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Structural Analysis of Ladder Type Suv Chassis Frame (Diagonal Cross Bracing) using ANSYS 14.0

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Abstract

The vehicle chassis frame is an important part of an automobile. The chassis frame is the main structure of any vehicle. The main function of chassis frame is to support the body, different parts of an automobile and two longitudinal side members placed on it. The chassis frame has to withstand the stresses as well as deformation occurs in it and to withstand the shock, twist vibration and other stresses. The function is to carry the maximum load for all designed and operating conditions safely and it exists within a limit. On the chassis frame has maximum shear stress and deflection under maximum load. In this project, have calculated the stress (von mises) and shear stress, for the chassis frame also safety factor for safe design and the validation of design for martial, section of frame and shape on life periods will be calculated by fatigue life. Finite element analysis has been done for validation of the chassis frame model. We have taken material as Mild sheet steel for "C" Channel section, with varying the section of rectangular hollow box, "I" Section, and "O" Section to design chassis frame of an SUV. For Analysis using ANSYS 14.0. Software used in this project:-Solid work for design purpose and ANSYS 14 is used for analysis.

Keywords- Ladder Chassis Frame, Mild Steel, C Channel Section, Rectangular Box (Hollow), I Type and Tubular Type Cross Section

I. INTRODUCTION

A vehicle frame is the main supporting structure of a motor vehicle to which all other components are attached, comparable to the skeleton of an organism.

The main functions of a frame in motor vehicles are:

1) To support the vehicle's mechanical components and body
2) To deal with static and dynamic loads, without undue deflection or distortion.

These include:

- Weight of the body, passengers, and cargo loads.
- Vertical and torsional twisting transmitted by going over uneven surfaces.
- Transverse lateral forces caused by road conditions, side wind, and steering the vehicle.
- Torque from the engine and transmission.
- Longitudinal tensile forces from starting and acceleration, as well as compression from braking.
- Sudden impacts from collisions.

A. Ladder Frame

Ladder chassis is one of the oldest forms of automotive chassis these are still used in most of SUVs today. It is clear from its name that ladder chassis resembles a shape of ladder having two longitudinal rails inter linked by lateral and cross braces. Ladder chassis with diagonal cross-bracing and lighting holes.so named for its resemblance to ladder, the ladder frame is one of the simplest and oldest of all desie.it consists of two symmetrical beams, rails, or channels running the length of the vehicle and several transverse cross-members connecting them. Originally seen on almost all vehicles, the ladder frame was gradually phased out on car in favour of parameter frames and unitized body construction. It is now seen mainly on trucks, this design offers good beam resistance because of its continuous rails from front to rear, but poor resistance to torsion or warping if simple, perpendicular cross-members are used. Also, the vehicle's overall height will be grater due to the floor pan sitting above the frame instead of inside it. [1]

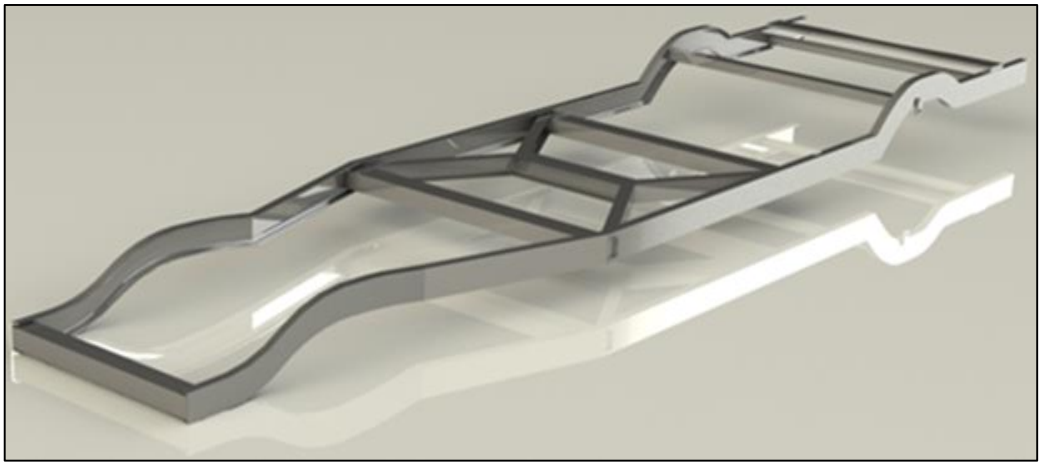


Fig. 1: Ladder frame

B. Diagonal Cross Bracing

In this cross bracing structure, which has diagonal supports exist more load on the cross bracing structure. Cross bracing is usually seen with two diagonal supports placed in an X shaped manner. These supports have to hold certain amount of tension and compression force. The compression force is one that squeezes material together, that acting on diagonal supports which is negligible. Tension force pulls the material apart then the diagonal supports wear total load acting on it. It subjected to more load on the center with respect the side. Depending on the forces, one brace may be in tension while the other is compression. [2]

- The common uses of cross bracing includes bridge (side) supports
- Cross bracing can be applied to any rectangular frame structure.

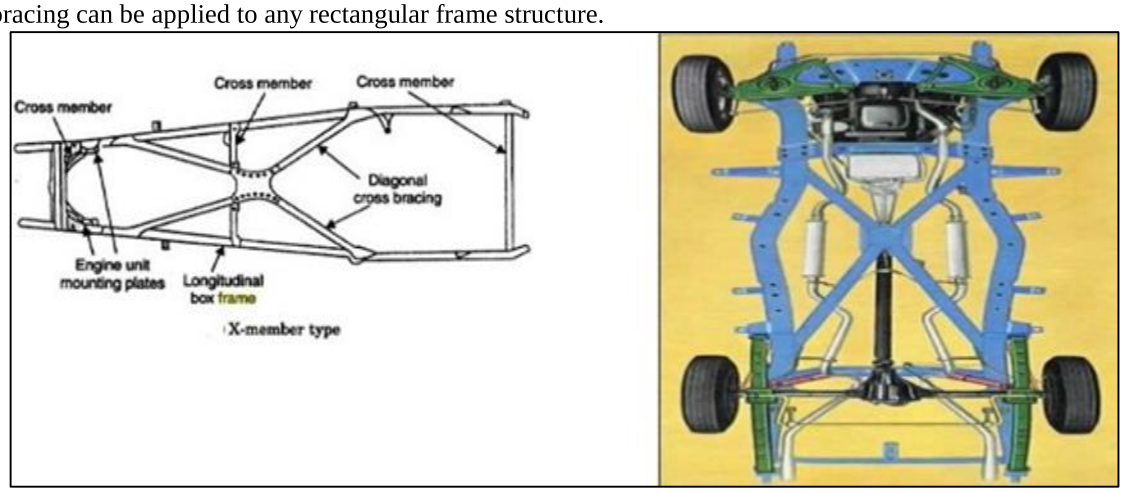


Fig. 2: Diagonal Cross Bracing

II. LITERATURE REVIEW

According to [1] Nikhil Tidke1, et al. (2017) takes an Eicher E2 Truck. In this work, author taken has higher strength of chassis because the main issue, that the magnitudes of total deformation in existing vehicle chassis of Eicher E2 (Model No. 11.10) Truck. Materials have considered for analysis are ASTM A710 steel, ASTM A302 steel and metal alloy 6063-T6, subjected to constant load. The section of design truck frame Vehicle chassis are modeled by considering two different cross-sections specifically C and Rectangular Box (Hollow) sort cross sections. Software Using CATIA modeling of the chassis is done and ANSYS for analysis. Al alloy 6063 chassis has been preferred for low loading conditions C cross sections due to low density and weight. After analysis, it is observed that the Rectangular box section have additional strength than C cross section. The Rectangular box sections have low deflection, lowest stress and deformation. Material “Al alloy 6063” is considered. In the same manner [2] Priyanka Ranu, et al. (2017) analyzed Structural Analysis of Heavy Vehicle Chassis Dimensions of PCHVC (polymeric composite heavy vehicle chassis) are taken as that of the conventional SHVC (steel heavy vehicle chassis). Width of the chassis is 80mm and the properties of PCHVC vary with directions. Take a 3-D model of chassis is needed for analysis. The loading conditions are assumed to be static. Every element is specifying element of six degrees of freedom at each node translations in the nodal x, y, and z directions and rotations about the nodal x, y, and z-axes. As result finite element analysis is carried out. The chassis acts as the backbone of a heavy vehicle which carries the maximum load for all designed operating conditions on I section and taken three different materials, steel as existing or already used materials and two others are composites materials (e-glass epoxy & carbon epoxy). By simulation results they found that carbon epoxy provides better strength as compare to e-glass epoxy and steel. Deformation and weight is reduced by efficient. Take same geometrical section with different materials like Steel, E-glass Epoxy and Carbon Epoxy FEM using ANSYS. It uses a numerical technique called the finite element method (FEM) to solve boundary value problems. The total load of chassis of magnitude 58860N is applied on each side of beam and the gravitational force of 9806.6N is also considered. With the "I" Section. As a result Carbon epoxy induces low deformation and stress distribution when compared to E-glass epoxy and steel.

[3] Mr. Navnath V. Palde, et al. (2016) in this research has focused on investigation of static and dynamic characteristic like Torsional stiffness and natural frequency of car chassis. The analysis has been completed by Finite Element Method and Experimental approach. According to that some modification has suggest on existing chassis. Modification of chassis has been performing undergo the static structural analysis, modal analysis and experimental analysis. Modeling PRO-E software use, analysis of finite element package ANSYS 14.5 and RADIOSS is used for further analysis. As a result observe above analysis that there is an improvement in Natural frequency by 28.33% , the Equivalent stresses is reduce by 63.95 %, Torsional stiffness is increase by 56.20 %.also the total deflection is reducing by 36 %. The error is found up to 13 % [4] S.Sivaraj, et al. (2016) presented that the chassis frame has to withstand the stresses developed as well as deformation occurs in it and to withstand the shock, twist vibration and other stresses. Here take two sections of "I" and "C" type of bus and truck chassis frame of travelling on. Due to the failure/fracture in the chassis/frame is obtained. Therefore Chassis with high strength cross section is needed to minimize the failures including factor of safety in design take rectangular section. On chassis, frame maximum shear stress and deflection under maximum load are important criteria for design and analysis. it have taken certain material as Mild sheet steel, aluminum alloy and titanium alloy for the rectangular hollow box type to design chassis frame. Take CATIA software for modeling and pre-processing. And using Hyper mesh 13 for rivet joints in 2-D for analysis ladder frame using ANSYS14. The conclusion find out generated shear stresses are less than the permissible value so the design is safe for all three materials. Shear stress was found minimum in aluminum alloy and maximum in mild sheet steel under given boundary conditions. Von mises stress was found minimum in aluminum alloy and maximum in titanium alloy under given boundary conditions. At the same field [5] Divyesh N. Chaudhari1, et al. (2016), AMW 2523 TP truck is taken for Structural analysis of heavy vehicle chassis with constraints of maximum shear stress and deflection of chassis under maximum load and it is modeled by considering three different cross-sections. These are C, I and Rectangular Box type cross section. Materials have taken namely BSK 46 Steel for all section. Applying the vertical load acting on the horizontal different cross sections is uniformly distributed. As result The Rectangular Box section is having least deflection i.e., 1.901 mm in all the three chassis of different cross section. Software use Cero Parametric 2.0 & ANSYS 14.0. In the same cross- section [6] Pankaj Badhe, (2016) consider a Mini Tractor Trolley chassis with the same dimensions of design analysis with respect to "C" section and "I" section and calculate the weight. "I" section Chassis reduces 36 % of weight as compared to the existing "C" section Chassis. Safer stresses are obtained in new suggested design. Tractor trolley Chassis is modeled using CATIA software. It is then imported to analysis on software ANSYS. Here also as a result find the least deflection of rectangular Box type. Should be consider [7] Kamlesh Y. Patil1, et al. (2015) In this paper study has analyzed the strength and stability to the vehicle under different conditions. The dimensions of an existing vehicle chassis of a TATA 912 Diesel bus is taken for analysis with materials namely Steel alloy (Austenitic) subjected to the same load. The three different vehicle chassis have been modeled by considering three different cross-sections. C, I, and Rectangular Box (Hollow) type cross sections and varying the thickness of the C, I and rectangular box, adding material of Steel alloy –Austenitic. Using ANSYS software for solve the results. it is observed that the Rectangular Box (Hollow) section has more strength than the conventional steel alloy chassis with C and I design specifications. The Rectangular Box (Hollow) section is having least deflection i.e., 2.683 mm and stress is 127 N/mm2 in all the three type of chassis of different cross section.

III. PROBLEM STATEMENT

The present work is focused on to determine the strength, stability of the frame on the basic of safety factor and fatigue life. The objective of research work is design the leader frame according to the application of load on it. It is observed that some area of the chassis comes under heavy load on side member and remaining part of it under low load. The generation of stresses will be according to the applied load on the frame. Some area of chassis, magnitude of stress will be high and remaining portion of frame will be under low stresses. Here a ladder frame can be considered structurally as grillages. It consists of two side members bridged and held apart by a series of cross members. The side member's function is to resist the shear forces and bending loads while the cross members give torsion rigidity to the frame. Most of the light commercial vehicle chassis have channel C and box section steel frames, which provide vertical and lateral strength and resistance to torsion stress.

IV. METHODOLOGY

As per the vehicle loading condition, total load acting on the frame is taken as a sum of the weight of the vehicle body, engine and passengers. This total load is considered as uniformly distributed load acting throughout the side member. By apply load is calculating on total deformation, safety factor, and fatigue life, which is performed by finite element method (FEM) of pre-processer, numerical solving and post processer.

- First specify the accurate dimension of selected SUV vehicle. Then, it is being modeled by using SOLIDWORK 15. Then use weldments application of SOLIDWORK to create different sections on the frame, assigning “C” channel section, tubular section ”O”, box hollow section and “I” Section. After that this model has been converted in IGES File.
- This IGES file is further processed in ANSYS 14 software, which is based on finite element methods, for analysis of different parameters. Finite element analysis has three main steps, namely pre-process, solution and post processing. In the pre – processing, first assigning geometry and then specify the material
- (mild steel). Whole model is discretized by using number of elements (triangular) shape. Magnitude of default element size “10mm”. After meshing applying boundary conditions and load, go to the solution process.
- In the solution phase, the problem has been solved for total deformation, stress, strain, safety factor, fatigue life (safety factor, life & damage,) using ANSYS 14.0. Evaluation of the result i.e. magnitude of stress, safety factor, total deformation and plot constant amplitude load fully reversed with respect to end time, it is acting on no. of cycles on the total process. SN graph of endurance limit is specifying the highest deformation of the ultimate stress to damage in minimum no. of cycle. Obtain the result for whole problem. The reaction force is calculated on the fixed support of frame or on the boundary condition. Specified the load acting on X, Y & Z axis.
- First modeling simple ladder chassis fame of 6 supports, on the basis of actual dimensions with the channel “C” section. Analyzed by using ANSYS 14.0 software, but observation of result find that the safety factor is not specifying the actual design parameter and the deformation is high. Due to safe modeling take additional material on the same design parameter and add a diagonal cross bracing with 6 supports on the same longitudinal members.

Vehicle frame having two Side members of “C” Channels section and 6 supports

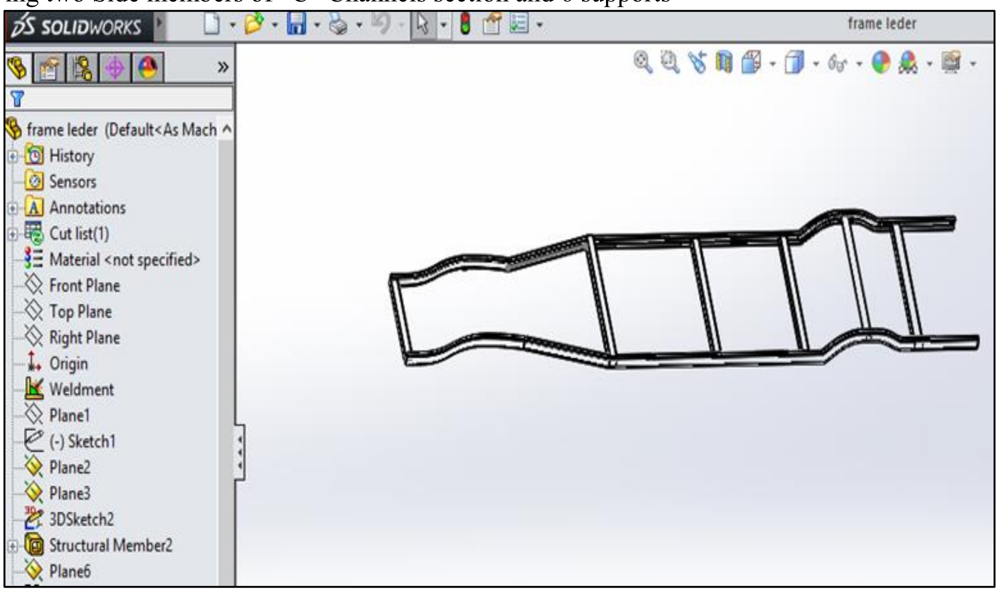


Fig. 3: Model of frame

V. Specification of Material

Mild steel has been selected for designing of frame because it is ductile, not brittle hard and low cost material. Mild steel is made by addition of carbon and other element in the iron. So, these elements improve the hardness, ductility and tensile strength of the metal. It widely uses in automobile industry for making the body of automobile industry and parts of the vehicle. Mild steel can be easily machined. These are the few reasons for selecting mild steel for designing the frame. [9]

Table 1: Specification of material

S. No.	Properties	Value
1	Density(kg/m^3)	7860
2	Tensile yield strength (MPa)	370
3	Tensile Ultimate strength (MPa)	440
4	Young’s Modulus (MPa)	210000
5	Poisson’s Ratio	0.303

A. Factor of Safety

It is known as the load carrying capacity of system beyond the expected or actual load. Essentially, the factor safety is how much stronger the system is then usually needs to be for an intended load. For the safety purpose it should always be one or greater than one. FOS exactly one will support only design load. [8]

VI. SPECIFICATION OF FRAME

Table 2: Specification of frame

Sl.no	Description	Dimension (mm)
1	Length	4232
2	Width	1050
3	Rear over hang (ROH)	888
4	Front over hang (FOH)	620
5	Gross weight of vehicle	1500 Kg (1.5 ton)
6	Wheel Base (WB)	2724
7	Wheel track (WT)	1570

A. Load Calculation

Gross weight =1500kg = 1.5 ton
Weight of passenger = Weight per passenger × No. of passengers = 75 kg × 6 = 450 kg = 0.45 ton
Total load acting on frame = Gross weight + weight of passengers
1500 kg + 450 kg =1950 kg =1.95 ton.
Frame have two longitudinal members so, load will be act upon these two longitudinal members. Therefore, load acting on each member will be half of the total load acting on frame.
Load acting on the one longitudinal member = 1.95/2 = 0.975 ton or 975 kg. The load is acting on all section of longitudinal members

VII. RESULTS & ANALYSIS

Case-1: Vehicle frame having two Side members of "C" Channels section and 6 supports.

Table 3: Specification of Vehicle frame having two Side members of "C" Channels section and 6 supports

Sl.no	Volume (mm³)	Mass (kg)	Element Size (mm)	Node	Element	Force(N)
1	2.119e+007	166.55	10	117716	56792	-9750

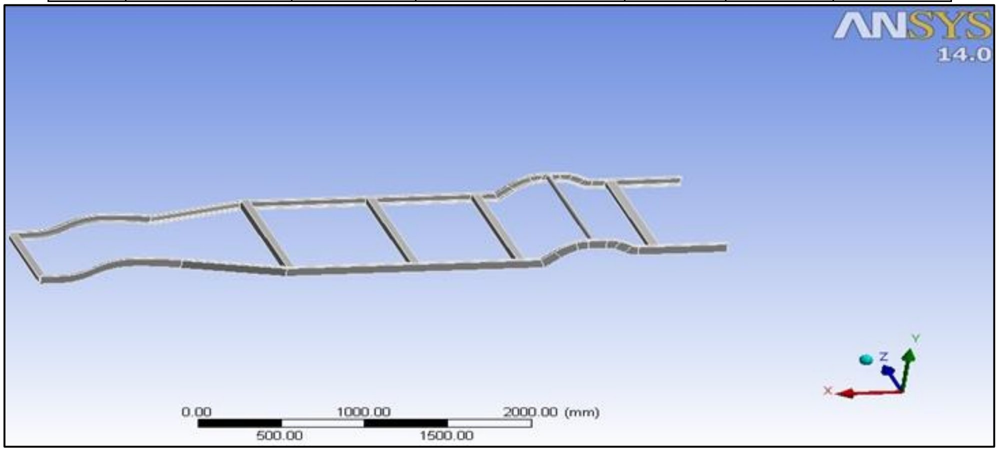


Fig. 4: Model

A. Meshing

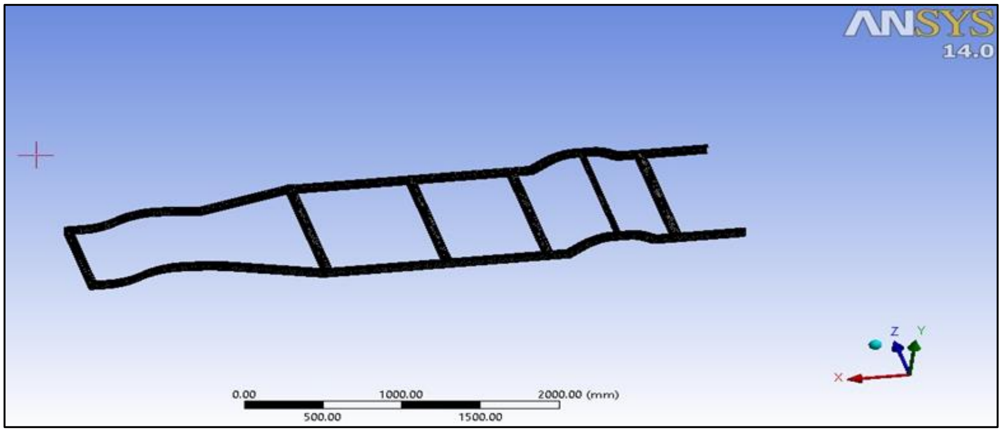


Fig. 5: Meshing

- Loading and Boundary Condition: In static bending condition, all the ends i.e. rear and front ends are kept fixed and same magnitude of uniformly distributed load is applied on the two longitudinal members of frame. is showing the fix supports and load applied on frame.

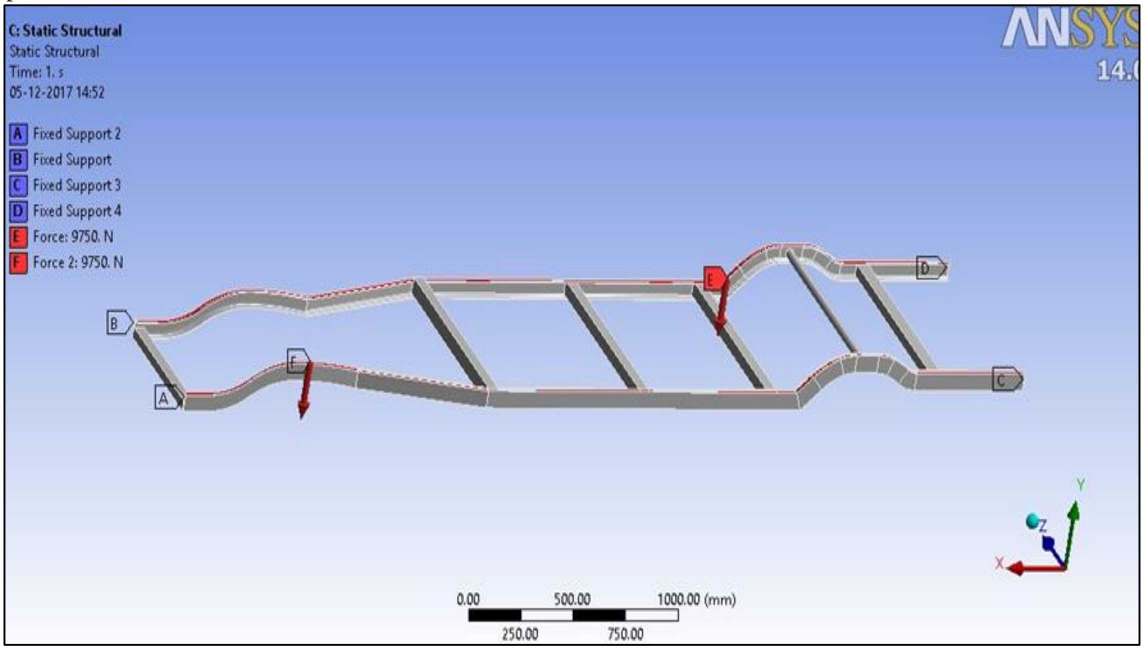


Fig. 6: Loading and Boundary condition

VIII. RESULT

Table 4: result on Vehicle frame having two Side members of "C" Channels section and 6 supports

Sl.no	*Mass (kg)*	*Total Deformation (mm)*	*Stress(Von-Mises) max (MPa)*	*Safety Factor*	*Fatigue life min (cycles)*
1	*166.55*	*24.29*	*1917.2*	*0.19299*	*49.318*

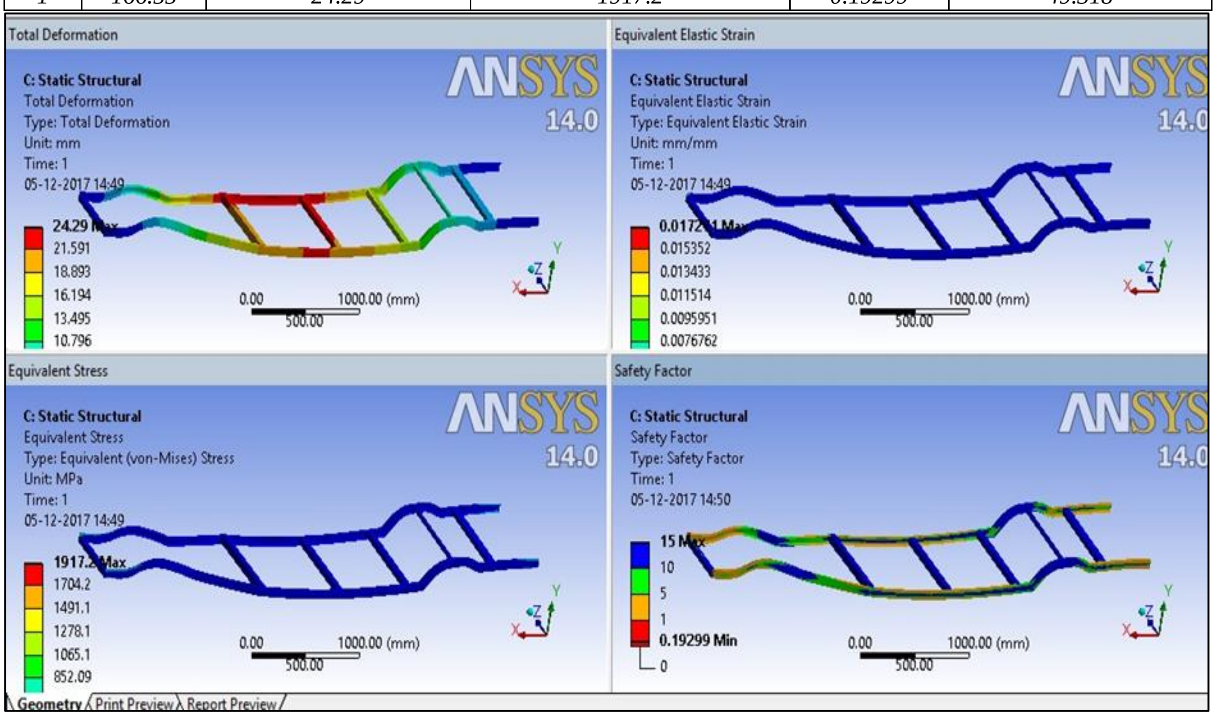


Fig. 7: Result on Vehicle frame having two Side members of "C" Channels section and 6 supports

Side member of "C" channel section and 6 supports along with diagonal cross bracing

Table 5: Specification of Side member of "C" channel section and 6 supports along with diagonal cross bracing

Sl.no	*Volume (mm³)*	*Mass (kg)*	*Element Size (mm)*	*Node*	*Element*	*Force(N)*
1	*2.8431e+007*	*223.47*	*10*	*270444*	*137267*	*-9750*

A. *Loading and Boundary Condition*

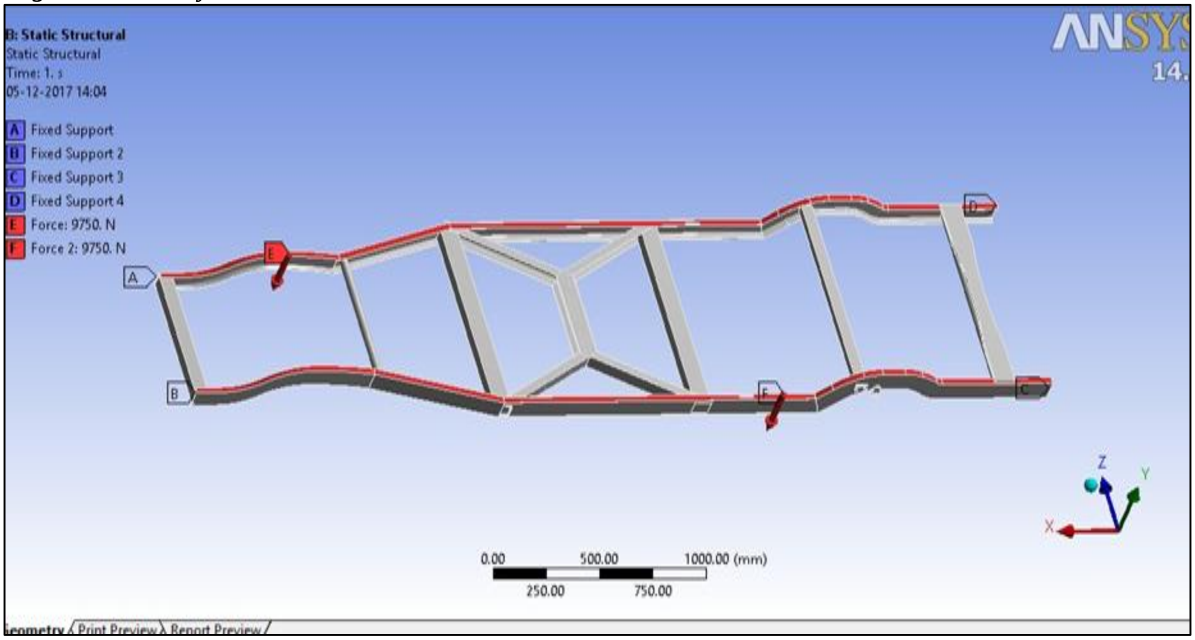


Fig. 8: Loading and Boundary condition

- Result

Table 6: Result on Side member of "C" channel section and 6 supports along with diagonal cross bracing

Sl.no	*Mass (kg)*	*Total Deformation (mm)*	*Stress(von-Mises)max (MPa)*	*Safety Factor*	*Fatigue life min (cycles)*
1	*223.47*	*10.827*	*233.36*	*1.5855*	*15967*

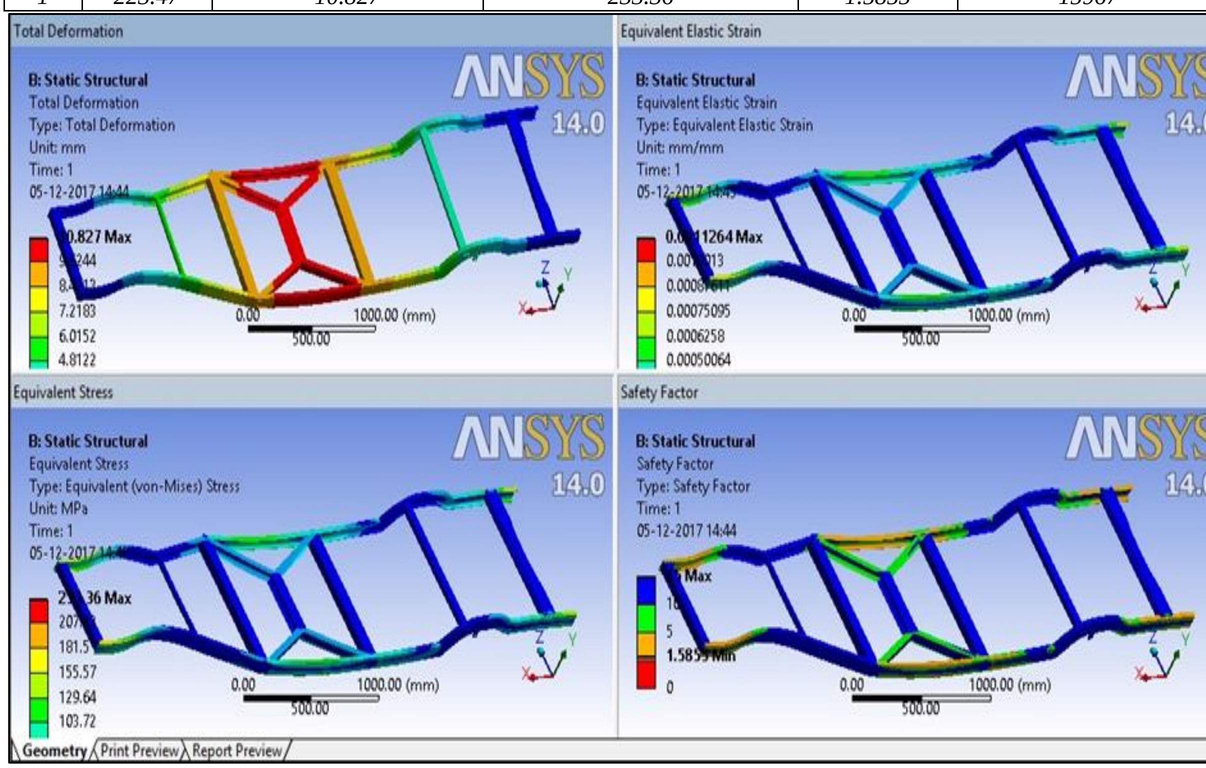


Fig. 9: result on Side member of "C" channel section and 6 supports along with diagonal cross bracing

Side member of "C" channel section with 5 supports along with diagonal cross bracing

Table 7: Specification of Side member of "C" channel section with 5 supports along with diagonal cross bracing

Sl.no	*Volume(mm³)*	*Mass (kg)*	*Element Size (mm)*	*Node*	*Element*	*Force(N)*
1	*2.7471e+007*	*215.92*	*10*	*271289*	*137302*	*-9750*

- Loading and Boundary Condition

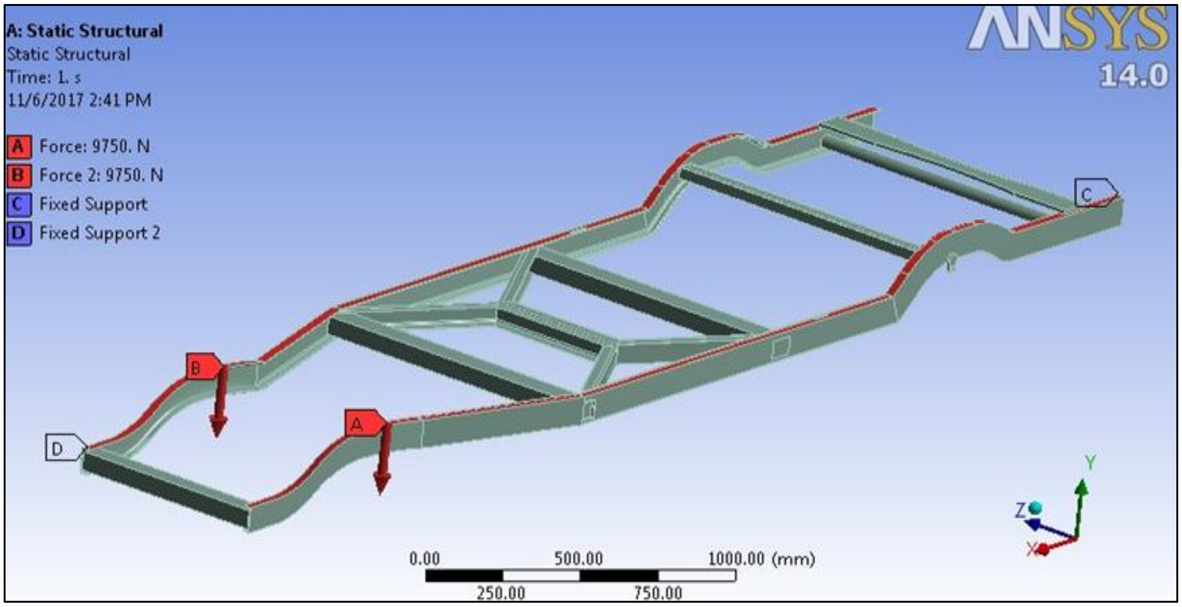


Fig. 10: Loading and Boundary Condition

- Result

Table 8: Result on Side member of "C" channel section with 5 supports along with diagonal cross bracing

Sl.no	Mass (kg)	Total Deformation (mm)	Stress(von-Mises) max (MPa)	Safety Factor	Fatigue life min (cycles)
1	215.92	11.011	230.14	1.6077	16638

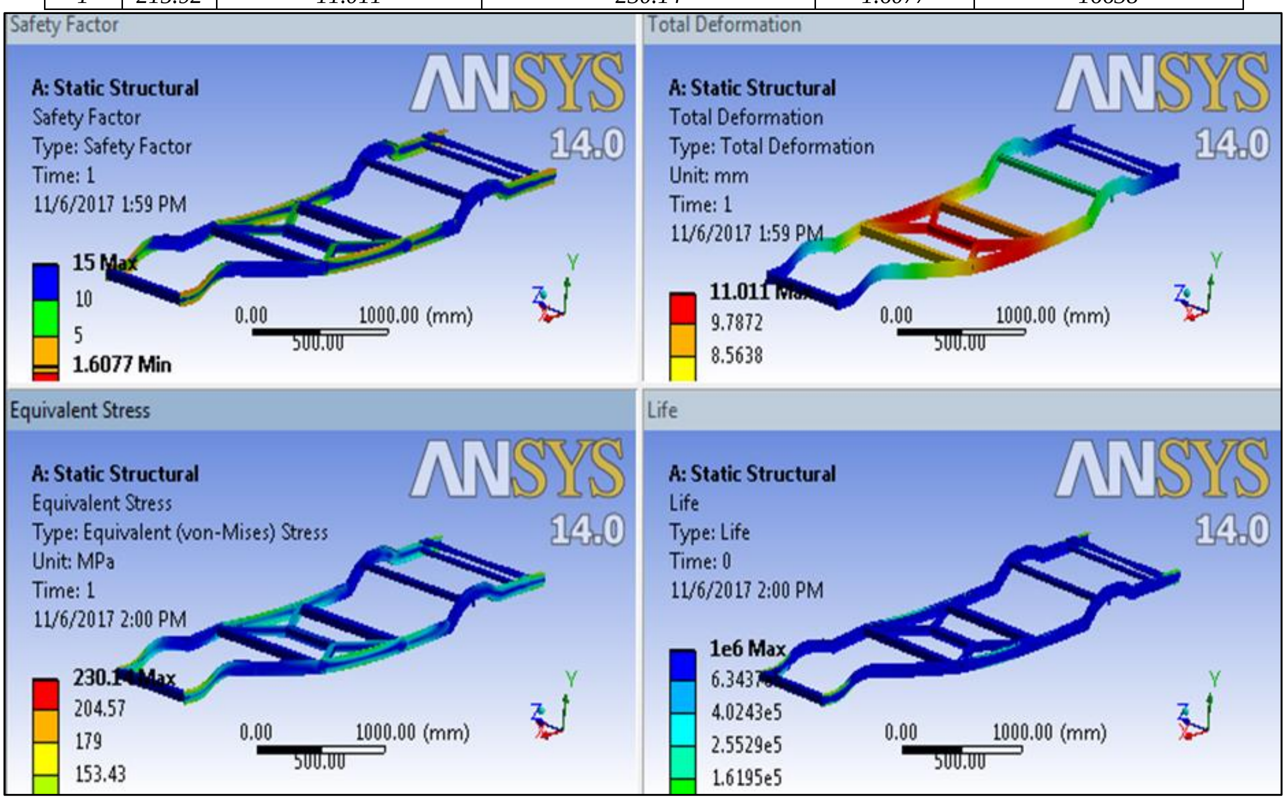


Fig. 11: Result on Side member of "C" channel section with 5 supports along with diagonal cross bracing

Side member of "C" channel section with 4 supports along with diagonal cross bracing

Table 9: Side member of "C" channel section with 4 supports along with diagonal cross bracing

Sl.no	Volume(mm³)	Mass (kg)	Element Size(mm)	Node	Element	Force(N)
1	2.6261e+007	206.41 kg	10	238974	120479	-9750

- Loading and Boundary Condition

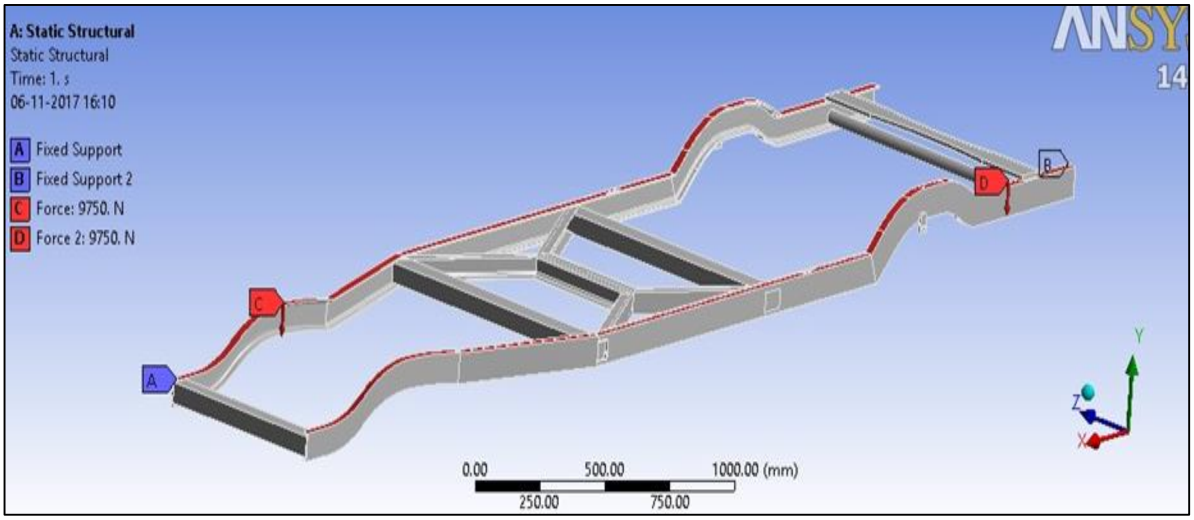


Fig. 12: Loading and Boundary Condition

– Result

Table 10: Side member of "C" channel section with 4 supports along with diagonal cross bracing

Sl.no	*Mass (kg)*	*Total Deformation (mm)*	*Stress(von-Mises) max (MPa)*	*Safety Factor*	*Fatigue life min (cycles)*
1	*206.41*	*10.973*	*251.93*	*1.468*	*12098*

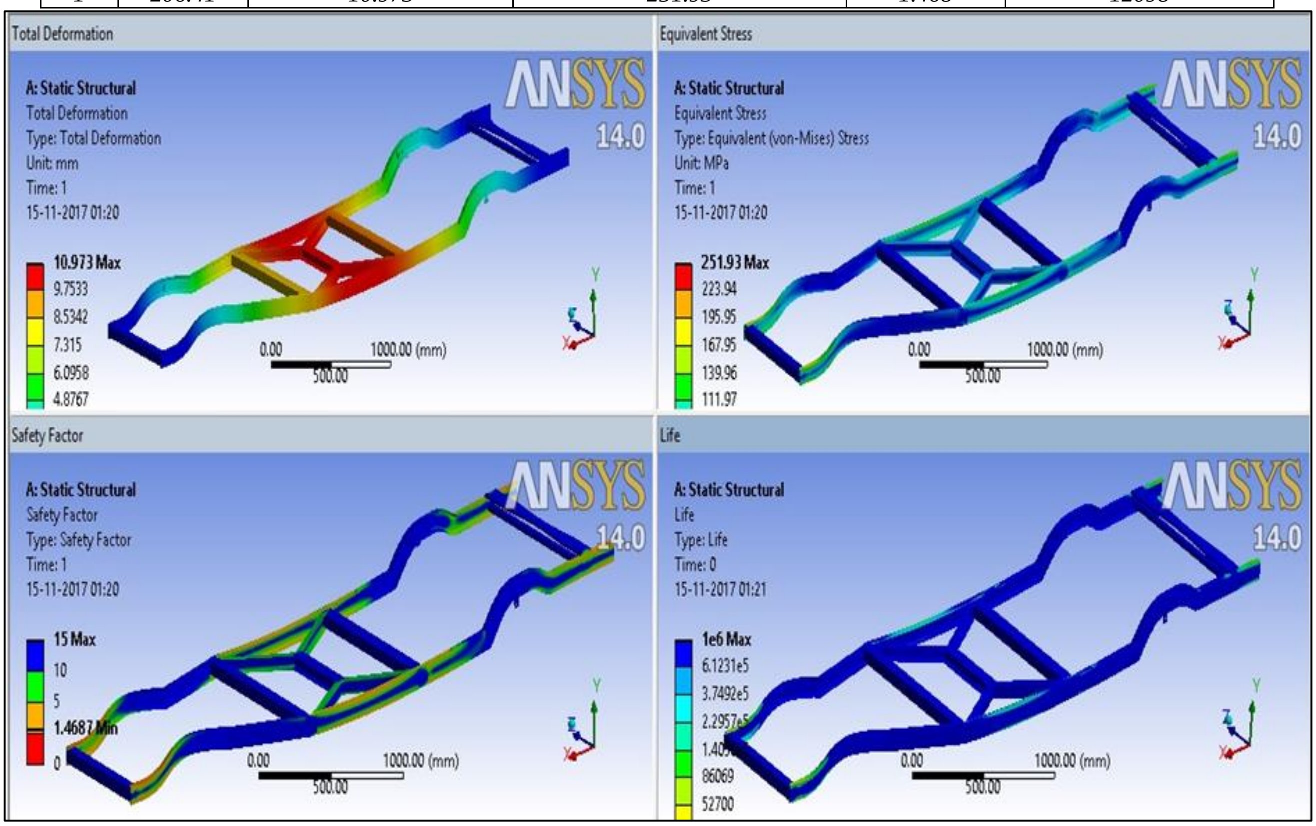
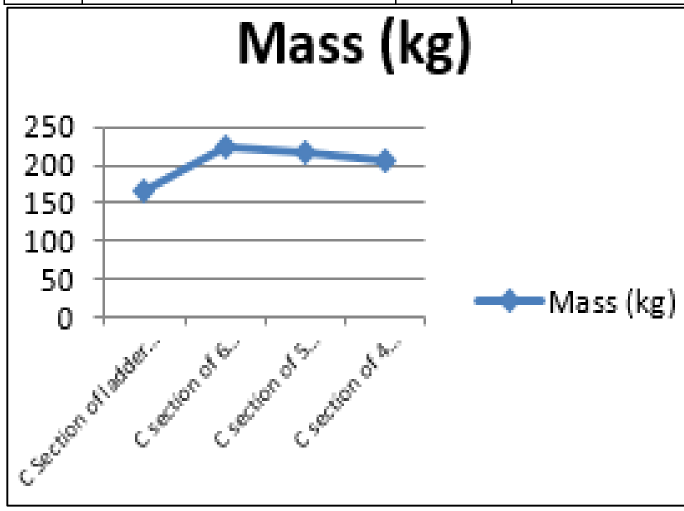


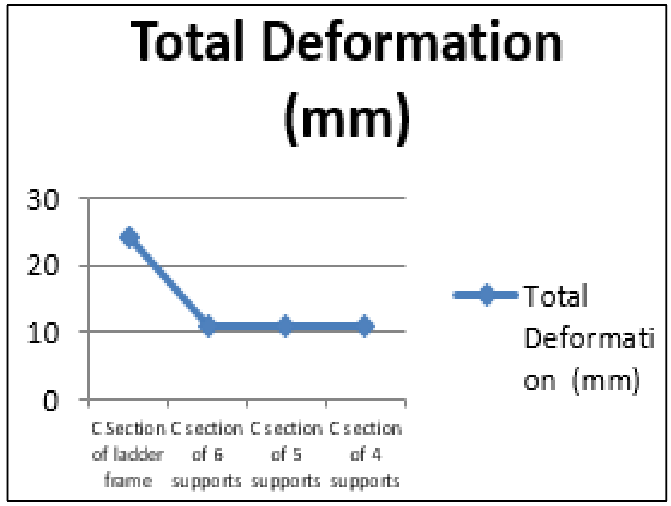
Fig. 13: Side member of "C" channel section with 4 supports along with diagonal cross bracing

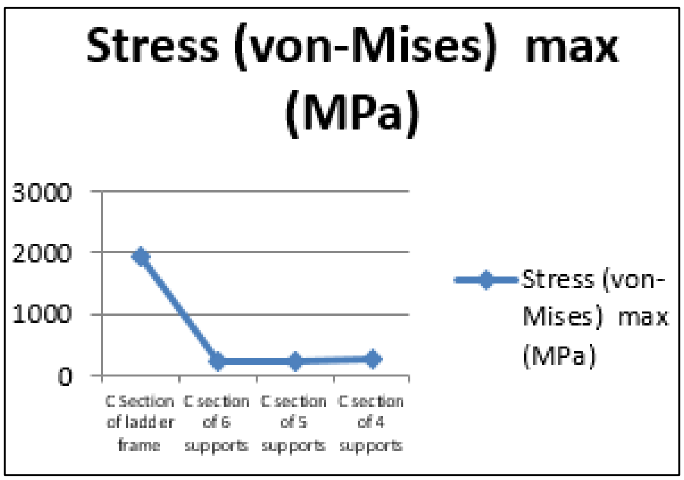
IX. COMPARISON RESULT OF DIFFERENT C SECTION FRAME

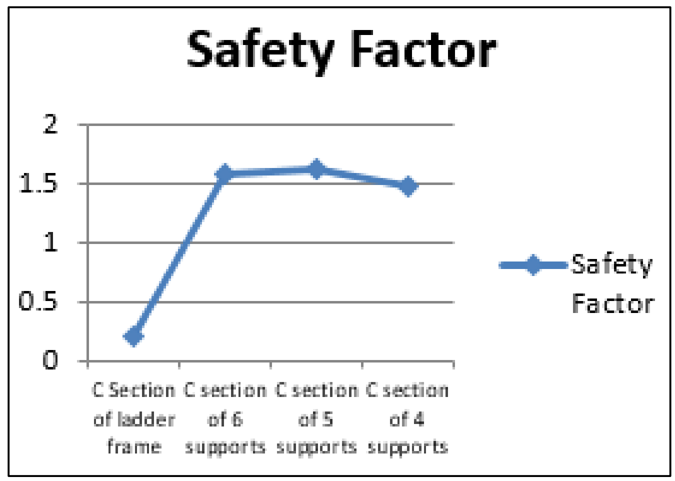
Sl.no	*Selection of frame*	*Mass (kg)*	*Total Deformation (mm)*	*Stress(von-Mises) max (MPa)*	*Safety Factor*	*Fatigue life min (cycles)*
1	*C Section of ladder frame*	*166.55*	*24.29*	*1917.2*	*0.1929*	*49.318*
2	*C section of 6 supports cross bracing*	*223.47*	*10.827*	*233.36*	*1.5855*	*15967*

3	*C section of 5 supports cross bracing*	*215.92*	*11.011*	*230.14*	*1.6077*	*16638*
4	*C section of 4 supports cross bracing*	*206.41*	*10.973*	*251.93*	*1.468*	*12098*









From the results, it is observed that the C channel Section of 5 supports is having more strength and minimum deflection as compare to 4 and 6 supports frame. It is having value of stress (Von Mises) is 230.14 MPa and minimum safety factor is 1.6077. The fatigue life of frame is 16638 no. of cycles for mild steel. Total deformation is 11.011mm

It is clear from the result that 5 supports frame is safe, as compare to 4 and 6. But in the SUV or any four wheel vehicle frames are of different cross-section of longitudinal member also used. Here in this work the same analysis work is also performed on the frame of different cross section of longitudinal member with decreasing one supports and increasing one supports. In order to finding the total deformation; stress (von-mises) and safety factor of the change on design modeling. After analyzing the result best one frame can be find out. Analysis for the same is presented in case-2.

A. Case-2

The case-2 has assigned the selection of frame with rectangular side member and same diagonal cross bracing but with the different number of cross member supports and compares the result in order to find out which one is good according to the total deformations and safety factor to safe design. The Load acting is same (-9750N) for every model of frame. Take box hollow rectangular on 4 and 6 supports, I section on 4 and 6 supports and tubular section on 4 and 6 supports.

Side member with box hollow rectangular section and 4 supports along with diagonal cross bracing

Table 11: Specification of Side member with box hollow rectangular section and 4 supports along with diagonal cross bracing

Sl.no	*Volume(mm³)*	*Mass (kg)*	*Element Size (mm)*	*Node*	*Element*	*Force(N)*
1	*2.9439e+007*	*231.1*	*10*	*109941*	*57389*	*-9750*

1) Loading and Boundary Condition

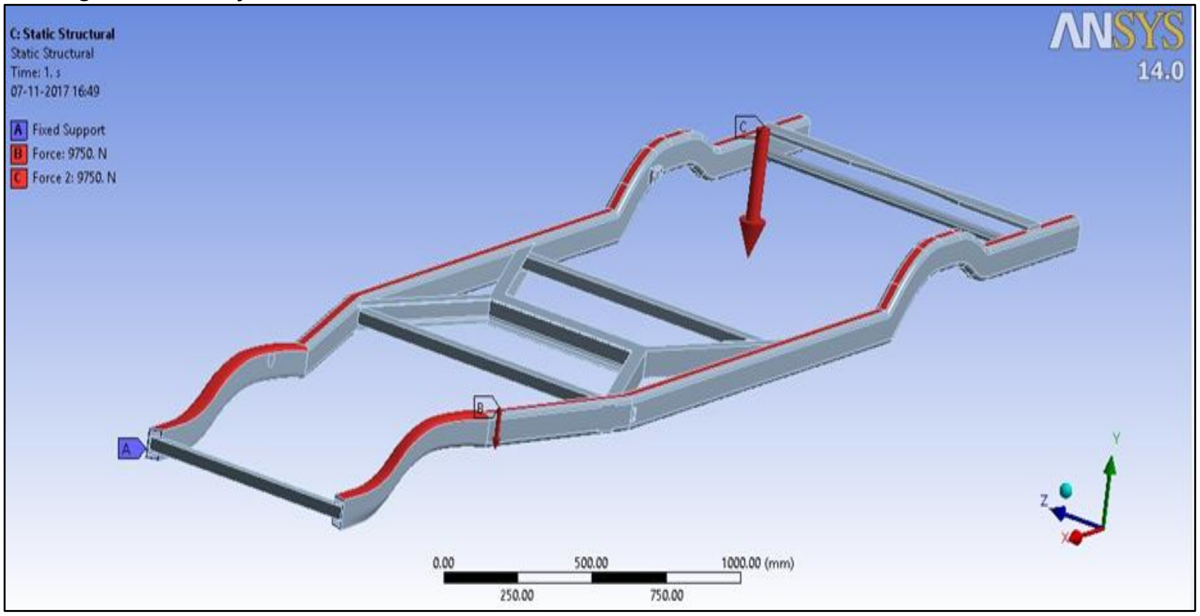


Fig. 14: Loading and Boundary Condition

2) Result

Table 12: Result on Side member with box hollow rectangular section and 4 supports along with diagonal cross bracing

Sl.no	*Mass (kg)*	*Total Deformation (mm)*	*Stress(von-Mises) max (MPa)*	*Safety Factor*	*Fatigue life min (cycles)*
1	*231.1*	*3.8279*	*76.372*	*3.2735*	*1.e+006*

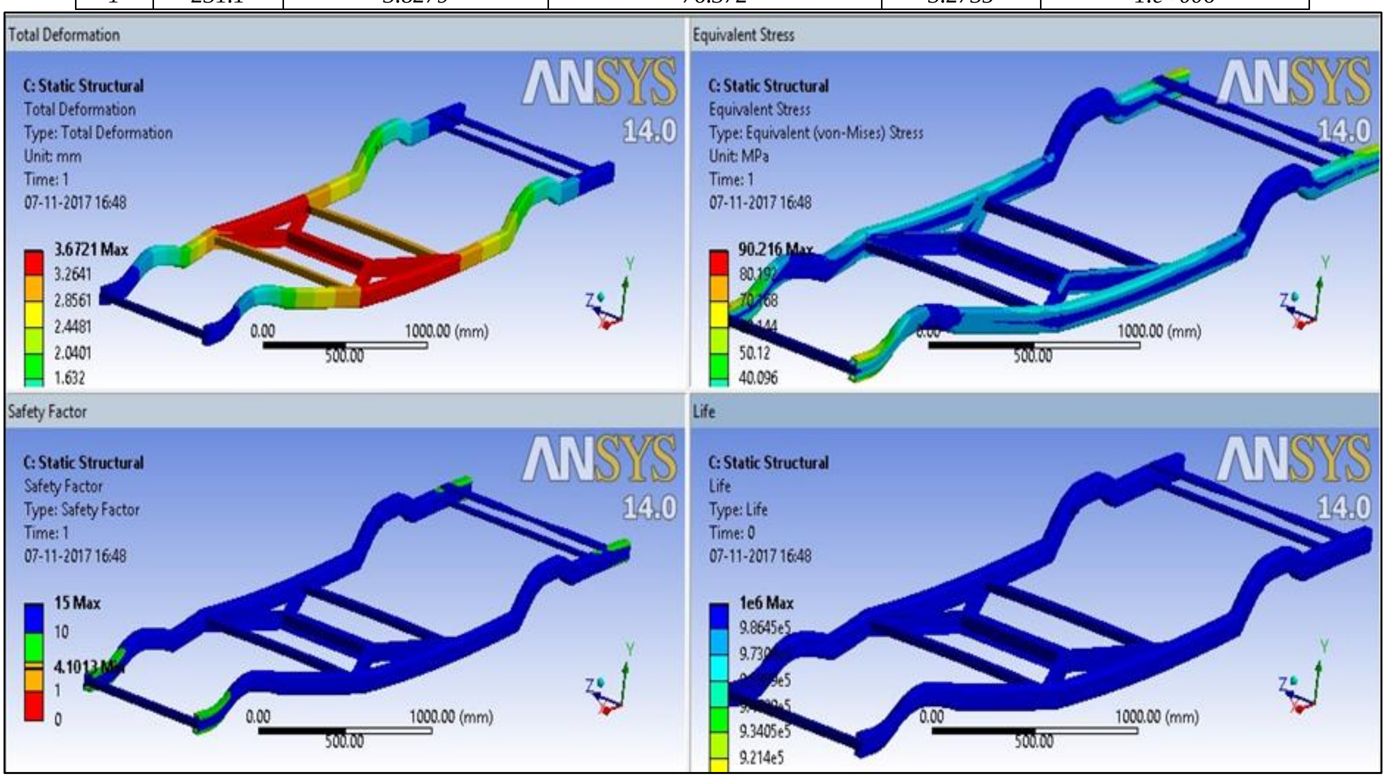


Fig. 15: Result on Side member with box hollow rectangular section and 4 supports along with diagonal cross bracing

Side member with box hollow rectangular section with 6 supports along with diagonal cross bracing

Table 13: Specification of Side member with box hollow rectangular section with 6 supports along with diagonal cross bracing

Sl.no	*Volume(mm³)*	*Mass (kg)*	*Element Size (mm)*	*Node*	*Element*	*Force(N)*
1	*3.1512e+007*	*247.69*	*10*	*261345*	*132600*	*-9750*

3) Loading and Boundary Condition

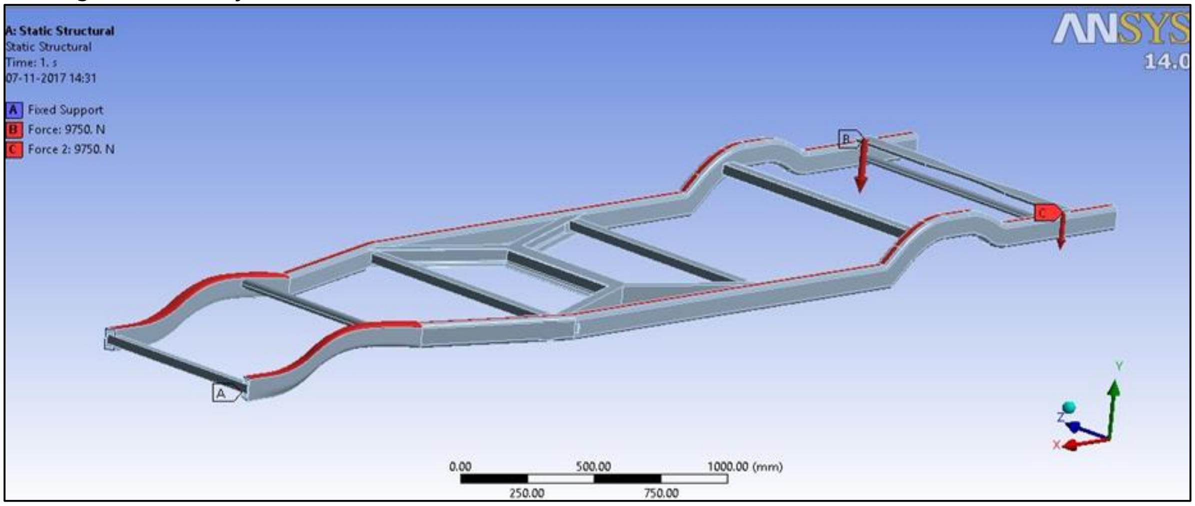


Fig. 16: Loading and Boundary Condition

4) Result

Table 14: Result on Side member with box hollow rectangular section with 6 supports along with diagonal cross bracing

Sl.no	Mass (kg)	Total Deformation (mm)	Stress(von-Mises) max (MPa)	Safety Factor	Fatigue life min in (cycles)
1	247.69	3.6229	95.601	3.8703	7.2947e+005

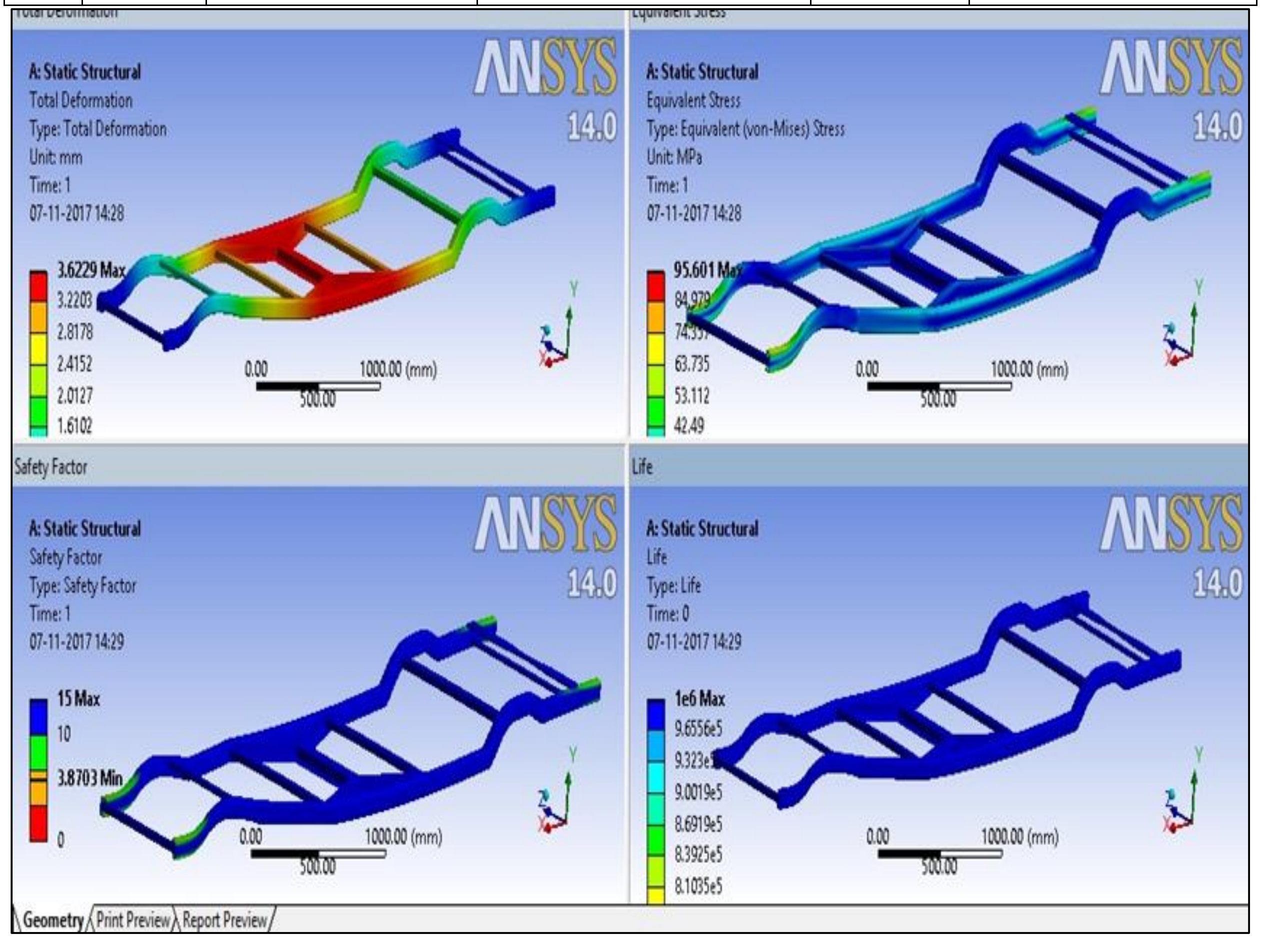


Fig. 17: Result on Side member with box hollow rectangular section with 6 supports along with diagonal cross bracing

Side member with I section, 4 supports and diagonal cross bracing

Table 15: Specification of Side member with I section, 4 supports and diagonal cross bracing

Sl.no	Volume(mm³)	Mass kg	Element Size (mm)	Node	Element	Force (N)
1	3.3322e+007	261.91 kg	10	179349	88908	-9750

5) *Loading and Boundary Condition*

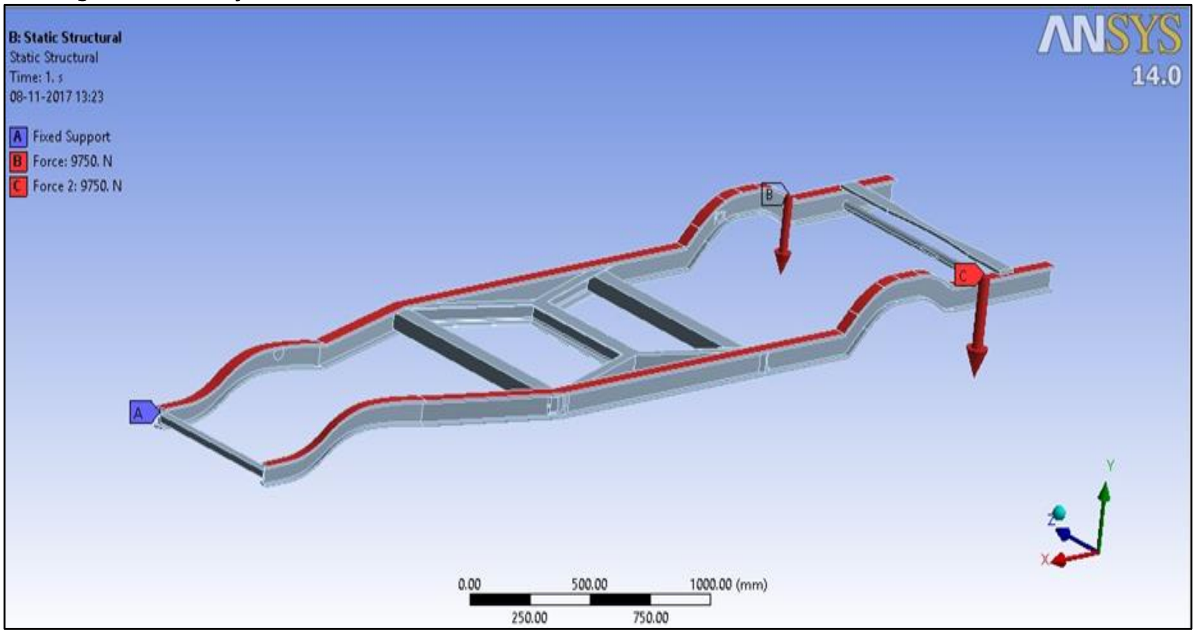


Fig. 18: Loading and Boundary Condition

- Result

Table 16: Result on Side member with I section, 4 supports and diagonal cross bracing

S.l.no	*Mass (kg)*	*Total Deformation (mm)*	*Stress(von-Mises) max (MPa)*	*Safety Factor*	*Fatigue life min in (cycle)*
1	*261.91*	*3.9773*	*108.38*	*3.414*	*3.6178e+005*

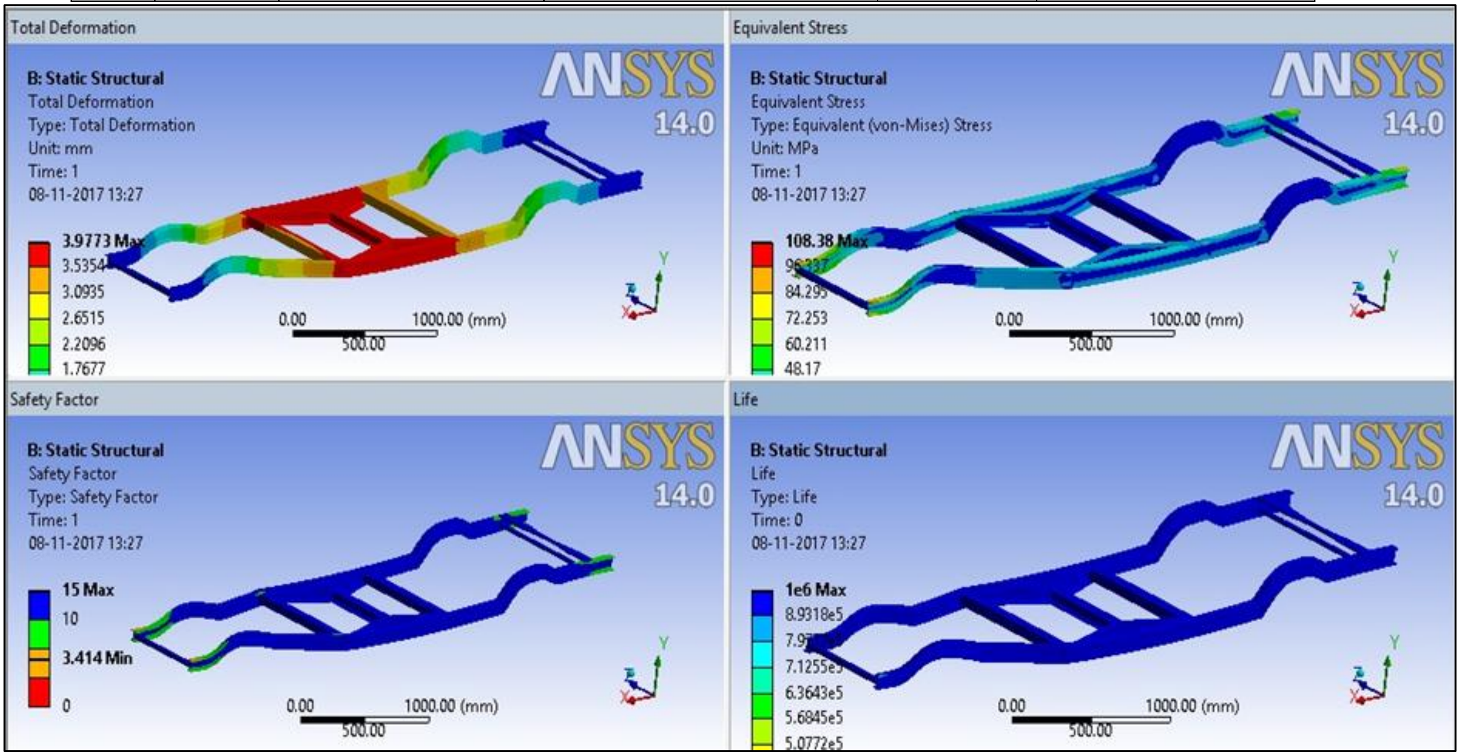


Fig. 19: Result on Side member with I section, 4 supports and diagonal cross bracing

Side member with I section, 6 supports and diagonal cross bracing

Table 17: Specification of Side member with I section, 6 supports and diagonal cross bracing

Sl.no	*Volume(mm³)*	*Mass (kg)*	*Element Size (mm)*	*Node*	*Element*	*Force(N)*
1	*3.5345e+007*	*277.81*	*10*	*201051*	*99459*	*-9750*

6) Loading and Boundary Condition

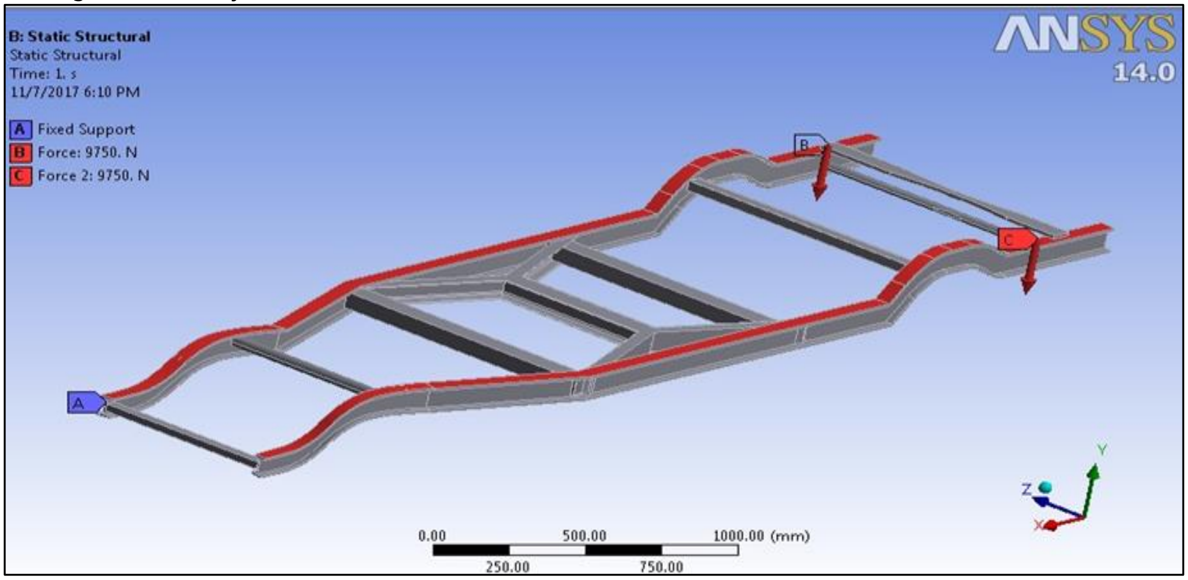


Fig. 20: Loading and Boundary Condition

- Result

Table 18: Result on Side member with I section, 6 supports and diagonal cross bracing

S.l.no	*Mass (kg)*	*Total Deformation (mm)*	*Stress(von-Mises) max (MPa)*	*Safety Factor*	*Fatigue life min (cycle)*
1	*277.81*	*3.9484*	*99.87*	*3.7048*	*6.0663e+005*

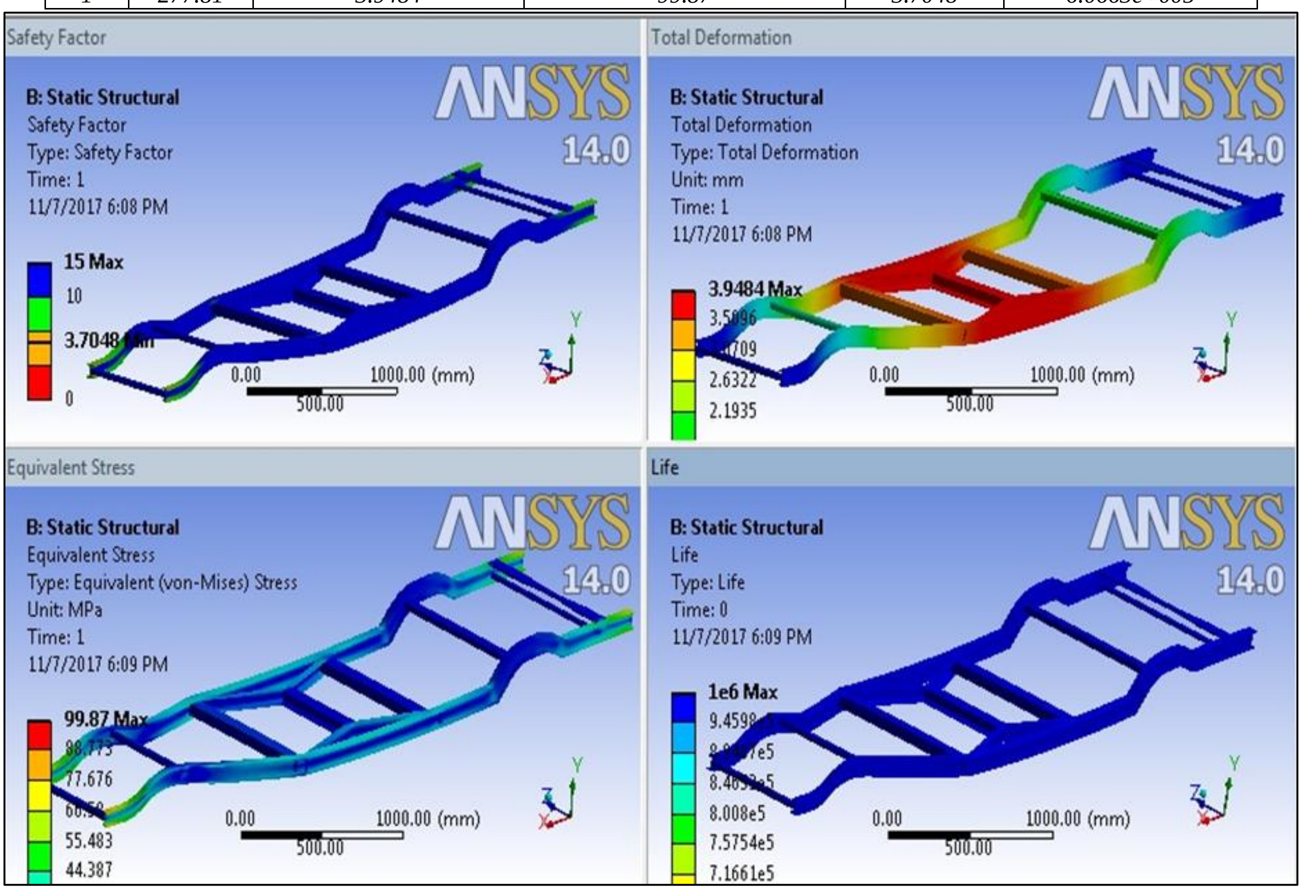


Fig. 21: Result on Side member with I section, 6 supports and diagonal cross bracing

Side member with Tubular O section, 4 supports and diagonal cross bracing

Table 19: Specification of Side member with Tubular O section, 4 supports and diagonal cross bracing

Sl.no	*Volume(mm³)*	*Mass (kg)*	*Element Size(mm)*	*Node*	*Element*	*Force(N)*
1	*3.2189e+007*	*253.*	*10*	*191354*	*96739*	*-9750*

7) Loading and Boundary Condition

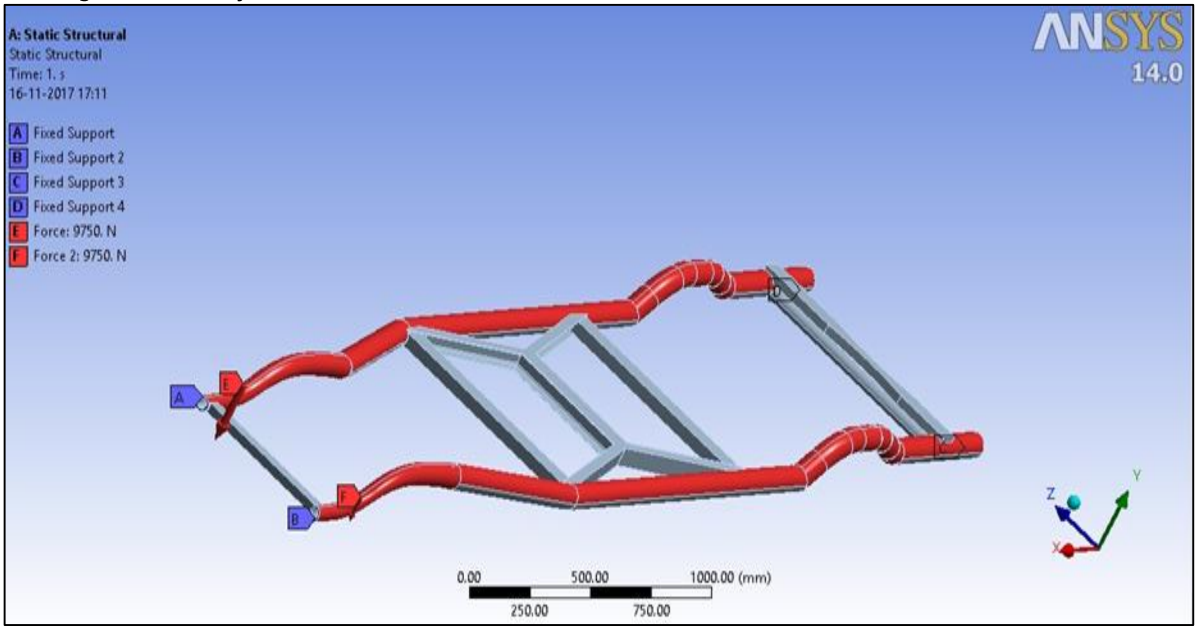


Fig. 22: Loading and Boundary Condition

8) Result

Table 20: Result on Side member with Tubular O section, 4 supports and diagonal cross bracing

S.l.no	Mass (kg)	Total Deformation (mm)	Stress(von-Mises) max (MPa)	Safety Factor	Fatigue life min (cycle)
1	253	5.7645	123.73	2.9905	1.5948e+005

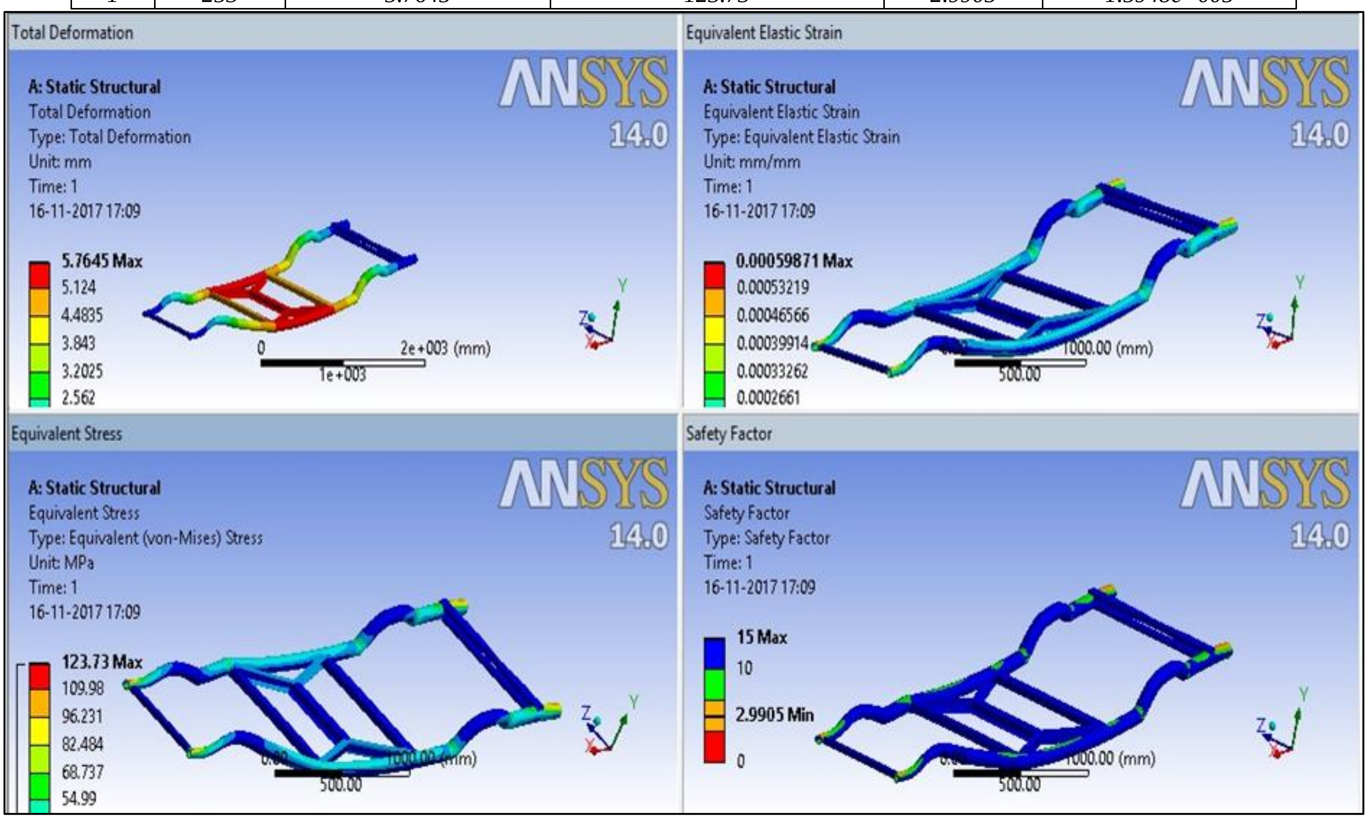


Fig. 23: Result on Side member with Tubular O section, 4 supports and diagonal cross bracing

Side member with Tubular O section, 6 supports and diagonal cross bracing

Table 21: Specification of Side member with Tubular O section, 6 supports and diagonal cross bracing

Sl.no	Volume(mm³)	Mass (kg)	Element Size(mm)	Node	Element	Force(N)
1	3.6581e+007	287.52	10	204793	103748	-9750

9) Loading and Boundary Condition

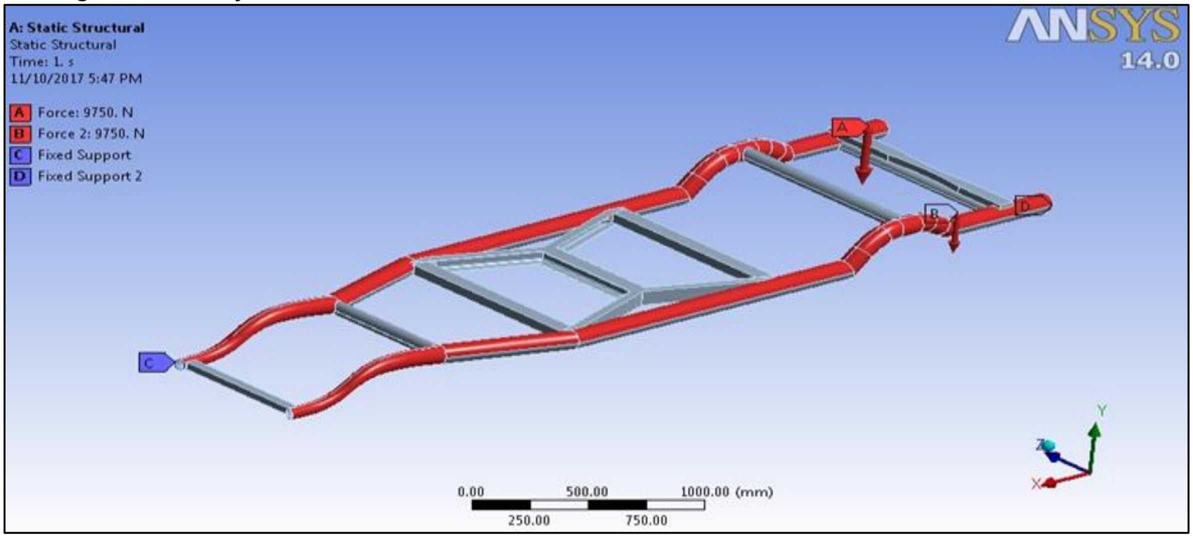


Fig. 24: Loading and Boundary Condition

10) Result

Table 22: Result on Side member with Tubular O section, 6 supports and diagonal cross bracing

S.l.no	*Mass (kg)*	*Total Deformation (mm)*	*Stress(von-Mises) max (MPa)*	*Safety Factor*	*Fatigue life min (cycle)*
1	*287.52*	*5.7587*	*123.45*	*2.9973*	*1.6064e+005*

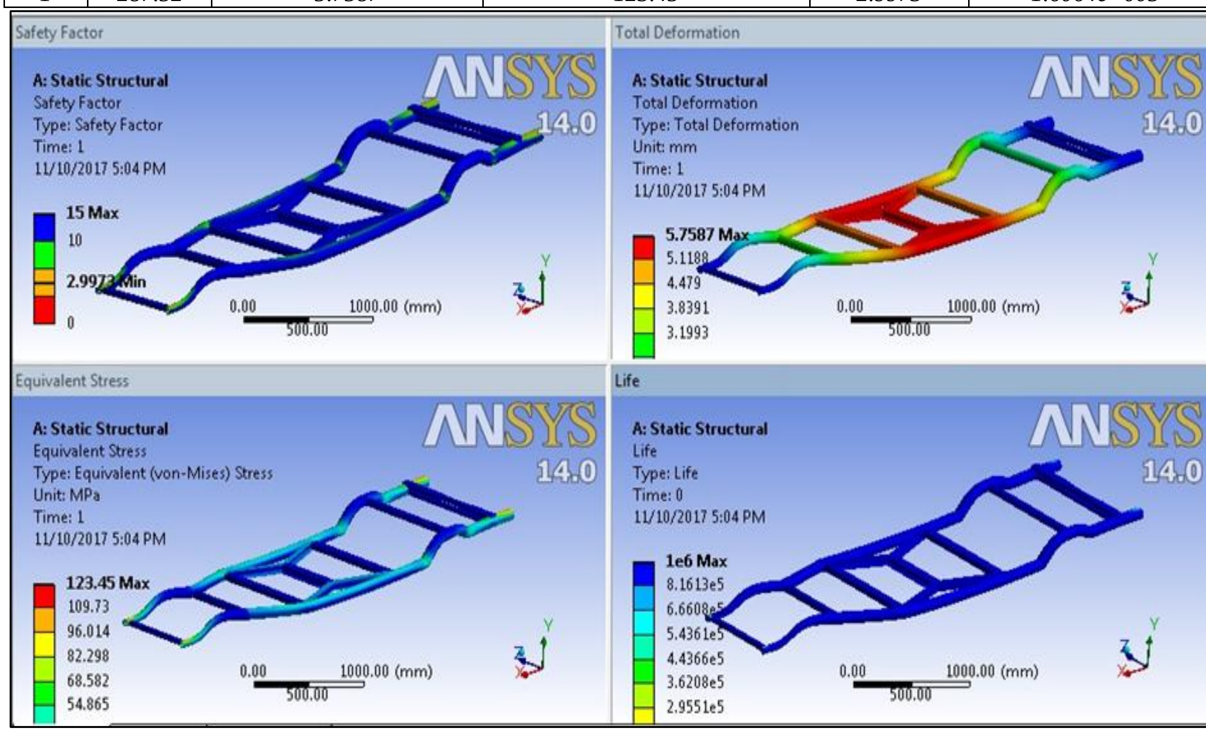
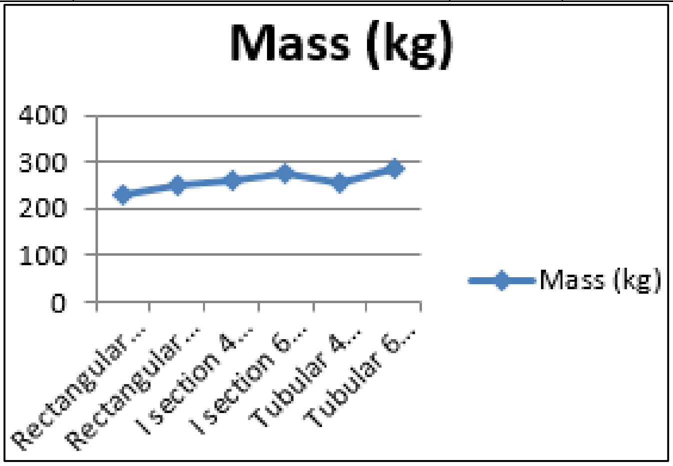


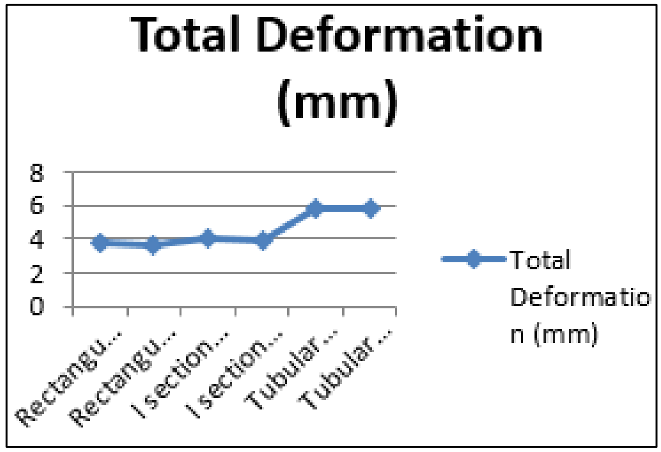
Fig. 25: Result on Side member with Tubular O section, 6 supports and diagonal cross bracing

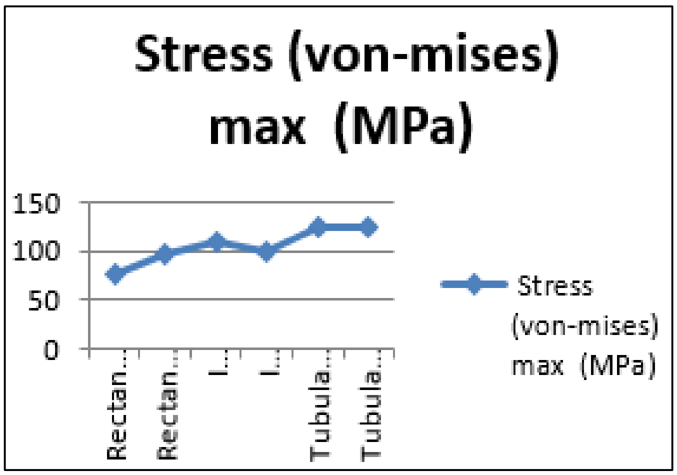
B. Comparison Result on Varying Longitudinal Section with Varying Cross Member

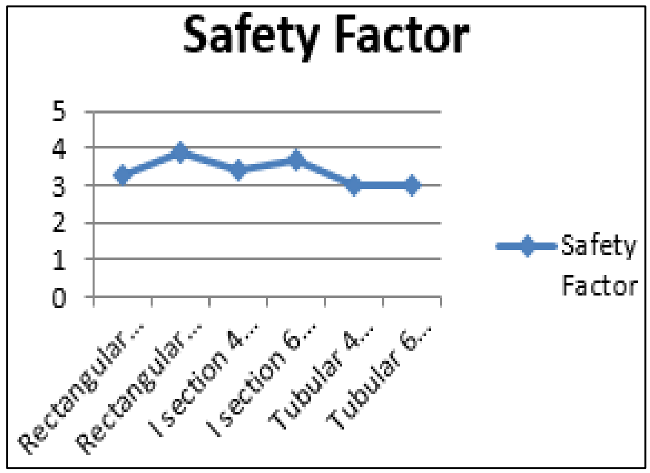
S.l.no	*Type of frame*	*Mass (kg)*	*Total Deformation (mm)*	*Stress (von-Mises) max (MPa)*	*Safety Factor*	*Fatigue life min (cycle)*
1	*Rectangular 4 supports with diagonal cross bracing*	*231.1*	*3.8279*	*76.372*	*3.2735*	*1.e+006*
2	*Rectangular 6 supports with diagonal cross bracing*	*247.69*	*3.6229*	*95.601*	*3.8703*	*7.2947e+005*
3	*I section 4 supports with diagonal cross bracing*	*261.91*	*3.9773*	*108.38*	*3.414*	*3.6178e+005*

4	*I section 6 supports with diagonal cross bracing*	*277.81*	*3.9484*	*99.87*	*3.7048*	*6.0663e+005*
5	*Tubular 4 supports with diagonal cross bracing*	*253*	*5.7645*	*123.73*	*2.9905*	*1.5948e+005*
6	*Tubular 6 supports with diagonal cross bracing*	*287.52*	*5.7587*	*123.45*	*2.9973*	*1.6064e+005*









From the results, it is observed that the Rectangular Cross Section of 6 supports is having more strength than C channel, tubular and I Cross Section type Ladder Chassis. The Rectangular Box Cross Section Chassis is having no of total deformation 3.6229 mm as compare to all section, Stress (Von Mises) 95.601 Mpa and the minimum safety factor 3.8703 is higher than to all as well as the fatigue life 7.2947e+005 no of cycles

X. CONCLUSION

In the present work, the ladder type chassis frame is analyzed by using ANSYS 14.0 Software. The numerical analysis is done through using the essential concepts of strength of materials.

Case-1: Modeling the actual dimension on "C" channel section with 6 support ladder frame and analysis of the result found that minimum safety factor is 0.1929. But by adding material and change the cross section of diagonal cross bracing, on same 6 supports of Ladder frame. The safety factor is 1.5855. Along with change the supports 6 to 5 & 4 are analyzed and the result found safety factor are 1.6077 and 1.468. It is cleared "C" channel section of 5 supports is more safe due design of vehicle flame and the of total deflection is 11.011mm, stress (Von-mises) 230.14Mpa and the life period of material is specify by fatigue life 16638 no. of cycle. Frame is safe under all the loading conditions.

Case-2: To the selection of different types of frame with change the supports 4 & 6. From the analysis and a result on Rectangular Box section of 4 & 6 supports, it has found that minimum safety factor 3.2735 and 3.8703. Selection of "I" section 4 & 6 supports has minimum safety factor 3.414 & 3.7048. Lastly Selection of Tubular "O" section with 4 & 6 supports the minimum safety factor 2.9905 & 2.9973. Comparisons of 4 & 6 supports of selection frame Rectangular Box, "I" and Tubular "O" sections, found that Rectangular Box with 6 supports has minimum safety factor which is higher than to other. Hence the frame is safer. The total deformation is 3.6229 mm; stress (Von-mises) 95.601MPa and life period of material on fatigue life is 7.2947 no. of cycle.

All the cases observed that Rectangular Box of 6 supports is safer due to other design of model analyses and the other observations are as follow:

- Reduction in weight show raw material required for manufacturing of the chassis is reduced.
- As raw material required is reduced, for reduction of cost.

XI. FUTURE SCOPES

- The chassis strength can be improved by providing the stiffeners in rectangular box section due to frame design
- From linear static analysis, maximum deformation of the component and maximum stress can be known and from that the material can be changed if required to meet the loading condition.
- The dynamic analysis can be done for finding the natural frequency and impact testing of chassis frame.
- Finite Element Analysis can be used as a frame or tool to redesign the component. It is designed by classical design theory and dimension.
- For modeling of different design change & material change on stress & weight reduction can be done by FEA

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