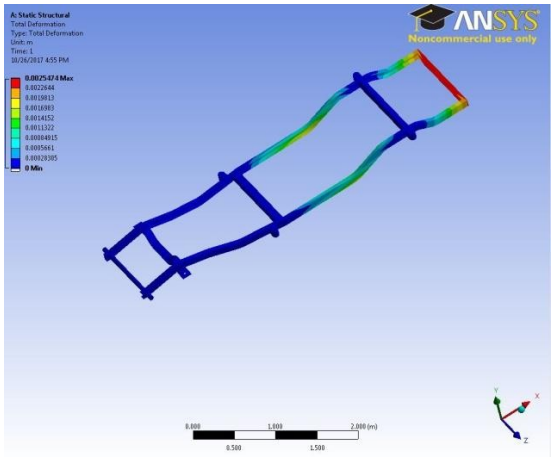

Fig. 6: total deformation Von misses stress:

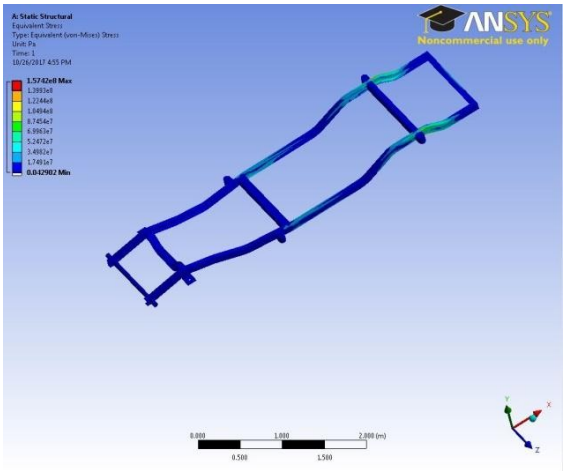

Fig 7: Von misses stress of static loads shown in above figure.

Parameter	Max	Min
VonMisses stress for StaticLoad	1.742e8(Pa)	0.0429(Pa)
Total Deformation	0.00254(mm)	0.00023(mm)
Von Misses stress during frontal Impact	2.667e7(Pa)	753.44(Pa)
Total deformation during frontal Impact	0.0060978(m)	7.622e-5(m)
Safety Factor	15	2

Deformation and Stress Developed In Front Impact

In front impact, one side that is rear side of chassis is completely fixed and force is applied from another side

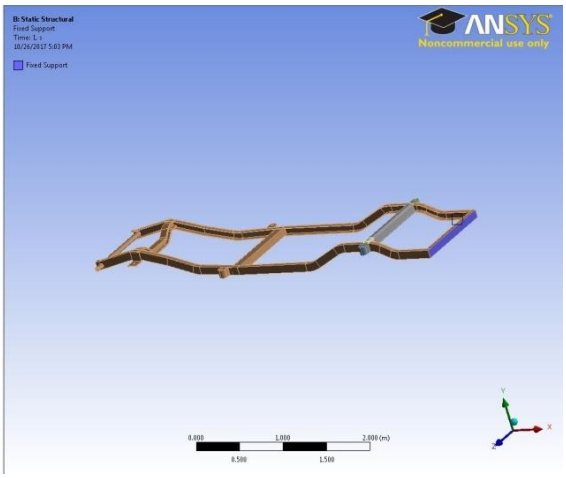

Fig 8: Fixed support at the rear end of chassis.

Total deformation:

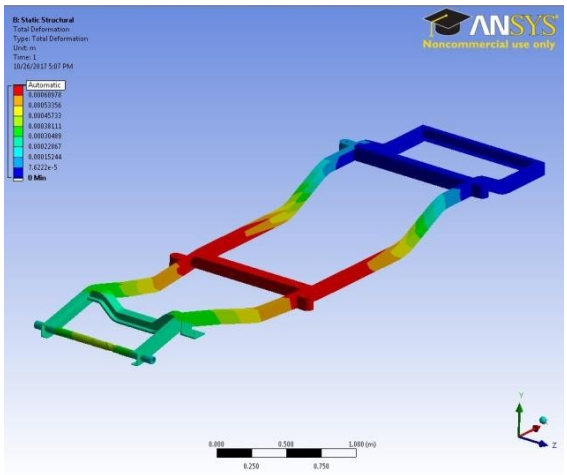

Fig 9: Total deformation during front impact.

Von misses stress:

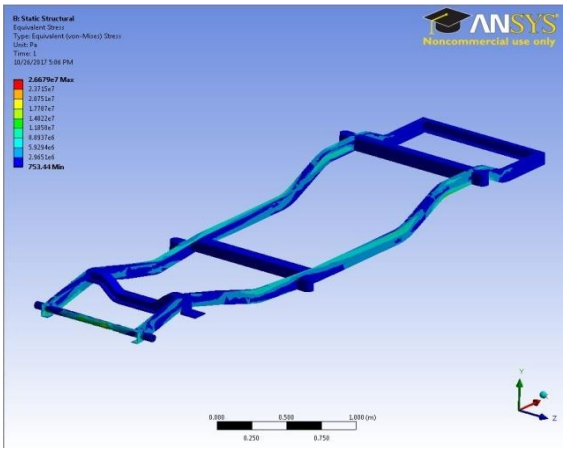

Fig :10: von misses stress during front impact

Safety factor:

Factor of safety (FoS), also known as (and used interchangeably with) safety factor (SF), is a term describing the load carrying capacity of a system beyond the expected or actual loads.

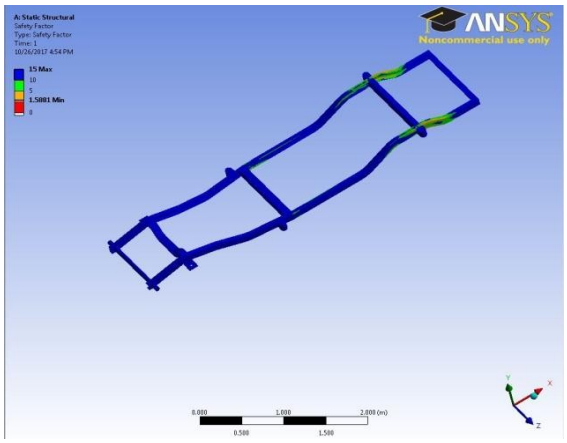

Fig:11: Safety factor

VI. CENTER OF GRAVITY OF CHASSIS

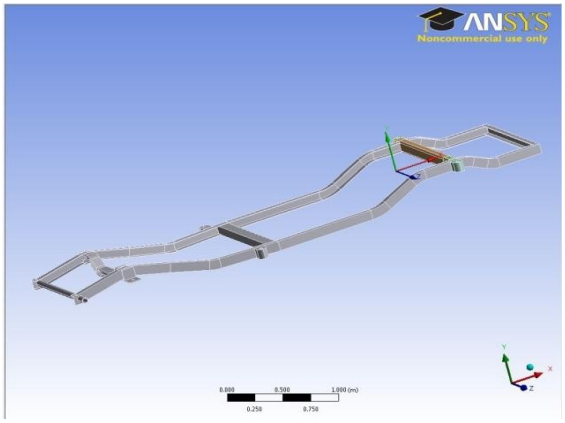

Fig. 12: Center of gravity of chassis

Origin X	3.4964 m
Origin Y	9.561e-002 m
Origin Z	-0.32151 m

Fig: 13: Co-ordinates of CG

VII. CALCULATIONS

Material Used- Structural Steel E= 210GPa

Poisson's Ratio= 0.3

Allowable Shear Stress= Yield Strength / F.O.S Yield Strength= 340 MPa

F.O.S= 2

So, Allowable Shear stress= 340 / 2

= 170 MPa

For the given Chassis the Allowable Shear Stress if more than the induced Shear Stress and hence we can say that the Chassis is safe.

VIII. CONCLUSION

It was shown that an FEA model could be used to simulate the automotive chassis accurately by verification of stresses using the beam model.

It was also noted that bending of structure may occur if payload is increased that may result in failure of structure.

In order to make the structure safer and more reliable, length of plate should be increased and more no. of cross section should be added. More cross sections in chassis will it heavy but it will also increase its stiffness and loading capacity.

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