STATIC LOAD ANALYSIS OF TATA SUPER ACE CHASSIS AND ITS VERIFICATION USING SOLID MECHANICS

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Abstract— Automotive chassis can be considered as the backbone of any vehicle. Chassis is tasked at holding all the essential components of the vehicle like engine, suspension, gearbox, braking system, propeller shaft, differential etc. To sustain various loads under different working conditions it should be robust in design. Moreover chassis should be stiff and strong enough to resist severe twisting and bending moments to which it is subjected to. This paper presents the static load analysis (excluding damping and inertia effects) of the chassis of TATA super ace using ansys workbench and its verification using solid mechanics.

Keywords-FEM, CAD, G.V.W. , CATIA.

I. INTRODUCTION

Chassis usually denotes the basic frame that decides the overall shape of the vehicle. It is aimed at holding important components of the vehicle. Here the chassis of TATA super ace is of ladder frame type which has two side members or longitudinal members of C- cross section and five transverse members called as cross members of box cross section. The chassis has been modelled in CATIA V5R18 using the most of the actual dimensions. FEM analysis was done using ansys 14 workbench.

II. BASIC CALCULATION

Model:- tata super ace
Length of vehicle = 4340 mm
Width of vehicle = 1565 mm
Height of vehicle = 1858 mm
Wheelbase = 2380 mm
Track width = 1320 mm
Material of chassis = structural steel
Youngs modulus = 2 e+5
Poissons ratio = 0.3
Length of chassis = 4201 mm
Width of chassis = 808 mm
Dimensions of side bar = 100mm x 36mm x 5 mm
Dimensions of cross bar = 90 mm x 90 mm
Gross vehicle weight (G.V.W) = 2180 kg
Kerbweight = 1180 kg

The above load (G.V.W) is applied in the form of pressure.

Hence the total area of application of load as calculated from chassis dimensions = 1182600 mm^2.

Total load to be applied = 2150 x 9.81
= 21091.5 N

Pressure to be applied = 21091.5/1182600
= 0.017834 MPa.

III. FEM ANALYSIS OF CHASSIS

For carrying out the FE analysis of the frame the CAD model is prepared in CATIA and then the analysis is done in ansys workbench. CAD model is prepared using following dimensions:-

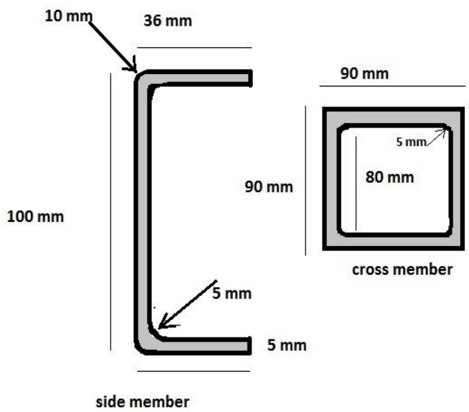

Figure 1 Dimensions of cross sections

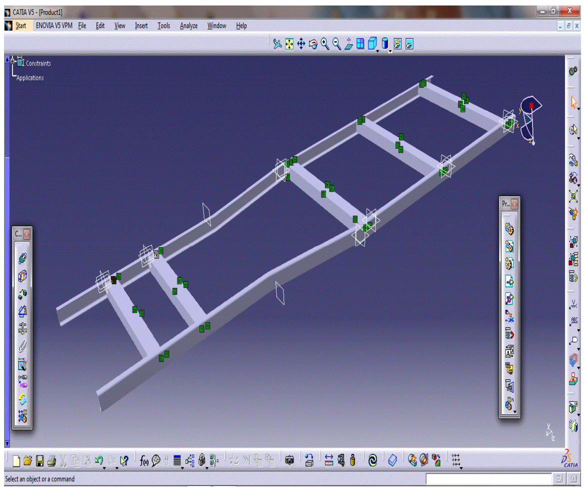

Figure 2 CAD model of chassis

IV. MESHING

Meshing is done using the auto mesh mode of ansys workbench. The mesh model has 8112 elements and 20998 nodes.

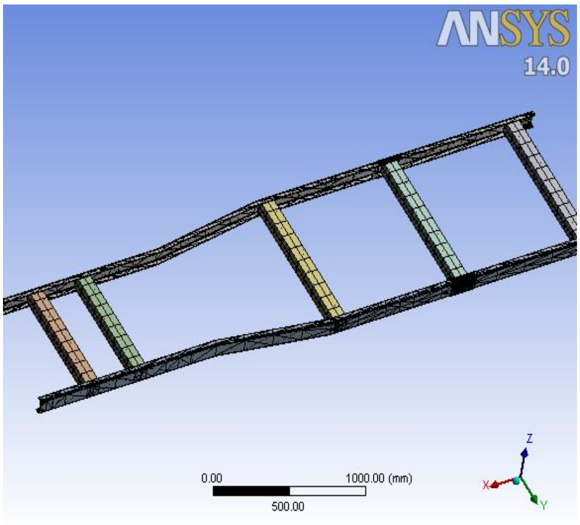

Figure 3 Meshed model of chassis

V. LOAD APPLICATIONS AND BOUNDARY CONDITIONS

Load is applied in the form of pressure of magnitude 0.017834 MPa. There are two boundary conditions which includes fixing the front and the rear axle.

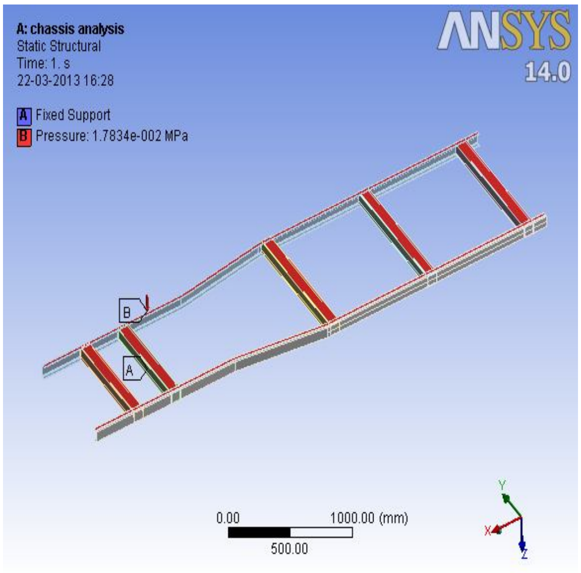

Figure 4 Fixed support and pressure application

VI. RESULTS

The maximum stress intensity of magnitude 149.51 MPa is found to be in close proximity of rear axle at the joint of side member and cross member. The von mises stress magnitude is 146.37 MPa. Also the magnitude of total deformation is 1.6471 mm.

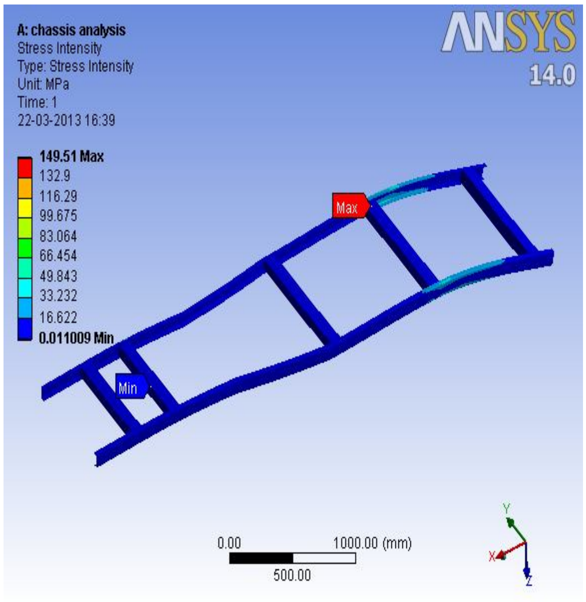

Figure 5 Stress intensity

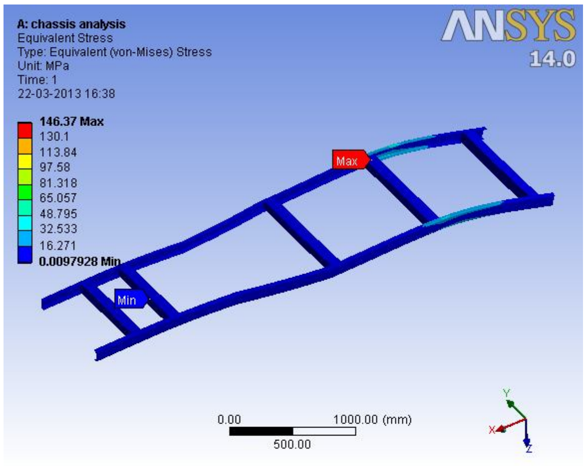

Figure 6 Von Mises stress

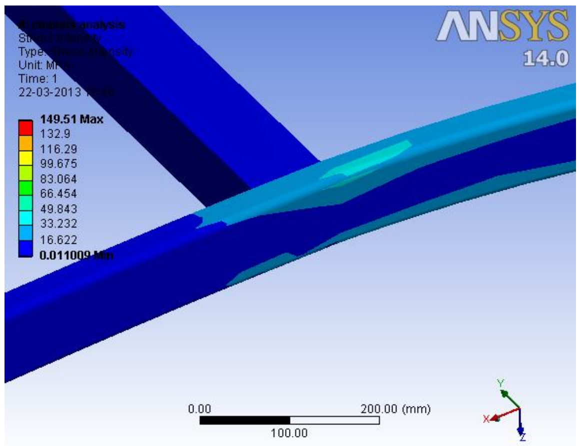

Figure 7 Close view of maximum stress

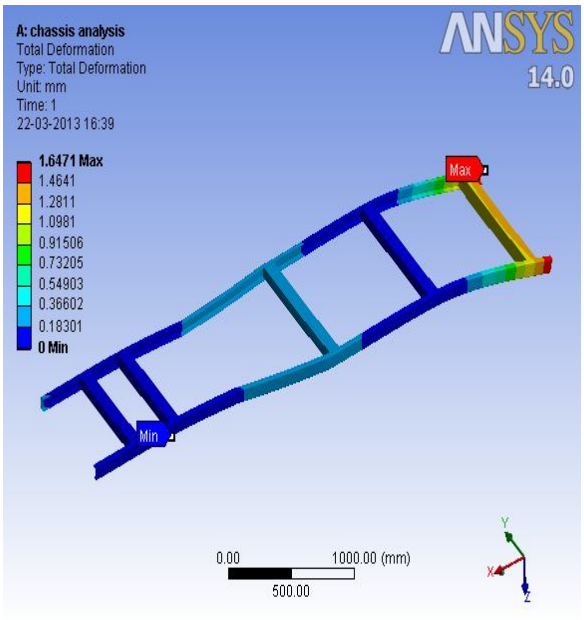

Figure 8 Total deformation

VII. VARIFICATION OF RESULTS USING SOLID MECHANICS

Verification of software results can be done by considering the chassis as an overhanging beam carrying a uniformly distributed load (U.D.L).

Uniformly distributed load = total load/length of chassis

=21091.5/4201 =5.0209 N/mm

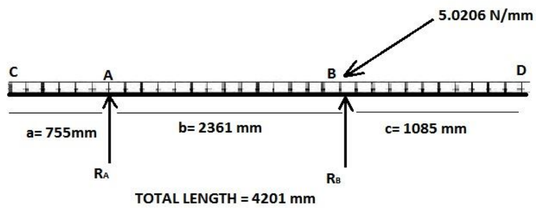

Figure 7 chassis as an overhanging beam

Calculating the reactions R_A and R_B :-

Here

$R_A + R_B = 21091.5$ N

Taking the moment about A,

$R_B \times 2361 = 17300.98 \times 1723 - 3790.55 \times 377.5$

$R_B = 12019.76$ N

$R_A = 9071.74$ N

BENDING MOMENTS:-

BMB (at B) = $- \{5.0206 \times (1085)^2\}/2$

= -2955187.91 N-mm

BMA (at A) = $- \{5.0206 \times (3446)^2\}/2 + 12019.76 \times 2361$

= -1430948.275 N-mm

Hence the maximum bending moments occurs at B.

MOMENT OF INERTIAS:-

M.O.I. of side members (I_1) = $36 \times (100)^3 /12 - 31 \times (90)^3 /12$

= 1116750 mm^4

M.O.I. of cross members (I_2) = $90 \times (90)^3 /12 - 80 \times (80)^3 /12$

= 2054166 mm^4

Total M.O.I (I) = 1116750 x 2 + 2054166 x 5

= 12504333.33 mm^4

Using the bending equation,

$$M/I=\sigma_b/y, \qquad (1)$$

$$\sigma_b = My/I_1$$

= 2955187.91 x 50/ 1116750

= 132.312 MPa

Deflection of the chassis can be calculated using the empirical formula (ref to the structural analysis of ladder chassis frame ISSN 2232-2587)

$$Y = \frac{wL(b-L)[L(b-L)+b^2 - 2(c^2+a^2) -2b^{-1}\{c^2 L + a^2 (b-L)\}]}{24 EI} = 2.0803 \text{ mm}$$

Hence the stress and the deflection calculated are close to software values i.e 149.51 MPa and 1.6471 mm. the slight deviations in the values are may be because software not able to reproduce actual conditions and simplification of the chassis model.

CONCLUSION

Finally the design, static analysis and its verification using solid mechanics has been successfully accomplished. The work not only provides an insight into the design and analysis of the chassis but also pinpoints the critically stressed points where the design can be modified for improving the chassis.

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