iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 2 **Issue:** III **Month of publication:** March 2014

DOI:

ISSN: 2321-9653

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE AND ENGINEERING TECHNOLOGY (IJRASET)

Design and analysis of chassis frame of TATA 2516TC

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Abstract: Automotive chassis is an important part of an automobile. The chassis serves as a frame work 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 the chassis. This report is the work performed towards the analysis of the automotive chassis with constraints of stiffness, strength and natural frequency.

Keywords: Chasis frame, Design, Stress Analysis, Pro-Mechanica

I. INTRODUCTION

Automobile chassis usually refers to the lower body of the vehicle including the tires, engine, frame, driveline and suspension. Out of these, the frame provides necessary support to the vehicle components placed on it. Also the frame should be strong enough to withstand shock, twist, vibrations and other stresses. The chassis frame consists of side members attached with a series of cross members.

Along with the strength an important consideration in the chassis design is to increase the stiffness (bending and torsion) characteristics. Adequate torsional stiffness is required to have good handling characteristics. Normally the chassis are designed on the basis of strength and stiffness. In the conventional design procedure the design is based on the strength and emphasis is then given to increase the stiffness of the chassis.

Structural systems like the chassis can be easily analyzed for the stress, and stiffness, etc. using finite element techniques. The chassis is modeled in PRO-E. FEA is done on the modeled chassis using the Pro-Mechanica.[1]

II. BASIC CALCULATION FOR CHASSIS FRAME [1]

Model No. = 2516 TC (TATA)

Capacity of Truck = 25 ton

= 25000 kg

= 245250 N

Capacity of Truck with 1.25% = 245250 x 1.25 N

= 306562 N

Total Load acting on the Chassis = 306562 N

All parts of the chassis are made from "C" Channels with 285mm x 65mm. Each Truck chassis has two beam. So load acting on each beam is half of the Total load acting on the chassis.

Load acting on the Chassis

= Total load acting on the chassis / 2

= 306562 / 2

= 153281 N / Beam

ISSN: 2321-9653

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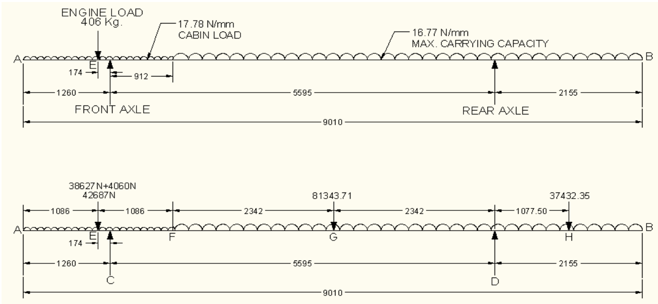

Fig.1 Load condition of the Chassis

2.1. Calculation for the Deflection

M_{max} = 84184504.18 Nmm

Material of the Chassis is as per IS :- 9345 standard is Structural Steel with St37.

Material Property of the St37 [5] :-

Ultimate Tensile Strength = 370 to 490 N/mm^2

E = 2.10×10^5 N / mm^2

Poisson Ratio = 0.29

Radius of Gyration R = (285 / 2)

=142.50 mm

Now we can calculate the maximum shear stress and maximum deflection using the equation given below.

Basic Bending equation are as follow :- $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$

Deflection of chassis

$$Y_1 = \{[(w \times X)/(24 \times E \times I)] \times [L^3 - 2LX^2 + X^3]\}$$

$$= \{[(17.78 \times 1260)/(24 \times 2.10 \times 10^5 \times 1520738354)] \times [9010^3 - 2 \times 9010 \times 1260^2 + 1260^3]\}$$

$$Y_1 = 2.05 \text{ mm}$$

$$Y_2 = \{[(w \times X)/(24 \times E \times I)] \times [L^3 - 2LX^2 + X^3]\}$$

$$= \{[(16.77 \times 2155)/(24 \times 2.10 \times 10^5 \times 1520738354)] \times [9010^3 - 2 \times 9010 \times 2155^2 + 2155^3]\}$$

$$Y_2 = 3.007 \text{ mm}$$

Maximum deflection produced in the Chassis frame is 3.007mm. According deflection span ratio is allowable for simply supported beam is 1 / 300

That is within safe limit according deflection span ratio.

III. FE Analysis of Existing Chassis Frame

For carrying out the FE Analysis of chassis as per standard procedure first it requires to create merge part for assembly to achieve the connectivity and loading and constraining is required to be applied also idealization of parts is done on structure this will lead to faster analysis since the connected structure will not be physical but it will be a sketch with mechanical properties of mechanical structure. Procedure is followed in this section.

3.1. Cross Section of Main Frame

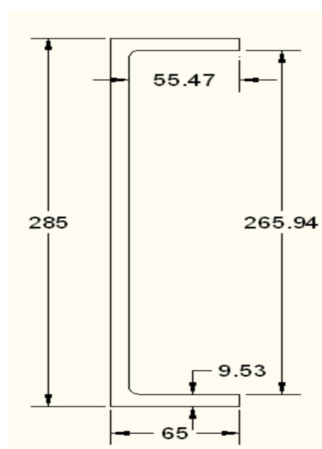

Fig.2 C-Section of Chassis Frame

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3.2. Assembly of Chassis

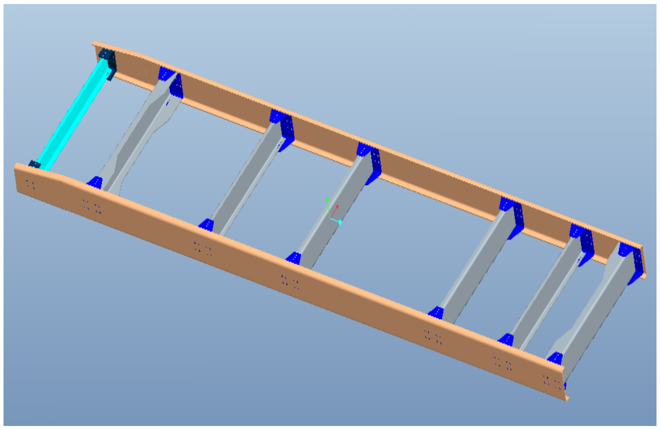


Fig 3 Assembly model of Chassis

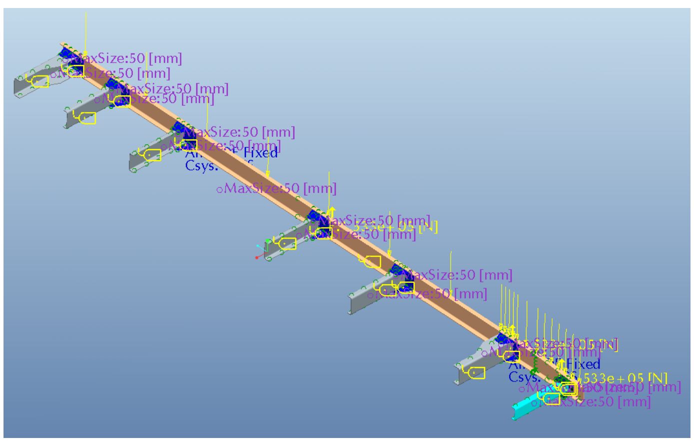


Fig.4 Loading and constraining of Chassis

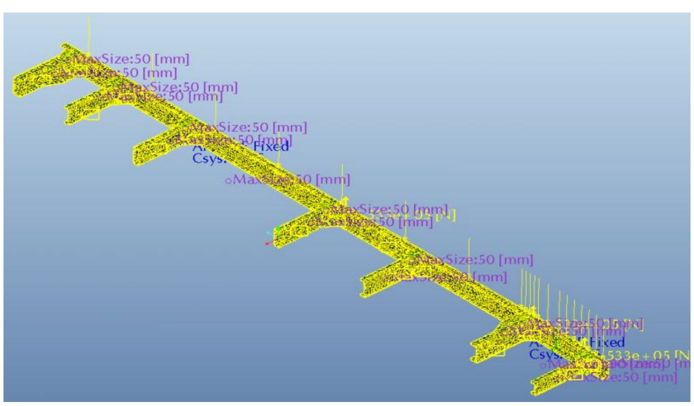
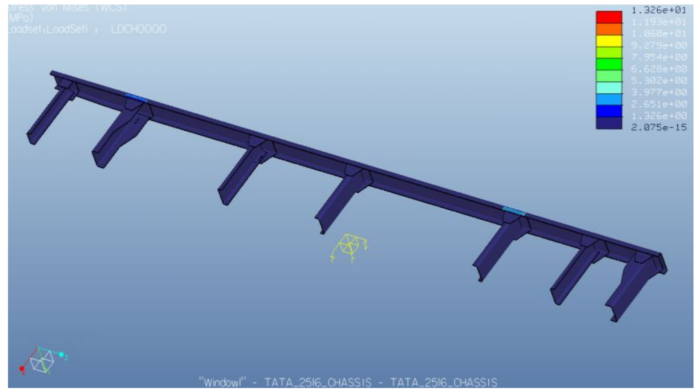


Fig.5 Meshing of Chassis

3.3. FEA Result



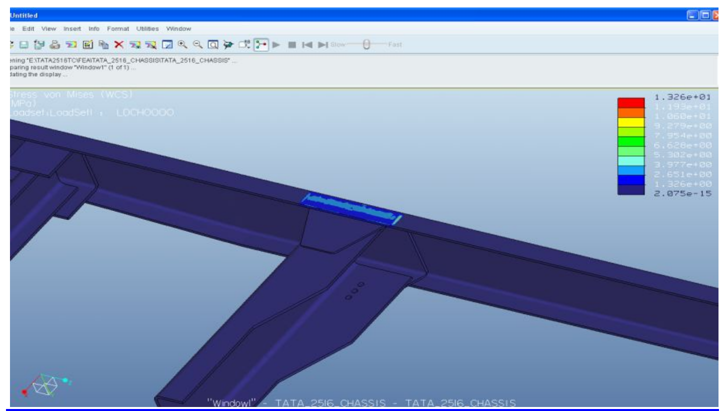


Fig 6 Von Mises Stress Result

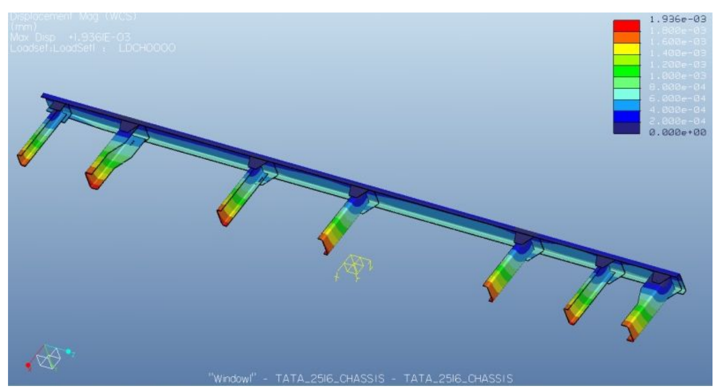


Fig 7 Displacement Result

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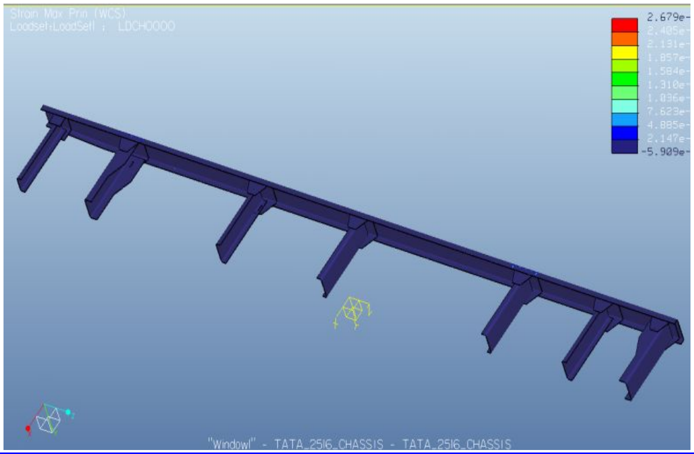


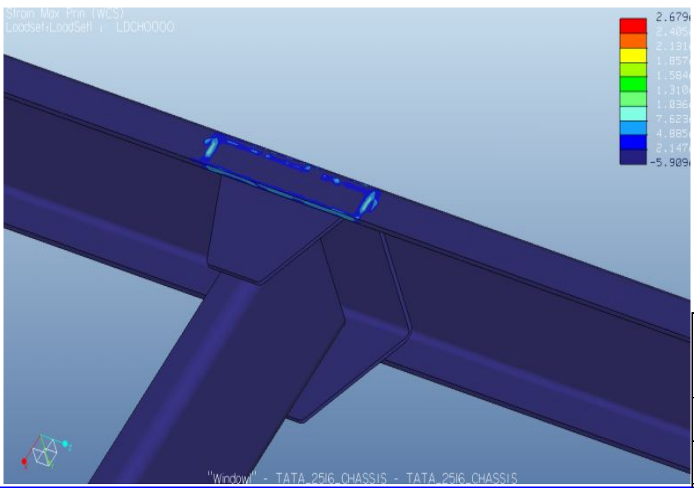
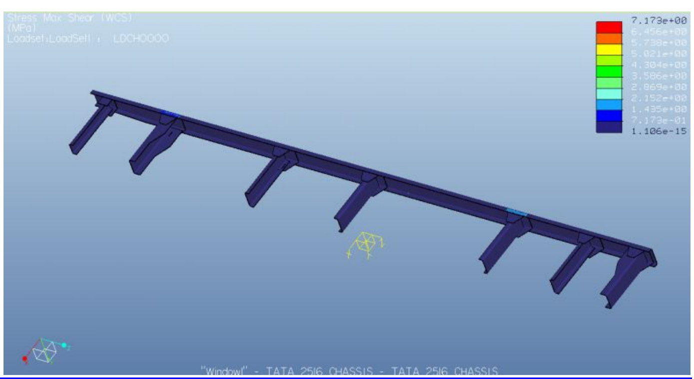


Fig 8 Strain Result



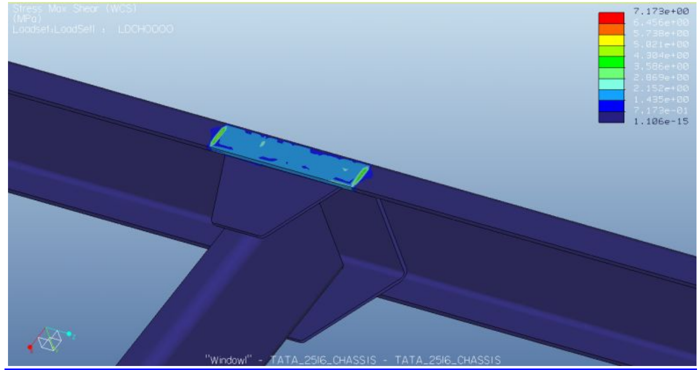


Fig 9 Max. Shear Stress Result

IV. RESULTS

TABLE I

ANALYSIS RESULT

Sr. No.	Parameters	Analysis Result
1	Assembly Weight (Kg.)	975.44
2	Stress (N/mm^2) (Max.)	13.26
3	Displacement (mm) (Max.)	0.001936
4	Strain (Max.)	0.00002679
5	Shear Stress (N/mm2) (Max.)	7.173

V. CONCLUSION

Allowable Tensile strength for St 37 Steel is 370 to 490 N/mm^2. By considering factor of safety is 5 times allowable tensile stress is 74 to 96 N/mm2. As Shown in above figures generated Von Mises Stress, Displacement magnitude, Strain and Max. Shear Stresses are Within Limit so **DESIGN IS SAFE.**

ISSN: 2321-9653

From this paper, author have experienced about the analysis software like Pro/Mechanica. Pro/Mechanica software is been used to analysis because modification is very easy as there is toggling possible between Pro/Mechanica & standard module Pro/E. In other software like Ansys, Ideas-CAE, Abacus etc., analysis procedure is too large & after analysis if results are not within the range, the entire model is to be rebuilt.

ACKNOWLEDGMENT

We would like to thankful to our faculties and technical guide for extending their support and for valuable suggestions

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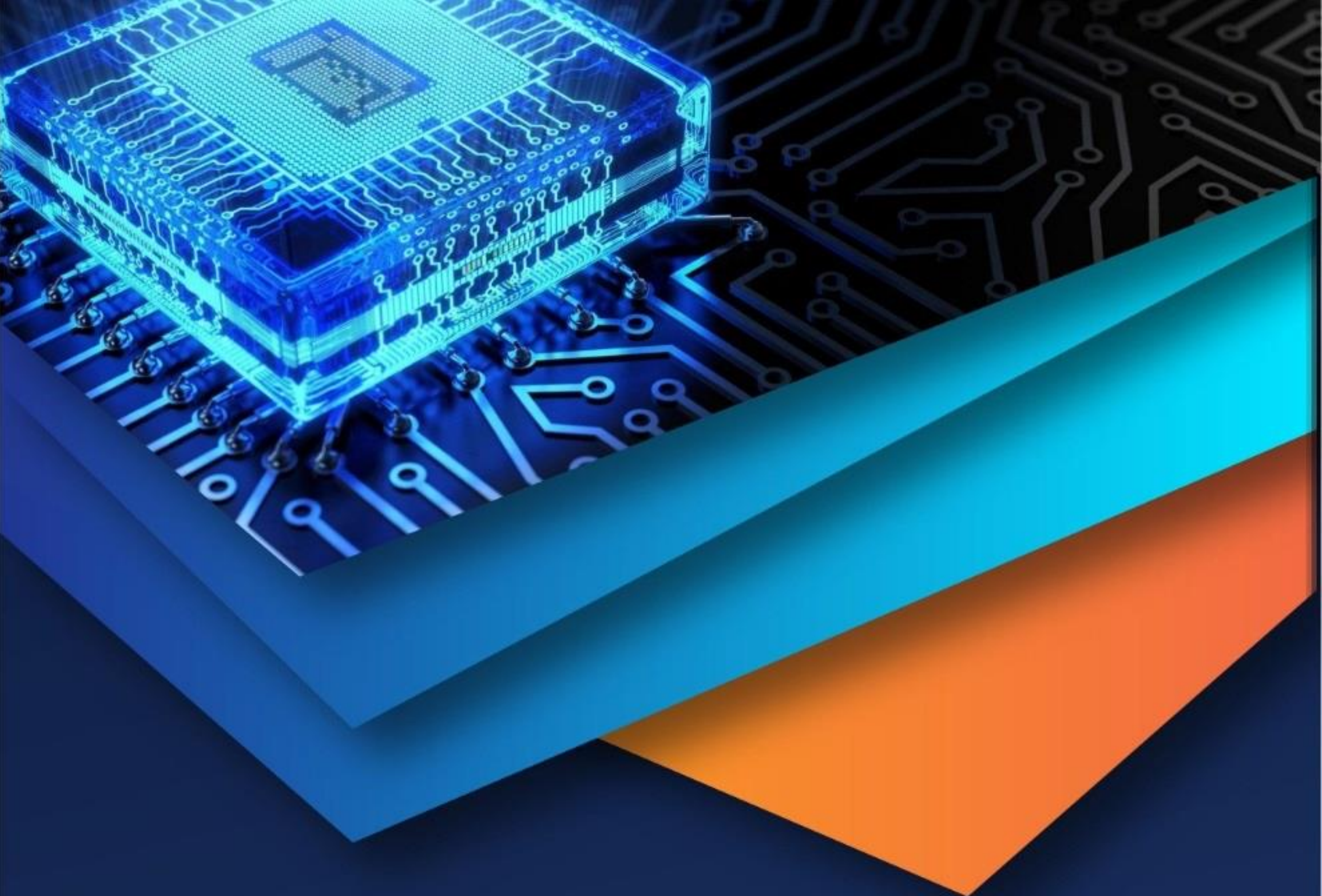

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