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Design And Optimization Of Truck Chassis Frame

[1]A. Satyanand, [2]Dr. K. Hemachandra Reddy

[1]PG Research Scholar, Product Design, [2]Professor, Department of Mechanical Engineering, JNTUA College of Engineering, Ananthapuramu, A.P., India.

[1]satyaayyala617@gmail.com, [2]konireddy@gmail.com

Abstract - Automobile chassis refers to the lower part of the vehicle which includes engine, frame, tires, suspension and driveline. Out of all these, the frame gives required support to the vehicle parts placed on it. Chassis frame must be so strong that it resists impact load, twists, vibrations and other bending stresses. In design of a chassis frame, along with strength it is important to consider Bending and Torsional Stiffnesses. On observing various researches previously done on chassis, it has been found that "C" section provides good Bending stiffness but lacks in Torsional stiffness. The present research aims to improve the stiffness of a truck chassis frame by combining two different types of cross sections to make the design more resistant to bending and torsional stresses with mass constraint. Eicher PRO 6025 model having "C" sectioned frame is considered for modeling. Generally C, I, BOX and TUBULAR cross sections are proposed for frames. A maximum of the torsional loads by road irregularities act on cross members. So, it is preferably assumed to modify the cross sections of transverse members with all proposed sections to get an optimized chassis frame with improved Bending and Torsional Stiffness.

Keywords: Bending Stiffness, Chassis, Combined Cross sections, Deformation, Stress, Torsional Stiffness

I. INTRODUCTION

Now a days usage of heavy structures and parts are popular as ready-made flyover structures, windmill turbines and blades, heavy engines, rockets and satellite parts etc,. Due to the uneven sizes and loads of the parts, air and water transportation becomes expensive and sometimes it may not be possible as the destination may be at hilly areas. So road transport becomes vital for movement of heavy loads to their destinations with less risk factor. Mostly Trucks are used for transport of the large dimensioned structures as they may be available from 6 tyres to 72 tyres and can weigh upto 80 tons. Since the chassis is a major component in the vehicle system, it is often identified for refinement.

The chassis frame consists of longitudinal side members riveted to a series of 5 to 6 cross members. Stress analysis can be done by using Finite Element Method (FEM) to determine the critical point which is having maximum stress. This critical point causes the fatigue failure. The magnitude of the stress controls the life span of the truck chassis. The design of an automobile structure is the fundamental importance to the overall performance. The vehicle structure plays a vital role in the reliability of the vehicle. In conventional way, initially the design is based on strength later it is focused on increasing the stiffness of chassis along with very small consideration given to weight of chassis.

Fig 1: Ladder type chassis

1.1. Different Sections used for chassis:

1.1.1. C Channel Sections:

This section shows good resistance for the bending stresses and mostly used in long sections of the frame [6].

1.1.2. I- Sections:

This section shows good resistance for both bending and torsional stresses. But due to clamping reason generally "I" section is not used for the practical use.

1.1.3. Box sections:

Box section shows good resistance for both bending and torsional stresses. It is mainly used in short members of frames.

1.1.4. Tubular sections:

Tubular section shows good resistance for torsional stresses. It is mainly used in three wheelers, scooters pick-ups and bicycle.

1.2. Loads and Stresses acting on Chassis frame:

Chassis frame is nothing but an under carriage or structure which supports pay load and other parts of the vehicle

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along with the driver cabin and so it can undergo various types of stresses according to the loads act on it [5]. Different loads induce on the frame are:

a. Weight of the vehicle components and the passengers
b. Loads appeared on crossing bumps and hollows.
c. Loads produced by road camber, cornering forces while taking turn.
d. Loads applied when wheels impact with path or road obstacles.
e. Sudden impact loads during collision.

II. LITERATURE REVIEW

Many researchers carried out study on truck chassis are as follows:

Chintada Vinnod babu [1] have studies about the structural importance of Heavy Vehicle Chassis as chassis has to have maximum stability and load bearing capacity. From his studies it is confirmed that Stress and Deformations are the properties to be calculated for achieving maximum stability.

Akash singh Patel, Jaideep Chitransh [2], Kamlesh Y. Patil, Eknath R. Deore [3] and Abhishek Singh et al. [4] investigated on truck chassis by considering different sections to find the bending stress and deformation values using analysis software. From the analysis, better strength and less deformation is achieved for Rectangular Section but when considered weight constraint, C-Section is next better one in performance.

Steven Tebby et al [9] have studies for the determination of Torsional Stiffness in Automobile Chassis and presented three approaches as Analytical Method, Simulation Method, and Experimental Method by assuming torsion stiffness is linear and angle of twists with 95% confidence. This paper suggests formulas for determining torsional stiffness.

B. Ramana Naik and C. Shashikanth [12] have objective to analyze an automobile chassis for a 10 tonne vehicle. Overhanging model of longitudinal beam is taken and is calculated for the stresses and deflections theoretically and those values are used for the comparison with the results obtained in the analysis software. Modal Analysis is also done to find the natural frequency of the chassis and seen that it is above than its excitation frequency. Both the results from Theoretical calculations and FE analysis results are compared for stresses and deflection and it is observed that they are within the permissible range. This frequency is more than 4 times the highest frequency of the excitation (i.e. 33 Hz) hence the chassis can faithfully transmit the input excitation to the vehicle body without any amplification.

Ashutosh Dubey and Vivek Dwivedi [13] have studies on the Load Cases and Boundary conditions for Stress Analysis of Vehicle Chassis and different loads are considered as static load cases, worst load cases which determine the maximum Bending Stiffness acts on longitudinal side bars. Dynamic load conditions mainly Loads on the Grades, Low Speed Acceleration, Braking and Steady State Cornering determines the Torsional Stiffness that results on both side members and cross members and some combination load cases are also analysed. From the results, both Bending and Torsional Stiffness has to be evaluated for better stress analyzation.

Goolla Murali [14] investigated on truck chassis by considering different thicknesses to find the Bending and Torsional Stiffness values using HyperMesh analysis software. From the analysis, better strength and less deformation is achieved and it is found that Torsion produced on cross members is more than longitudinal members and therefore Torsional rigidity plays a vital role in failure of chassis.

III. MODELING OF CHASSIS FRAME

When we talk about 3D modeling all the softwares are same, just the interfaces are changed. Most of the companies prefer CATIA and PRO E because the cost of these softwares is low when compared to the NX CAD. 3D components can be modeled first and assembly is done later precisely with constraint methodology. Errors may be discovered at the prototype stage itself which makes the work safer and less expensive.

Pro-E 5.0 (Creo) is used for modeling Chassis frame.

Fig 2: Selected model for Chassis frame

3.1. Model Selected: Eicher PRO 6025

3.2. Chassis Frame Specifications:

- Total Length of chassis frame: 9010 mm
- Width of chassis frame: 2440 mm
- Wheel Base: 4880 mm
- Front Overhang: 1260 mm
- Rear Overhang: 2155 mm
- Capacity: 25 ton
- Cross Section used: C-Channel (285 mm x76 mm x7 mm)
- No. of Cross Members used: 5

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3.3. Different combinations of Cross sections used (To improve Torsional Stiffness):

Longitudinal Frames	Cross Members
C-Section	C-Section
C-Section	I-Section
C-Section	BOX-Section
C-Section	TUBE-Section

3.4. Detailed drawing:

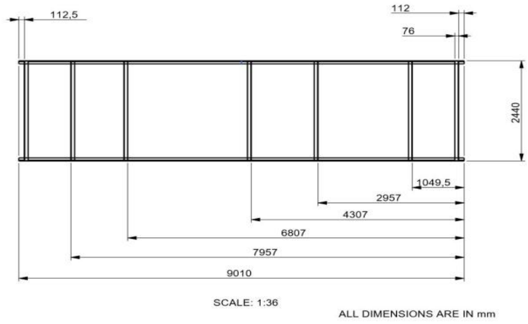

Fig 3: Chassis frame drawing with preferred dimensions

3.5. Modeled Chassis frames:

Fig 4: C-SECTION

Fig 5: C-I SECTION

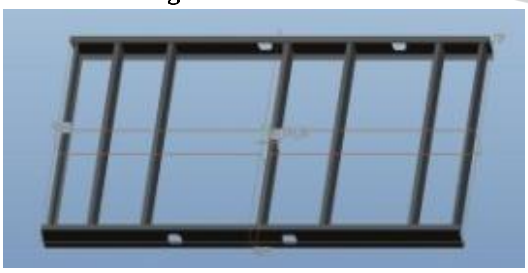

Fig 6: C-BOX SECTION

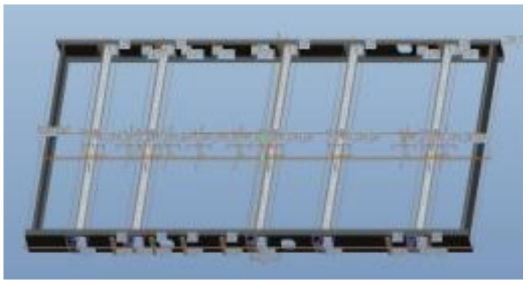

Fig 7: C-TUBE SECTION

IV. ANALYTICAL CALCULATIONS

4.1. Chassis Frame Material:

Currently used material for the chassis frame of Eicher PRO 6025 is (as per IS: 9345 standard) Structural steel ASTM A36 [7].

4.2. Mechanical Properties of Steel A36:

Property	Value
Modulus of Elasticity	200 GPa or 2x10^5 N/mm^2
Density	7850 Kg/m^3
Ultimate Tensile Strength	460 MPa or 460 N/mm^2
Yield Strength	250 MPa or 250 N/mm^2
Poisson Ratio	0.26

Table: 1 Specifications of Eicher PRO 6025 Truck Chassis frame

S. No.	Parameters	Value
1	Total length chassis frame	9010 mm
2	Width of chassis frame	2440 mm
3	Wheel Base	4880 mm
4	Front Overhang	1260 mm
5	Rear Overhang	2155 mm
7	Capacity (GVW)	25 ton
8	Kerb Weight	5750 Kg
9	Payload	19250 Kg

Longitudinal bars of the chassis frame are made of C-Section with Height (H) = 285 mm, Width (B) = 76 mm, Thickness (t) = 7 mm

4.3. Calculations:

4.3.1. Design Calculations of Chassis Frame:

Model No. = Eicher PRO 6025
Capacity of Truck = 25 tonne = 245250 N
Considering the Truck with 25% overload
= 245250 N * 1.25% = 306562.5 N
Therefore Total Load on Chassis = 306562.5 N
Each Truck chassis is having two longitudinal beams. Hence load acting on one beam is equal to half of the Total force or load acted on the chassis.
Load on one frame = Total force on the chassis / 2
= 306562.5 / 2

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= 153281.25 N / Beam

4.3.2. Loading Conditions:

Beam is clamped with the Shock Absorber and Leaf Spring. Therefore it is Simply Supported Overhanging Beam with Uniformly Distributed Load (UDL) acting on it.

Full length of the Beam is 9010 mm.

Load acting on full length of beam is 153281.25 N.

Uniformly Distributed Load (UDL) is

153281.25 / 9010 = 17.01 N/mm

Let the beam ends be A and B. It is supported by three wheel axles C, D and E.

4.3.3. Considering Moment:

The beam is considered as indeterminate structure. Different moments acting on beam are shown in below figure.

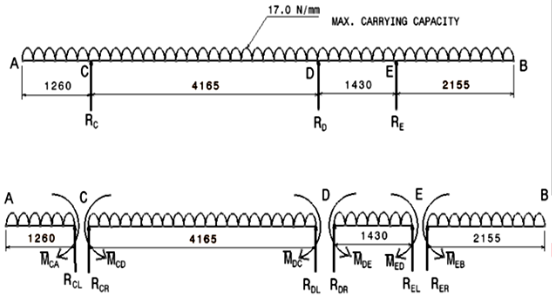

Fig 8: Moments produced at supports

$M_{CA} = (17.01*1260*1260) / 2 = 13502538$ N mm

$M_{CD} = (-17.01*4165*4165)/12 = -24589691$N mm

$M_{DC} = +24589691$N mm

$M_{DE} = (-17.01*1430*1430)/12 = -2898645.75$N mm

$M_{ED} = +2898645.75$N mm

$M_{EB} = (-17.01*2155*2155)/2 = -39497432.63$ N mm

$M_C = M_{CA} + M_{CD}$

$= 13502538 - 24589691 = -11087153$ N mm

$M_E = M_{ED} + M_{EB}$

$= 2898645.75 - 39497432.63$

$= -36598786.88$ N mm

For the span "CD"

$M_{DC} = 18495442.77$ N mm

For the span "DE"

$M_{DE} = - 18495434.13$ N mm

4.3.4. Calculations for Reaction and Shear Force Diagram:

$R_{CL} = 17.01*1260 = 21432.6$ N (↑)

$R_{CR} = (17.01*4165) / 2 + (13502538-18495434.13)/4165 = 34224.55$ N (↑)

$R_{DL} = 17.01*4165 - 34224.55 = 36622.1$ N (↑)

$R_{DR} = (17.01*1430) / 2 + (18495434.13-39497432.63)/1430 = - 2524.56$ N (↓)

$R_{EL} = 17.01*1430 + 2524.56 = 26848.86$ N (↑)

$R_{ER} = 17.01*2155 = 36656.55$ N (↑)

$\therefore R_C = R_{CL} + R_{CR} = 55657.15$ N (↑)

$R_D = R_{DL} + R_{DR} = 34097.54$ N (↑)

$R_E = R_{EL} + R_{ER} = 63505.41$ N (↑)

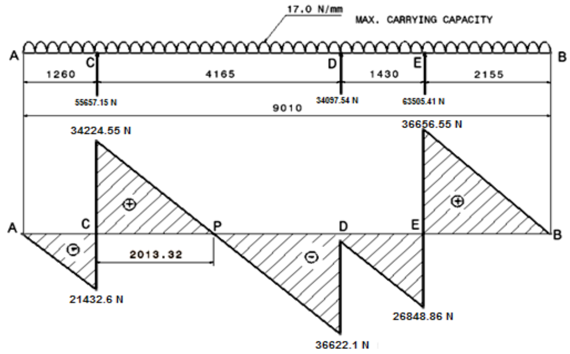

Fig 9: Shear Force Diagram

4.3.5. Calculations for Bending Moment Diagram:

$M_A = 0$ N mm

$M_C = -M_{CA} = - 13502538$ N mm

$M_P = (17.01* 4165* 4165) / 8 = 36884537.16$ N mm

$M_D = M_{DE} = - 18495434.13$ N mm

$M_Q = (17.01* 1430* 1430) / 8 = 4347968.63$ N mm

$M_E = M_{EB} = -39497432.63$ N mm

$M_B = 0$ N mm

So maximum bending moment occurs at "E"

$M_{max} = M_E = -39497432.63$ N mm

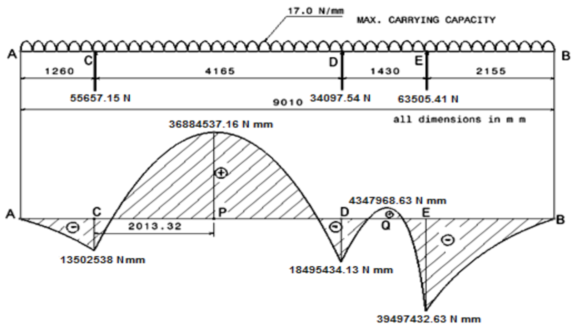

Fig 10: Bending Moment Diagram

4.3.6. Calculations for Maximum Deflection:

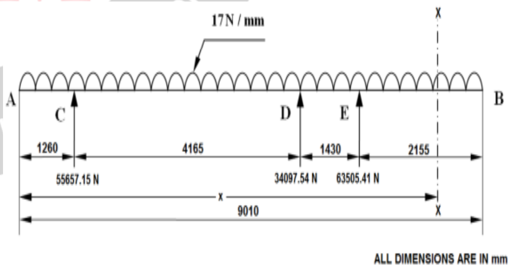

Fig 11: Reactions generated on beam

Using Macaulay's theorem,

$M_{xx} = EI\,(d^2y / dx^2)$

$= -8.5x^2 + R_C\,(x-1260) + R_D\,(x-5425) + R_E\,(x-6855)$

$y = \frac{1}{EI}\,[-17.01x^4/24 - 1.39*10^{10}\,x + 1.936*10^{13} + 55657.15\,(x-1260)^3/6 + 34097.54\,(x-5425)^3/6 + 63505.41\,(x-6855)^3/6]$

This is the equation for calculating deflection in chassis.

So the maximum deflection occurs at B

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$\therefore y_{max} = y_B = (-9.1 * 10^{13}) / EI$

4.3.7. Stress and Deflection in Chassis frame:

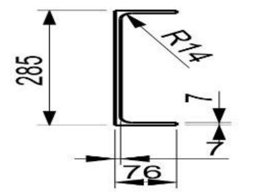
b =76 mm h =285 mm b_1 =69 mm h_1 =271 mm y = h / 2 = 285 / 2 = 142.5 mm	

Fig 12: Section considered for Chassis frame

Moment of Inertia on the X – X axis:

$I_{XX} = [bh^3 - b_1 h_1^3] / 12$

$= [76 * 285^3 - 69 * 271^3] / 12$

$= 32171686.75 \text{ mm}^4$

Section Modulus on the X – X axis:

$Z_{XX} = I_{XX} / y$

$= 32171686.75 / 142.5$

$= 225213.068 \text{ mm}^3$

Basic Bending equations are as follows:

$M/I = \sigma/y = E/R$

Maximum Bending Moment acting on the beam

$M_{max} = -39497432.63$ N mm

$Z = 225213.068 \text{ mm}^3$

Maximum Stress produced on the Beam,

$\sigma = M/Z = -39497432.63 / 225213.068$

$= -175.37 \text{ N/ mm}^2$

$E = 210000 \text{ MPa} = 2.10 \times 10^5 \text{ N / mm}^2$

$I = 32171686.75 \text{mm}^4$

Maximum Deflection produced on the Beam,

$y_{max} = (-9.1 * 10^{13})/EI$

$= (-9.1 * 10^{13}) / (210000 * 32171686.75)$

$= -13.47$ mm

V. STRUCTURAL ANALYSIS OF CHASSIS FRAME

FEM is used to find the result of complex problems with comparatively easy way. The FEM has been an influential tool for the mathematical solution of an extensive range of engineering problems. Applications of FEM are Stress analysis and Deformation of Defense aircrafts, automotives, missiles, nuclear towers, nuclear reactors, building dams, arches, ship decks, shell roofs, ship structure, space craft panels, underground mining problems, fluid flow in pipes and canals, hydrostatic, hydrodynamic reservoir dams interactions, analysis of layered shell and solids, ceramic and metal composites, structural and acoustic interaction problem. With the improvement in computer aided design, solving critical problems becomes easy [8].

5.1. Simulation Software used:

ANSYS WORKBENCH 15.0

5.2. Material used: Structural steel ASTM A36

5.3. Procedure for Structural Analysis of Chassis Frame:

In order to perform FE Analysis of Chassis Frame, Static Structural Analysis is used.

1. Four separate Static structural schematic files are created and the four designs(C-Section, C-I Section, C-Box Section, C-Tube Section) created in Pro-E are converted from PRT file to IGES geometry files and are imported in Geometry section. Meshing is performed
2. All Chassis frames are fixed and force loads are applied on each beam of the frame.
3. Equivalent Stress, Total Deformation, Directional deformation are selected for Solution Analysis.

5.4. FOR C-SECTION:

Fig 13: Stress

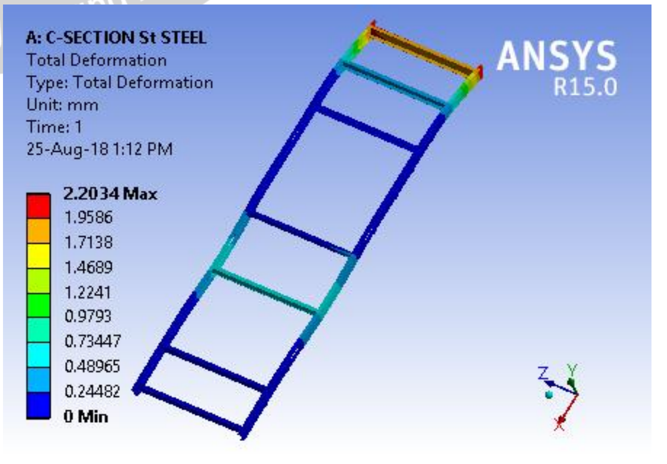


Fig 14: Deformation

A uniformly distributed load of 153281.25 N is applied on each beam of the chassis frame in negative Y-Direction.

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Equivalent Von-Mises Stress and Total deformation is needed for understanding Stress distribution and displacement pattern. Stress is found to be 143.78 MPa with a displacement of 2.20 mm.

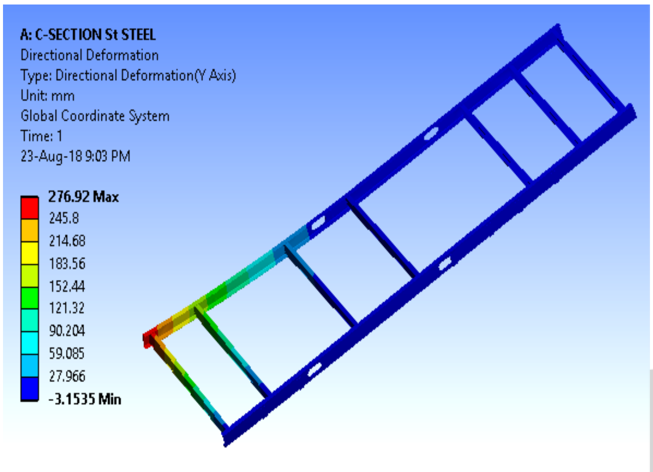

Fig 15: Torsional Deformation

Usage of moment loads to get torsion is restricted in Chassis and so we apply twist loads of 1000 N opposite to each other in Y-Direction on front end of the frame making rear end fixed to get Torsional Stress in chassis which is used for finding Torsional Stiffness.

5.5. FOR C-I SECTION:

Fig 16: Stress

Fig 17: Deformation

A uniformly distributed load of 153281.25 N is applied on each beam of the chassis frame in negative Y-Direction. Equivalent Von-Mises Stress and Total deformation is needed for understanding Stress distribution and displacement pattern. Stress is found to be 132.52 MPa with a displacement of 2.21 mm.

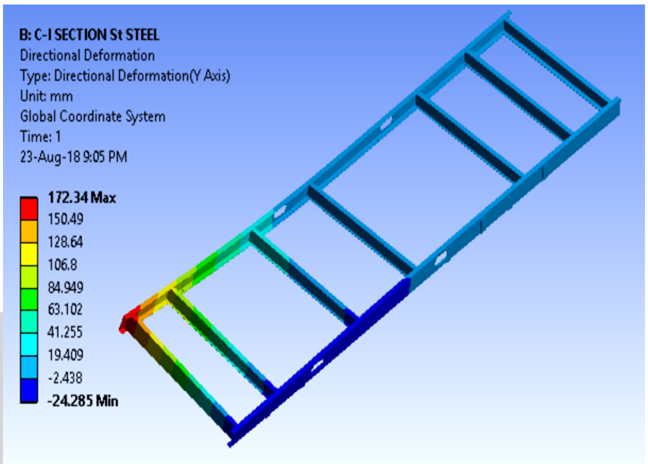

Fig 18: Torsional Deformation

Usage of moment loads to get torsion is restricted in Chassis and so we apply twist loads of 1000 N opposite to each other in Y-Direction on front end of the frame making rear end fixed to get Torsional Stress in chassis which is used for finding Torsional Stiffness.

5.6. FOR C-BOX SECTION:

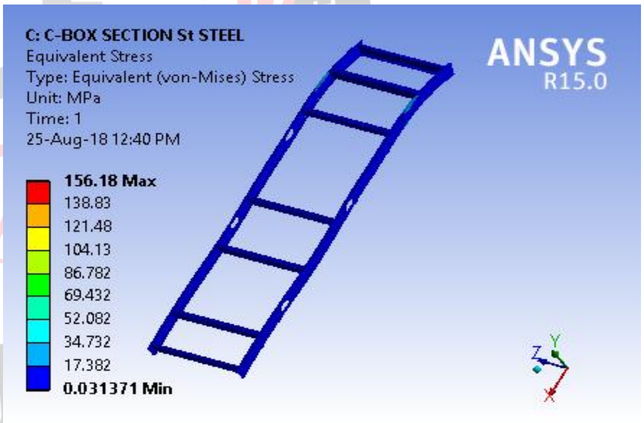

Fig 19: Stress

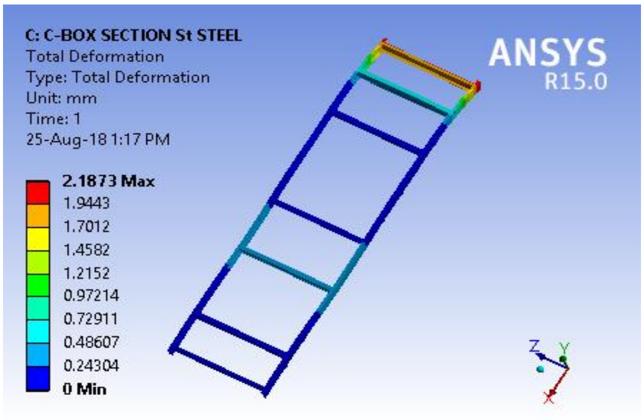

Fig 20: Deformation

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A uniformly distributed load of 153281.25 N is applied on each beam of the chassis frame in negative Y-Direction. Equivalent Von-Mises Stress and Total deformation is needed for understanding Stress distribution and displacement pattern. Stress is found to be 156.18 MPa with a displacement of 2.18 mm.

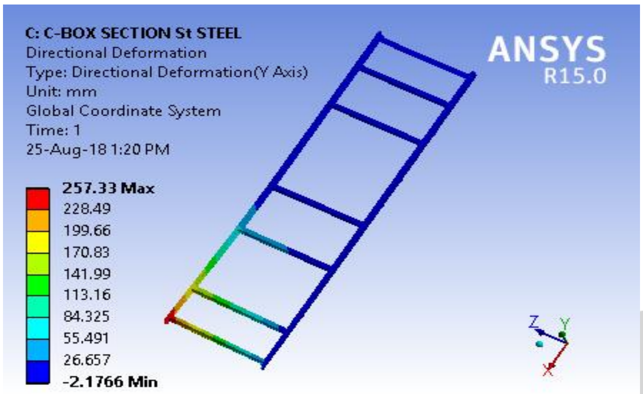

Fig 21: Torsional Deformation

Usage of moment loads to get torsion is restricted in Chassis and so we apply twist loads of 1000 N opposite to each other in Y-Direction on front end of the frame making rear end fixed to get Torsional Stress in chassis which is used for finding Torsional Stiffness.

5.7. FOR C-TUBE SECTION:

Fig 22: Stress

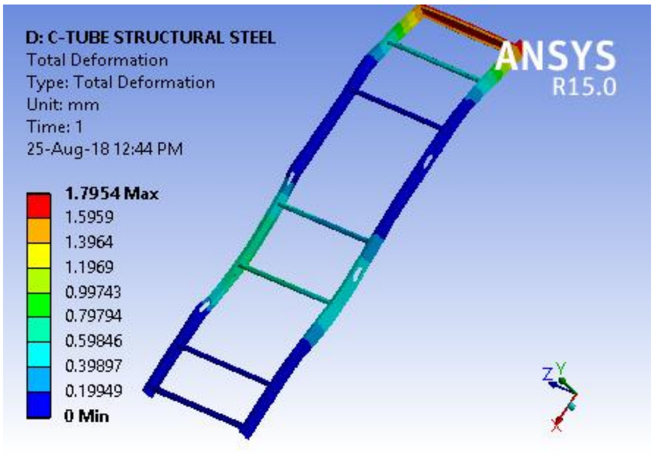

Fig 23: Deformation

A uniformly distributed load of 153281.25 N is applied on each beam of the chassis frame in negative Y-Direction. Equivalent Von-Mises Stress and Total deformation is needed for understanding Stress distribution and displacement pattern. Stress is found to be 113.79 MPa with a displacement of 1.795 mm.

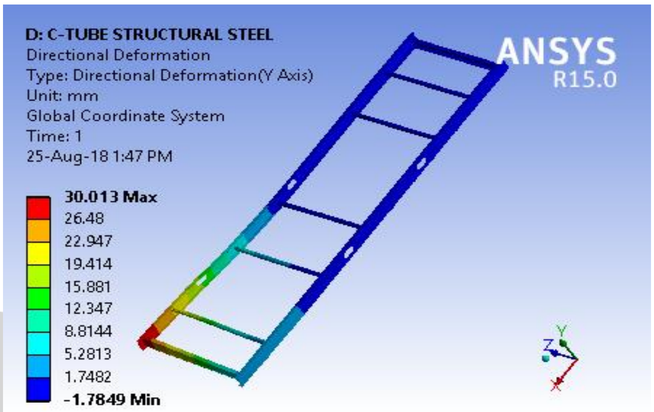

Fig 24: Torsional Deformation

Usage of moment loads to get torsion is restricted in Chassis and so we apply twist loads of 1000 N opposite to each other in Y-Direction on front end of the frame making rear end fixed to get Torsional Stress in chassis which is used for finding Torsional Stiffness.

VI. RESULTS AND DISCUSSION

Table 2: Simulation Values of Bending Stress and Deformation of four models:

SECTION	MASS (Kg)	STRESS (MPa)	DEFORMATION (mm)
C-SECTION	825.82	143.78	2.20
C-I SECTION	828.83	132.52	2.21
C-BOX SECTION	1024.8	156.18	2.18
C-TUBE SECTION	757.41	113.79	1.795

6.1 Calculation of Bending and Torsional Stiffness for all sections:

Bending Stiffness, K = $\frac{F}{\delta}$

Here F is the Load or Force acting on the body

δ is the displacement or deformation observed along the length of beam [10].

Torsional Stiffness, K = $\frac{Torque\ applied\ on\ the\ beam(T)}{Angle\ of\ twist(\theta)}$

Torque applied on the beam, T = $(\frac{Rf+Rr}{2})Ls$

T = $R * Ls$ (Rf and Rr are equal and opposite forces)

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Here Ls is the distance noted from center of the beam and the load applied end.

Angle of twist, $\theta = \frac{2*\delta}{Lf}$ (measured in radians)

$$\theta = \frac{114.6*\delta}{Lf} \text{ (measured in degrees)}$$

Here δ is the vertical deflection noted from Simulation.

Lf is the distance between two ends where loads are applied.

Torsional Stiffness, K = $\frac{Torque\ applied\ on\ the\ beam(T)}{Angle\ of\ twist(\theta)}$

$$= \frac{R*Ls*Lf}{114.6*\delta}$$

The values of deflection (δ) for stiffness calculations are taken from simulation analysis of all four models.

6.1.1. For C- Section:

Bending Stiffness, K = $\frac{F}{\delta} = \frac{306562.5}{2.20}$

$= 139.35*10^3$ KN/m

Torsional Stiffness,

$$K = \frac{Torque\ applied\ on\ the\ beam(T)}{Angle\ of\ twist(\theta)} = \frac{R*Ls*Lf}{114.6*\delta}$$

$$K = \frac{1000*2440*1220}{114.6*3.150} = 8.24 \text{ KNm/deg}$$

6.1.2. For C-I Section:

Bending Stiffness, K = $\frac{F}{\delta} = \frac{306562.5}{2.21}$

$= 138.71*10^3$ KN/m

Torsional Stiffness,

$$K = \frac{Torque\ applied\ on\ the\ beam(T)}{Angle\ of\ twist(\theta)} = \frac{R*Ls*Lf}{114.6*\delta}$$

$$K = \frac{1000*2440*1220}{114.6*2.844} = 9.13 \text{ KNm/deg}$$

6.1.3. For C-BOX Section:

Bending Stiffness, K = $\frac{F}{\delta} = \frac{306562.5}{2.18}$

$= 140.62*10^3$ KN/m

Torsional Stiffness,

$$K = \frac{Torque\ applied\ on\ the\ beam(T)}{Angle\ of\ twist(\theta)} = \frac{R*Ls*Lf}{114.6*\delta}$$

$$K = \frac{1000*2440*1220}{114.6*2.17.016} = 11.93 \text{ KNm/deg}$$

6.1.4. For C-TUBE Section:

Bending Stiffness, K = $\frac{F}{\delta} = \frac{306562.5}{1.795}$

$= 170.78*10^3$ KN/m

Torsional Stiffness,

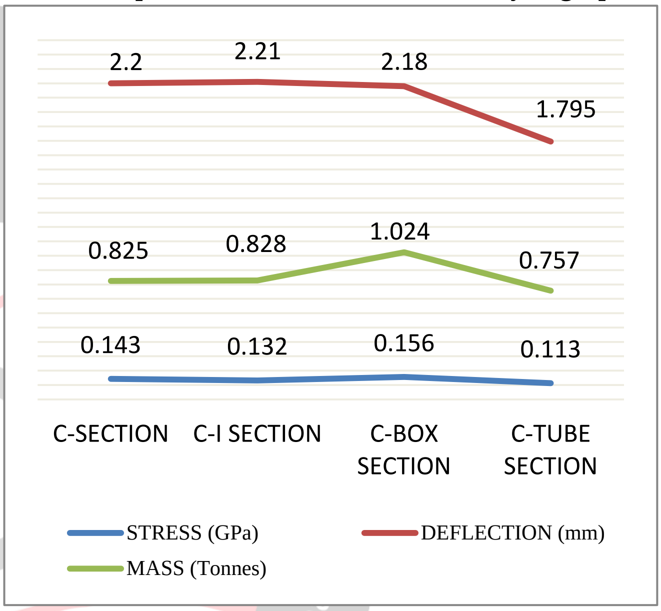
$$K = \frac{Torque\ applied\ on\ the\ beam(T)}{Angle\ of\ twist(\theta)} = \frac{R*Ls*Lf}{114.6*\delta}$$

$$K = \frac{1000*2440*1220}{114.6*1.783} = 14.56 \text{ KNm/deg}$$

Table 3: Comparison of Bending Stiffness and Torsional Stiffness values for four sections:

SECTION	Bending Stiffness (KN/m)	Torsional Stiffness (KNm/deg)
C-SECTION	139.34E03	8.24
C-I SECTION	138.71E03	9.13
C-BOX SECTION	140.62E03	11.93
C-TUBE SECTION	170.78E03	14.56

6.2. Comparison of all models by graphs:



Graph 1: Comparison of Equivalent stress, deformation and mass for four models

In this analysis, stress values were obtained from analytical and simulation solution. Stress analysis of original component was performed through computer simulation by using finite element modeling. The stresses were elastic determined using monotonic stress–strain curves of the used materials. The stress distribution cause by a load input of 25000 kg is applied on the Centre of Gravity point of the chassis. The maximum Von-Mises stress value was 156.18 MPa. This value is greater than the yield stress of the material. The generated Von Mises Stress and deformations are less than the permissible values i.e., σ = 175.37 MPa and y = 13.47 mm. So the design of all four cross sections is safe for applied loading condition. Graph 1 indicates that the stress is reduced for modified sections when compared with existing C-Section. Deformation and mass is also reduced by the usage Combination of cross sections.

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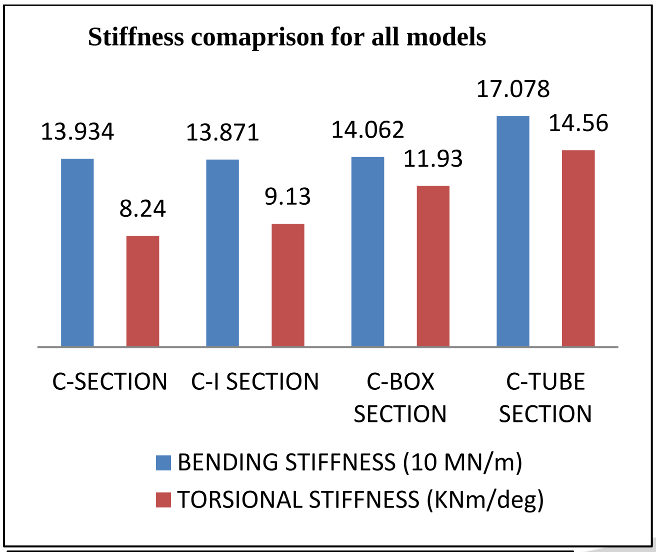

Graph 2: Comparison of Bending and Torsional Stiffness for all cross sections

Figure 13, 16, 19 and 22 shows Von-Mises stress of the models and therefore bending stresses are calculated with applied load and displacement. From Table 3, it can be said that Bending Stiffness is more for C-TUBE Section.

Figure 15, 18, 21 and 24 shows the deflections of the four chassis models with a 1000N of torsional load acting on it. The chassis will deform in both passenger side and driver side, but in the opposite direction. The deflection at passenger side and driver side is noted. The deflections at both sides are not exactly same because of asymmetry condition of the model [11]. Based on both deflections, the torsional stiffness of the model was calculated. Based on data in Table 3, the torsional stiffness of all modified models are higher than the torsional stiffness of the existing C-Sectioned model. The C-TUBE Sectioned chassis model has the highest torsional stiffness of 14.56 KNm/deg, and the lowest one is the existing C-Sectioned chassis with magnitude of 8.24 KNm/deg.

Graph 1 indicates that C-TUBE Sectioned chassis model has the lowest mass value compared to all models which makes frame light weight and results fuel efficiency and performance of vehicle. Stress analysis is used for determining the stress and displacement patterns on receiving the loads. Figures 13, 16, 19 and 22 clearly show that the component mounting place has higher stress concentration. In other words, maximum stress occurs just under the loading point. From the values of both Bending and Torsional Stiffness along with stress, deformation and mass, it can be observed that a combination of C- Section (Longitudinal members) and Tubular section (Cross members) gives good results compared to other cross member combinations and so it can be taken as the optimized section.

Table 4: Comparison of Existing Section and Optimized Section for Chassis frame:

Property	C-Section	C-Tube Section
Mass (Kg)	825.82	757.41
Stress (MPa)	143.78	113.79
Deformation (mm)	2.20	1.795
Bending Stiffness (KN/m)	139.34E03	170.78E03
Torsional Stiffness (KNm/deg)	8.24	14.56

From Table 4, it can be said that Optimized section gives better results in all aspects compared to present used C-Section. Thus by using combination of cross sections concept in chassis frame can improve the performance of vehicle.

VII. CONCLUSION

Chassis frame of Eicher PRO 6025 is modeled in Pro-E Software with design parameters and analysed in Ansys 15.0 Software with a load of 306562 N. Stress and deformations are calculated in Analytical and Simulation methods. When using linear static analysis, the stress distribution and deformation pattern of the truck chassis frame has determined on subjecting to two loading conditions, one is truck components loading and the other is asymmetrical loading. Maximum stress occurred at the chassis and suspension joints while the maximum translation occurred at the rear end of the frame. The present model i.e., C-Sectioned frame gives Bending stress as 143.78 MPa and Total deformation as 2.20 mm with a mass of 825.82 Kg whereas the optimized section i.e., C-TUBE Section gives Bending stress as 113.79 MPa and Total deformation as 1.795 mm with a mass of 757.41 Kg. The simulation results indicate that the chassis weight optimization and combination of cross-sections have considerable effect on strength, ride comfort, handling, stability and prevention of vehicle rollover through quick speed maneuvers. Bending Stiffness and Torsional Stiffness are also calculated. The present model i.e., C-Sectioned frame gives Bending stiffness as 139.34 MN/m and Torsional Stiffness as 8.24 KNm/deg whereas the optimized section i.e., C-TUBE Section gives Bending stiffness as 170.78 MN/m and Torsional Stiffness as 14.56 KNm/deg. Thus by comparing all the models, C-TUBE Section gives good results. Therefore by using combination of C-Sectioned longitudinal frame member and Tubular cross member provides additional stiffness, load bearing capacity, better handling characteristics and good performance of vehicle.

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