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Effect of Torque on Ladder Frame Chassis of Eicher 20.16

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ABSTRACT
Automotive chassis is backbone of vehicle. Chassis carries steady load, vehicle load, driving force and braking force. Hence chassis has to be designed for static and dynamic loading. In this paper chassis of Eicher 20.16 has been considered, and the behavior of chassis under same load but varying thickness is studied through Ansys.
Keywords – Ansys, chassis, deformation, thickness, torque.

I. INTRODUCTION

The automotive 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 suspension and to the wheels. A ladder frame is the simplest and oldest frame used in modern vehicular construction. It was originally adapted from "horse and buggy" style carriages as it provided sufficient strength for holding the weight of the components. If a higher weight holding capacity was required then larger beams could be used. It was comprised of two beams that ran the entire length of the vehicle. A motor placed in the front (or rear sometimes) and supported at suspension points. Add the passenger compartment and a trunk with a load and it becomes a simple indeterminate beam.

Here the chassis of Eicher 20.16 is of ladder frame type which has two side members or longitudinal members of C- cross section and seven transverse members called cross members of C- cross section. The chassis has been modeled in Ansys 13 using the most of the actual dimensions. FEM analysis was done using Ansys 13.

II. DESIGN AND CALCULATIONS

2.1 Determination of load

Model No. = 20.16
Side bar of the chassis are made from "C" Channels with 230 mm x 76 mm x 6 mm
Cross member of chassis are made from "C" channels with 210mm x 76 mm x 6 mm
Front Overhang (a) = 1588 mm
Rear Overhang (c) = 2145mm

Wheel Base (b) = 4800 mm
Material of the chassis is St 52

E = 2.10 x 10^5 N / mm2
Poisson Ratio = 0.31
Radius of Gyration R = 230/2 =115 mm

Capacity of Truck = 11400 kg = 111834 N
Capacity of Truck with 25% overload = 139792.5 N
Weight of the body and engine = 2700 kg = 26487 N
Total load acting on chassis = Capacity of the Chassis + Weight of body and engine
= 139792.5 + 26487
= 166279.5 N
Chassis has two beams. So load acting on each beam is half of the Total load acting on the chassis.
Load acting on the single beam = 166279.5/2
= 83139.75 N

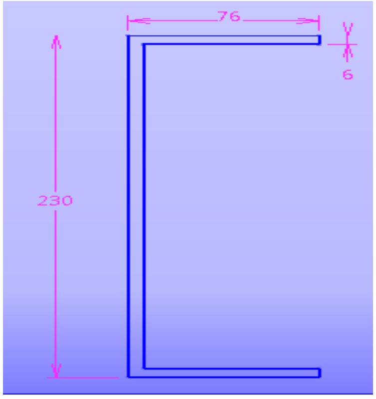

Fig. 2.1 (a) C- section of side member

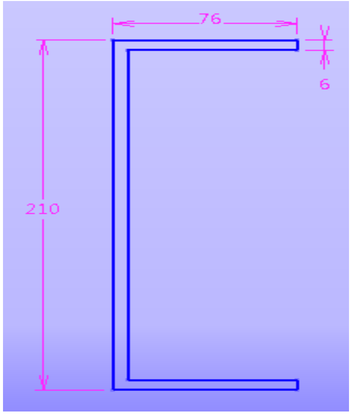

Fig. 2.1 (b) C-section of cross bar

For Validation of FEM Model i.e. type of element and mesh density, a cantilever beam is taken of same length as that of main member of chassis also the cross section is same.

2.2 Type of element: - Solid45 is used for the analysis.

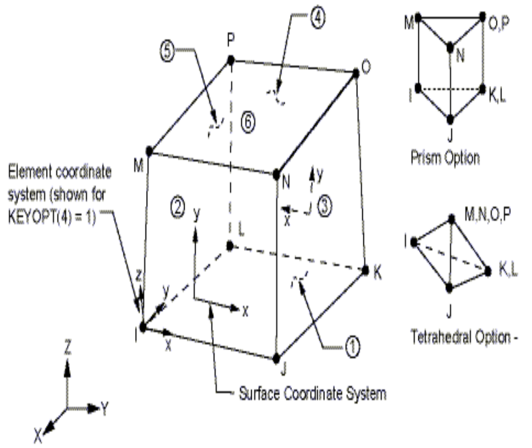

Fig.2.2 solid45 element type

Tab 2.2 Table of Mesh Density

No. of element	51614
No. of Nodes	18824

An arbitrary load of 1 N/mm is applied in the form of pressure on the upper face of C channel is constrained for all DOF at the end is determined using formula.

Deflection of chassis for cantilever beam

$Y= [(w \times l^4) / (8 \times E \times I)]$

Where,
Y = deflection at the free end of beam
w = Load per unit length
l = Length of beam
E = Young's modulus of the material of the beam
I = Area moment of Inertia of beam about an axis passing through its center of gravity

$= [(1 \times 85334) / (8 \times 2.1 \times 105 \times 16622980)]$

$= 189.84$ mm

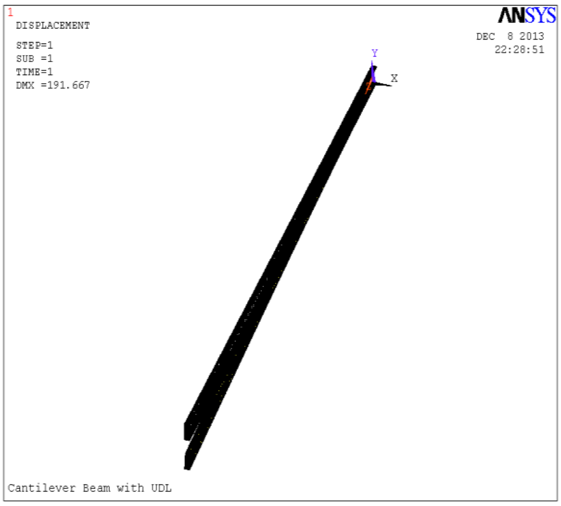

Fig. 2.2 (a) Deformation of cantilever beam

The fig. no.2.2 (a) shows deformed shape of cantilever beam with undeformed shape,
Deflection obtained by FEM= 191.66 mm
Deflection obtained by Analytical method=189.84mm

Error = [(191.66-189.84)/(189.84)] x 100
=0.959%

As error is within acceptable limit, mesh density and type of element selected are capable of giving correct results for whole chassis.

III. FEM ANALYSIS OF MODEL

3.1 Modeling

Model of chassis drawn in Ansys is as shown in figure..

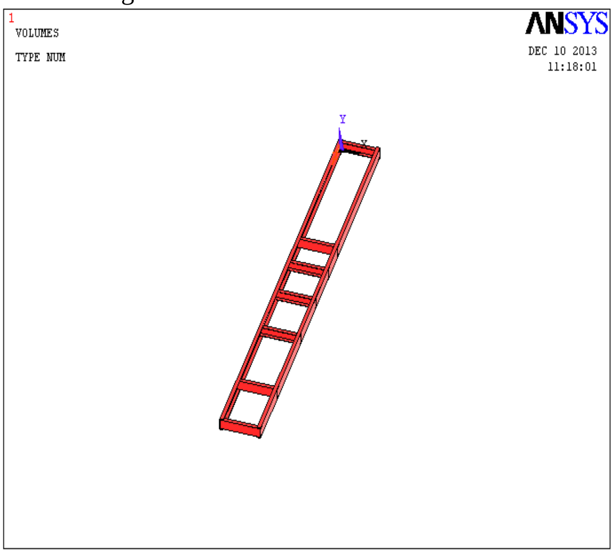

Fig.3.1 model of Ladder chassis frame

3.2 Boundary Conditions and Loading

The truck chassis model is loaded by static forces from the truck body and load. The load is assumed as a uniform distributed obtained from the maximum loaded weight divided by the total length of chassis frame. Detail loading of model is shown in Figure. The magnitude of force on the upper side of chassis is 166279.5N.There are 4 boundary conditions of model; the first two boundary conditions are applied in front of the chassis, the other 2 boundary conditions are applied in rear of chassis, there are shown in Figure.

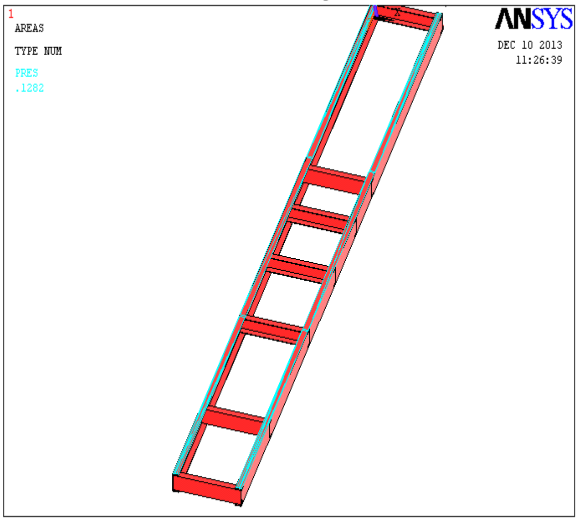

Fig. 3.2 (a) Load condition model

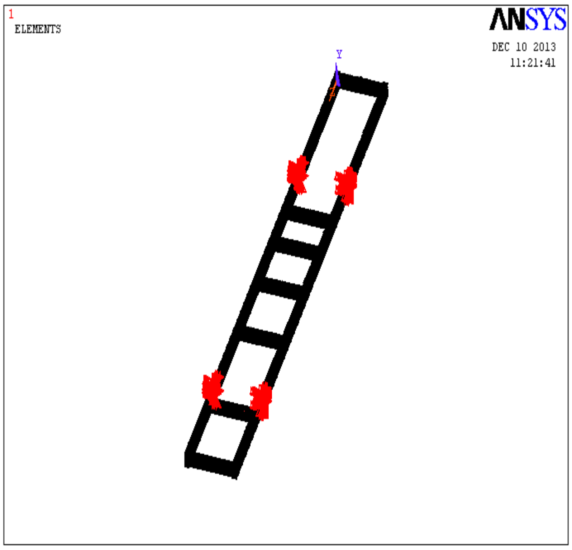

Fig. 3.2 (b) Boundary conditions

3.4 Element and nodes:

The meshed truck chassis model has 175988 elements and 62005 nodes. The element is tetrahedral.

3.5 Results:

The location of Von Mises stress and maximum shear stress are at corner of side bar which in Figure. is 182.994 MPa.

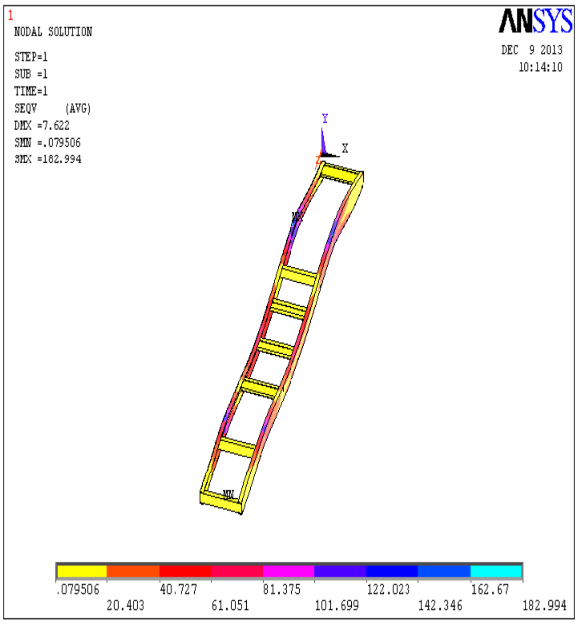

Fig. 3.5 (a) von mises stress in chassis

Von mises stress is more in the region near to rear leaf spring or axle.

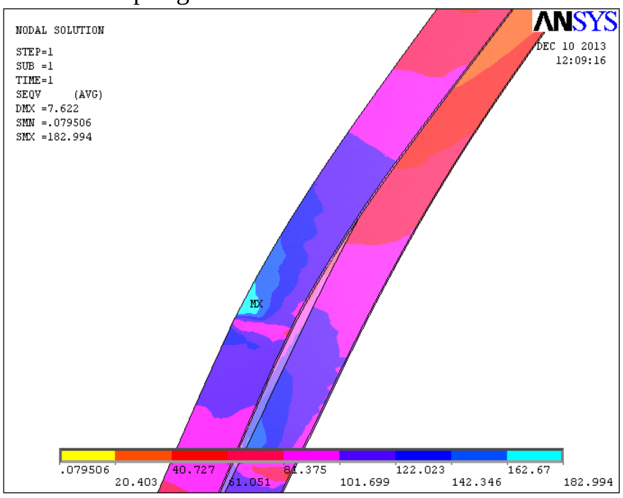

Fig.3.5 (b) maximum von mises stress location

3.5.1 Displacement:

The displacement of chassis shown in Figure. The magnitude of maximum displacement is 7.622 mm.

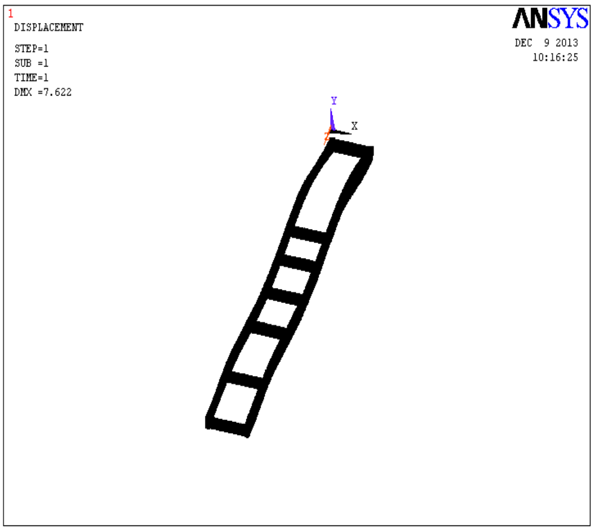

Fig.3.5.1 Deformation in chassis

Von mises stress is 182.944
Deformation is 7.622

3.6 Effect of torque:

During the study, Torque is varied & its effect on the stresses & deformation is observed.

Table 3.6 Effect of varying torque

Sr. No.	Torque(KN-m)	Max. Deformation (mm)	Max. Stress (MPa) Von Mises
1	8	48.304	430.752
2	8.5	51.323	457.674
3	9	54.341	484.594
4	9.5	57.361	511.518
5	10	60.38	538.44

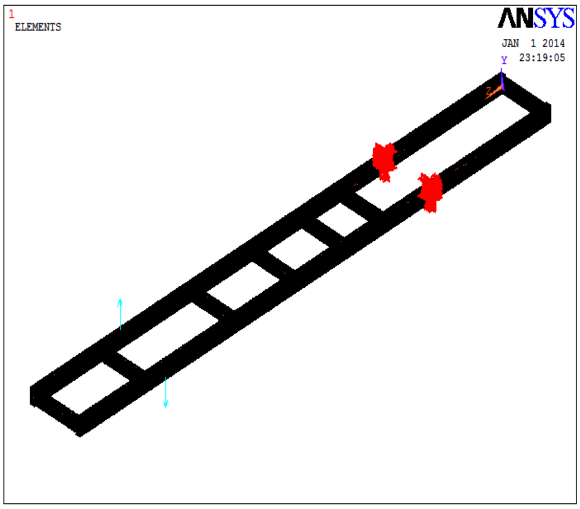

Fig. 3.6 boundary condition and load condition on ladder frame chassis

Here, it is observed that, as the torque increases, the maximum deformation increases continuously as shown in the figure.

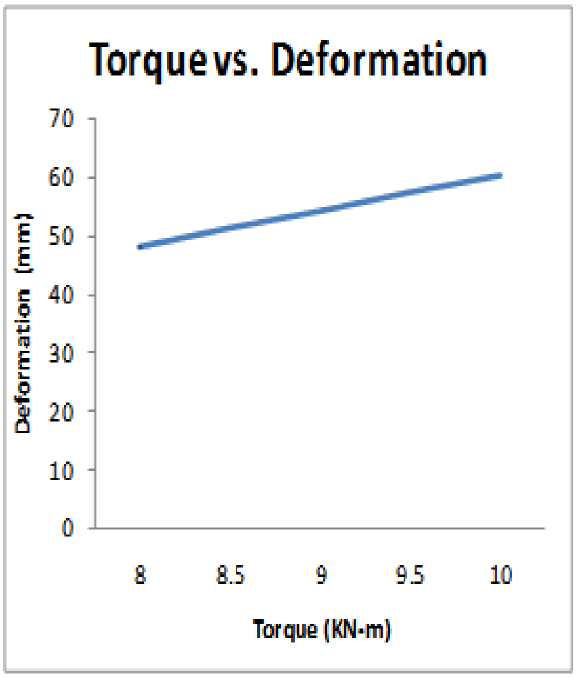

Fig. 3.6 (a) Torque Vs Maximum Deformation of Ladder Chassis

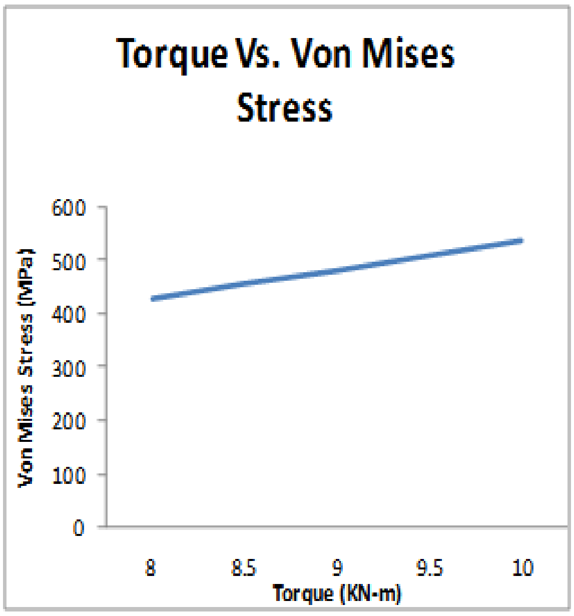

Fig. 3.6 (b) Torque Vs Maximum Von Mises Stress of Ladder Chassis

Here, it is observed that, as the torque increases, there is increase in von mises stress.

3.7 Effect of torque by varying thickness of cross member:

Table 3.7 Effect of torque by varying thickness of Cross member

Sr. No.	Thickness (mm)	Max. Deformation (mm)	Maximum stress (MPa) Von Mises
1	5.667	58.588	591.734
2	6.337	52.651	483.575

IV. CONCLUSION

Analysis of Ladder Chassis Frame is performed during this dissertation work. Following conclusions can be drawn from the same.

- ✓ The maximum value of Von Mises Stress is occurred at the Hinged point of at the Right end of the beam near the top edge of Ladder chassis frame.
- ✓ At the free end of the beam, highest deformation has occurred leading to lowest stresses.
- ✓ As the torque decreases, the maximum deformation decreases continuously.
- ✓ As the torque decreases, there is decrease in von mises stress.
- ✓ Deformation & Stresses are directly proportional to load applied.
- ✓ As thickness increases of cross member, there is decrease in von mises stress and deformation and vice versa.

REFERENCES

[1] Vijaykumar V. Patel and R. I. Patel, “Structural analysis of a ladder chassis frame”, World Journal of Science and Technology 2012, 2(4):05-08 ISSN: 2231 – 2587

[2] M. Ravi Chandra, S. Sreenivasulu & Syed Altaf Hussain, “Modeling And Structural Analysis Of Heavy Vehicle Chassis Made Of Polymeric Composite Material By Three Different Cross Sections”, Journal of Mechanical and Production Engineering Research and Development (IJMPERD), ISSN 2249-6890, Vol.2, Issue 2,Sep 2012 45-60.

[3] I. D. Paul, S. M. Sarange, G. P. Bhole And J. R. Chaudhari, “Structural Analysis Of Truck Chassis Using Finite Element Method”, International J.of Multidispl.Research & Advcs. in Engg.(IJMRAE), ISSN 0975-7074, Vol. 4, No. I (January 2012), pp. 85-98

[4] M. Zehsaz, Vakili Tahami and Esmaeili , “The Effect Of Connection Plat Thickness On Stress Of Truck Chassis”, Asian Journal of applied Science 2(1): 22-35, ISSN 1996-3343, 2009

[5] Akash Lodhi, Kushal Gawande, Udbhav Singh Chetan J. Choudhari, “Static Load Analysis of Tata-407 Chassis -An Approach”, Golden Research Thoughts (March ; 2012), Vol.1,Issue.IX/March 2012pp.1-4

[6] Mohd Husaini Bin Abd Wahab, “Stress Analysis of Truck Chassis”, Project Report Universiti Malaysia Pahang, 2009

[7] M. Ravi Chandra, S. Sreenivasulu, Syed Altaf Hussain, “Modeling And Structural Analysis Of Heavy Vehicle Chassis Made Of Polymeric Composite Material By Three Different Cross Sections”, International Journal of Modern Engineering Research (IJMER) Vol.2, Issue.4, July-Aug. 2012 pp-2594-2600 ISSN: 2249-6645

[8] Joseph Edward Shigley, Charles R. Mischke “Mechanical Engineering Design”, McGraw-Hill Book Company, New York, 2000, Sixth Edition

[9] M. F. Spotts, “Design of Machine Elements”, Prentice Hall of India Pvt. Ltd, New delhi, 2004.