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Analysis of Bitumen Carrying Chassis Structure

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Abstract - *Goods carriers are designed to carry the loads. The main load carrying structure of goods carrier is chassis. The chassis design performance is greatly influenced by its stiffness and strength characteristics. The stiffness factor controls the allowable bending deflection of the chassis at the centre and the strength factor makes the structure strong to withstand the stresses. The current scope of the project is to design the optimized chassis for the truck carrying the bituman. The bituman is available in two states of phase as solid and semisolid. Analysis is carried out considering the volume of bituman tank mounted on the chassis. The pay loads that occur within the bituman tank during turning, braking and bumping are considered for analyzing the chassis. The stress plots for all the three conditions are compared and accordingly the necessary design is incorporated within the existing chassis to meet the strength and stiffness factor of safety.*

***Key Words*: Chassis, bitumen, FEM, Analysis, Structure**

1.INTRODUCTION

The chassis is considered as the most essential member as it holds all parts and components jointly, the components that are generally attached to the chassis are engine, the suspension arms, breaking, steering system. It should safely protect the weight of other components and the loads that are resulting from longitudinal, lateral and vertical accelerations that are experienced during racing without failure.

The frame should be strong enough to withstand vibrations, shocks, twist and other cases like rolling over due to excess loading. These play an important role in determining vehicle safety, ride comfort, dynamics and quickness of motion.

2 LITERATUR REVIEW

Ojo Kurdi,et,al [1]: This paper tells about the torsional stiffness of the vehicle, In this paper the truck chassis of existing and modified chassis like arc type, block type, hole type, multi hole type and fully block type model is analyzed using Finite Element Method. Here they made the comparison of all the type of model chassis for torsional stiffness and less weight. From the simulation results it they found that multi holes type model is the best, the model used for analysis here has the length of 12.5m and width of 2.45m chassis, and 3 loads used here for analysis is 10,000N and 5000N and 1000N respectively. The chassis is deformed at both driver side and passenger side, finely here it is found that the torsional stiffness of the truck chassis can be increased by modifying the shape of chassis, it is found that multi holes type of chassis provide the best performance.

Jatin Rajpal,et,al[2]: This paper discussed about the structure analysis of automobile chassis and modification of design for lowering the weight. Here it is shown that with varying in web height the frame thickness can be altered by taking three different cross sections and FEA is carried out for finding safe designs. This paper also tells about the rolling over effect, and use of multi axle drives for prevention of rollover effect of vehicle. Here a new design was proposed to preventing rolling over effect that is active weights are introduced on the front and rear axle, and made use of ECU (Electronic Control Unit) which senses the chances of roll over and find the braking torque required, hence brakes are automatically applied and handling is smoother.

Cicek Karaoglu, N. Sefa Kuralay [3]: Here the authors have made the analysis of stress on riveted chassis, analysis was conducted by Finite Element Method. Thickness of side members, connection plate and its size in lengths are modified for achieving low stress magnitude near the joints of chassis frame. Numerical results showed here that rising the size of the connection plates locally the stresses near the side members can be lowered, and if thickness variation is not possible then rising of length of the connected plate is good alternative. Here it is concluded that stress in joint areas will increase the side member thickness reduces stresses on the joint areas, but the overall weight of the chassis frame increases, so heavy weight of the chassis is eliminated by introducing local plates in joint areas.

2.1 SUMMMARY OF LITERATURE SURVEY

Most of the research work has been carried out on heavy truck chassis and race car chassis. Work is done on torsional stiffness of different model chassis and research is done by considering the engine load at the front or rare portions. Importance is given to longer chassis. The dynamics of the load for longer chassis will have a different impact compared to medium chassis. This project work focuses on the bitumen carrying vehicle chassis which is medium size chassis type which will be of about 10 meter in length.

2.2 OBJECTIVES OF PROJECT

To analyze the stress and strain plots of bitumen carrying chassis structure and to modify the thickness of the chassis structure to reduce the mass without affecting the factor of safety.

3. METHODOLOGY

The existing bitumen carrying chassis length is 8.5m and width is 0.85m. The proposal of the customer was to increase the length of the chassis by around 1m to accommodate accessory parts. So the new design is initiated by considering existing chassis model as a reference. The existing model is modified to a 10m length without altering the cross members. The extended length of a chassis was weak with respect to a torsional stiffness, so an extra cross member is added at length of 0.85m from the existing cross member.

With this modification in the CAD model the CAD model is exported as neutral file from solid works software. The neutral files can be accessed in any third party software without losing the much of the geometric data information. The neutral files will be in the form of .STP, .IGES and PARASOLID (XT). The step files of the chassis CAD model is imported into the HYPERMESH software for descritization. While importing the model the unit scaling factor is set to 1:1 as the model is in mm units. Followed by importing of model the geometric cleanup is carried out de-featuring commands like edge editing, surface editing and hole removal are used to simplify the CAD model.

The meshing of the CAD model is done by extracting the mid surfaces of the CAD part. The shell mesh (quad and tria elements) is created on the mid surfaces by using commands like ruled, drag, spin and auto mesh options. The average element length of 20mm is maintained throughout the structure and at critical region (holes and fillets) the element length is dropped up to 5mm length so as to capture the features accurately for the stress analysis.

The meshed parts are assigned with appropriate thicknesses and steel material properties. The shell section properties are assigned and then the parts are interconnected using rigid elements or node to node connectivity, this condition/ connection satisfies element connectivity condition.

Once the FE model is created the solver ABAQUS deck file is created and exported .INP file. The .INP file is submitted for a run to solve the analysis.

The output from the ABAQUS solver is .ODB (output data base) file. This file is imported into the ABAQUS viewer for the post processing of the stress and displacements contour plots.

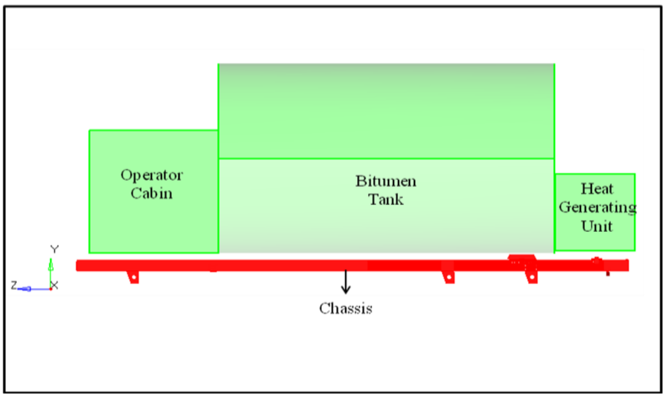

Fig- 3.1: CAD Geometry of bitumen carrying vehicle chassis

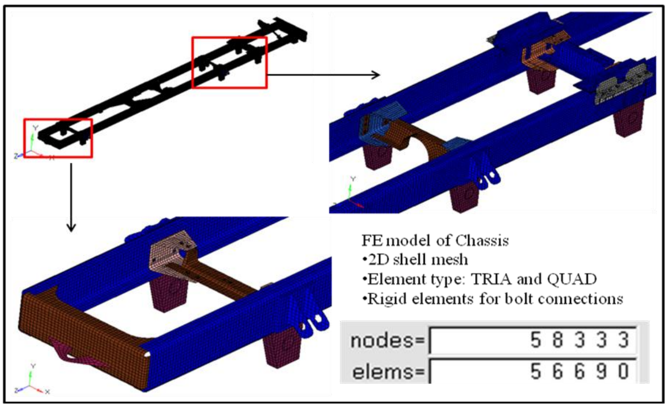

Fig- 3.2: FE Model of chassis

3.1 loading and boundary conditions on chassis

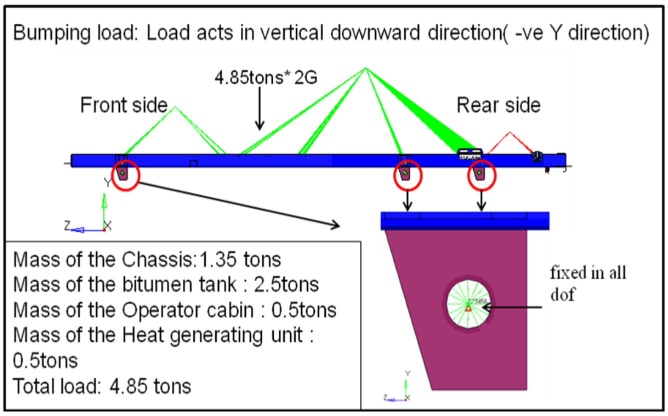

Fig- 3.1.1: Bumping load

Figure 3.1 shows the loading condition and boundary conditions while bumping.

The load during static condition acts gradually on the structure, but when the vehicle moves over the pits or humps the load will not be gradual instead it causes the impact on the structure. The impact load as per the transport standards is considered to be twice of the gradual load.

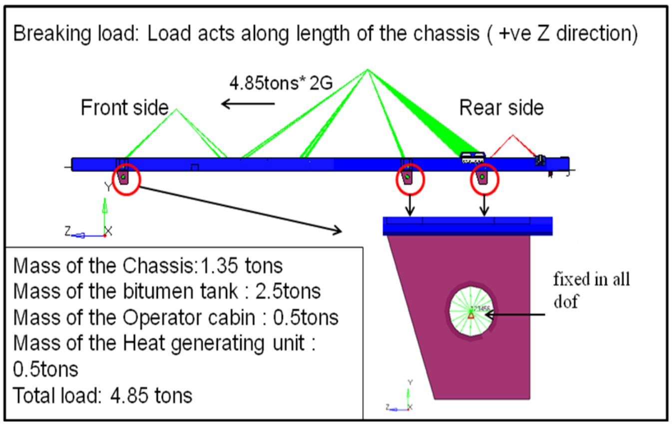

Fig- 3.1.2: Breaking load

The load during static condition acts gradually on the structure, but when the vehicle slows down (brakes) the speed due to emergency, all the load goes on to the cabin side and the load will be of impact in nature. This impact load along the axis of the chassis considered to be twice of the gradual.

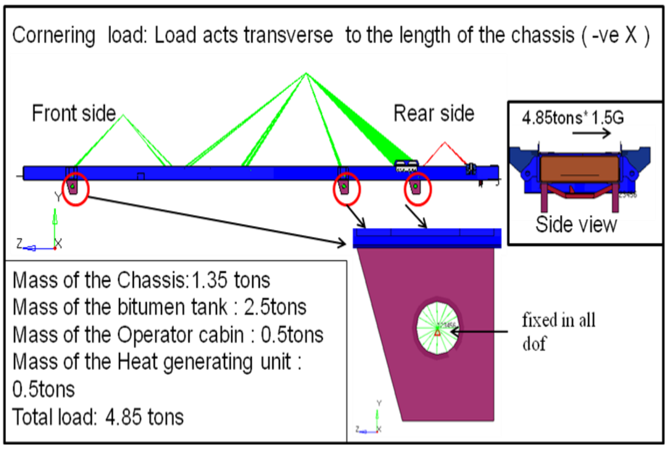

Fig-3.1.3: Cornering load

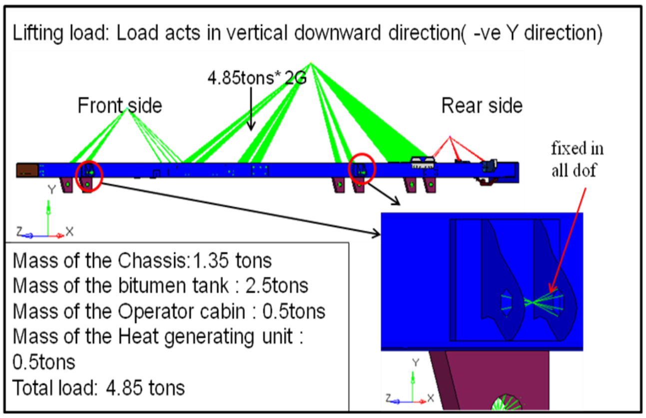

Fig- 3.1.4: Lifting load

This loading condition occurs during the lifting of the chassis part at the time of shipping from road transport to water transport. The loading conditions are similar to bumping expect the boundary conditions are different. The impact load as per the Logistics department is considered to be twice of the gradual load.

4. RESULTS AND DISCUSSIONS

4.1. Load case 1: Bumping load

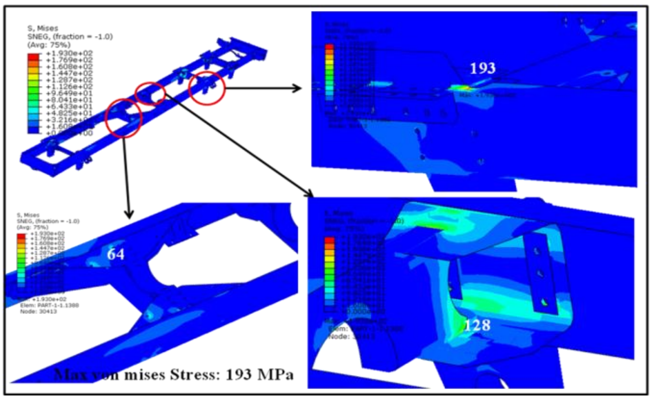

Fig- 4.1.1: Bumping load Von misses stress

The maximum von misses stress observed at the junction of C channel and cross member is 193MPa as in figure 4.1.1.

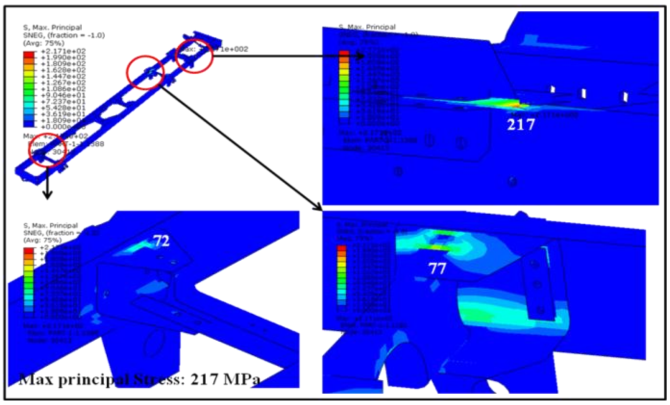

Fig- 4.1.2: Principal stress

Maximum principal stress obtained from the figure 4.1.2, is 217MPa while bumping load in vertical direction.

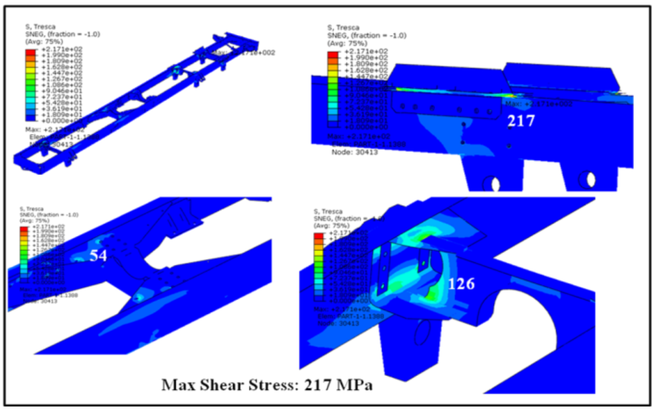

Fig- 4.1.3: Shear stress

The maximum shear stress obtained at the cross members and joints is 217 Mpa, in figure 4.1.3, during bumping load in vertical direction.

4.2. Load case 2: Breaking load in axial direction

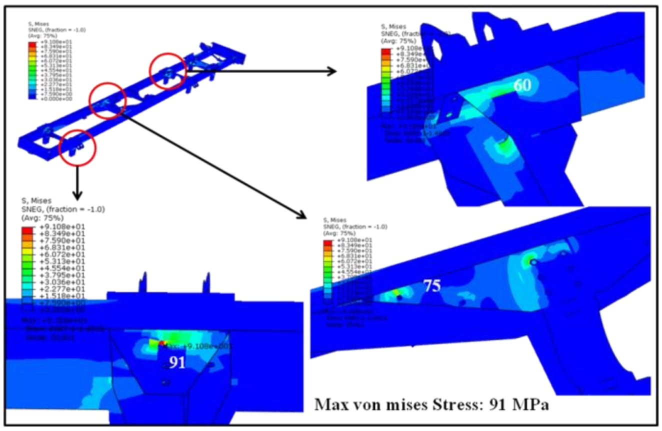

Fig.4.2.1: Von misses stress

The maximum von misses stress in the junction of cross members is observed as 91 Mpa. by figure 4.2.1.

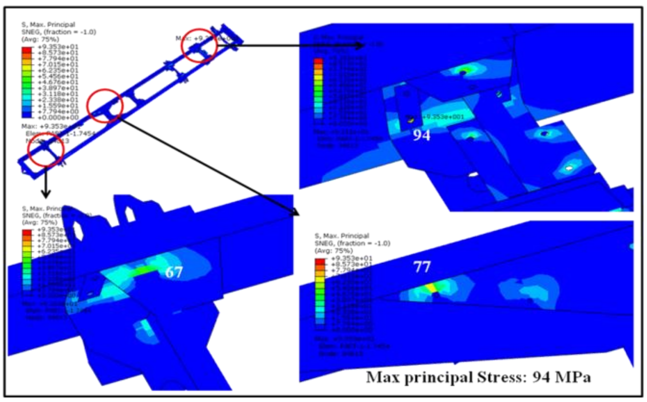

Fig-4.2.2: Maximum principal stress

From the figure 4.2.2 it is observed that the maximum principal stress is 94Mpa at the junction of cross member joint in case of breaking load

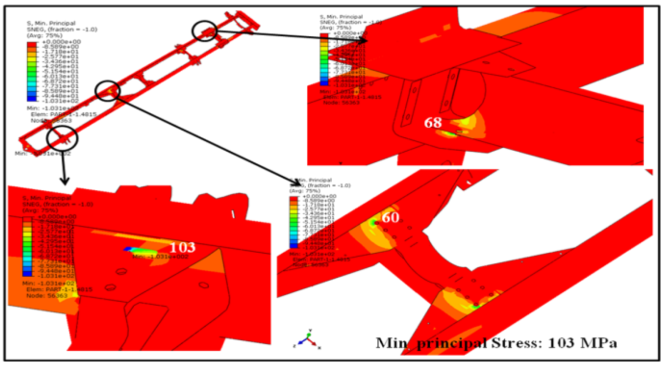

Fig-4.2.3: principal stress

From the figure 4.2.3, it can be seen that the minimum principal stress is 103Mpa at the joint of cross members and c-channel during breaking load.

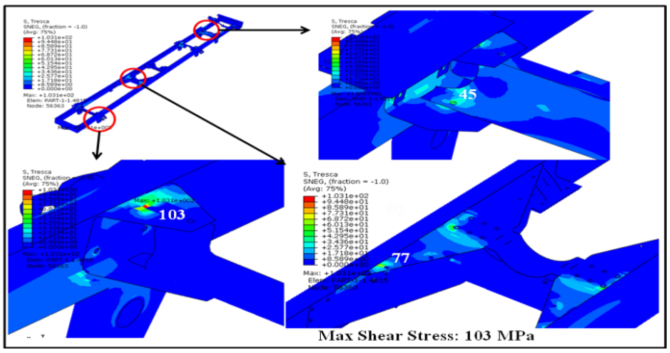

Fig- 4.2.4: Shear stress

By the figure 4.2.4, it is shown the maximum shear stress obtained is 103MPa.

4.3. Load case 3: Cornering load in lateral direction

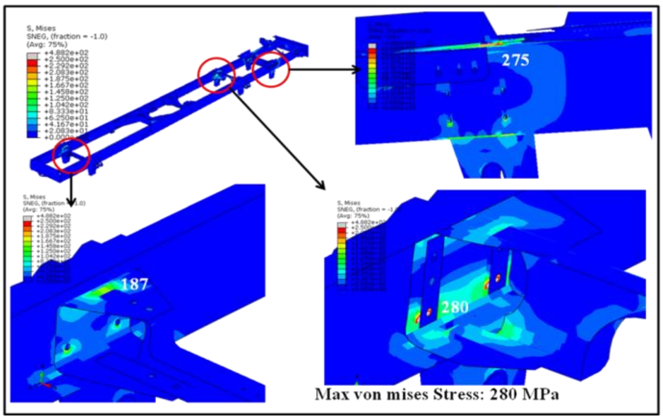

Fig-4.3.1: Von misses stress

From the above figure 4.3.1, 280 Mpa is observed while cornering in lateral direction.

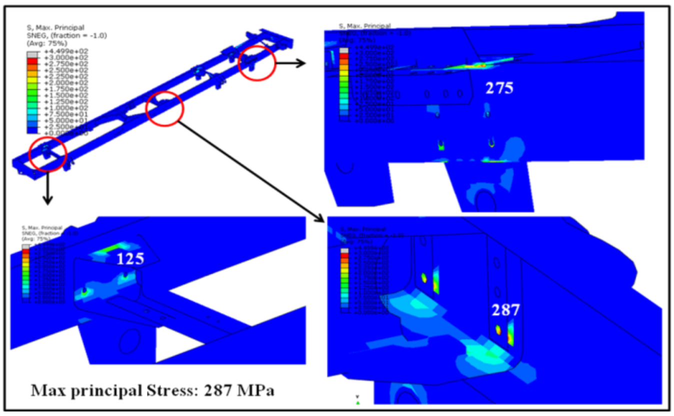

Fig- 4.3.2: Principal stress

From the above figure 4.3.2, maximum principal stress during cornering in lateral direction is shown that 287MPa.

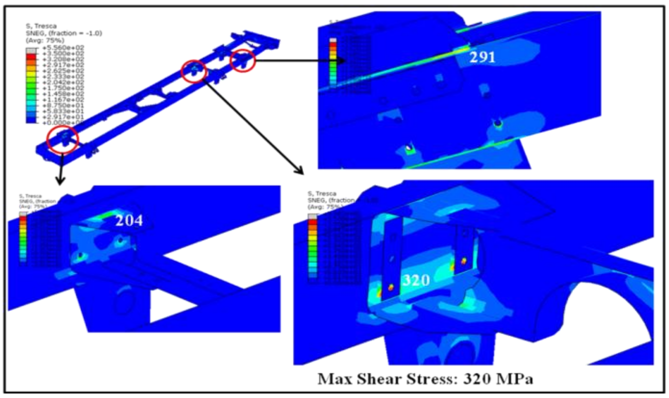

Fig- 4.3.3: Shear stress

From the above figure 4.3.3, the maximum shear stress observed when cornering load in lateral direction is 320MPa.

4.4. Load case 4: Lifting load in downward direction

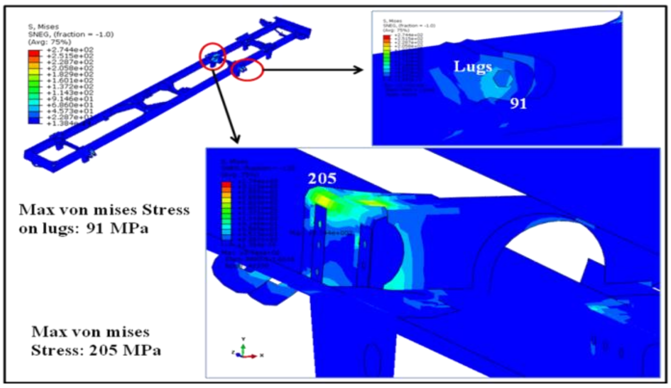

Fig-4.4.1: Von misses stress

By the figure 4.4.1, it is obtained that maximum von misses stress during lifting load in downward in downward is 205MPa in the junctions of cross members.

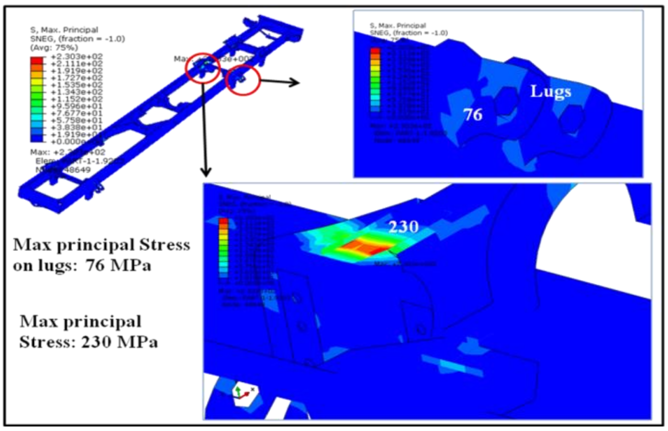

Fig-4.4.2: Principal stress

From above figure 4.4.2, it is observed that the stress while lifting load in downward direction is 230MPa at cross member.

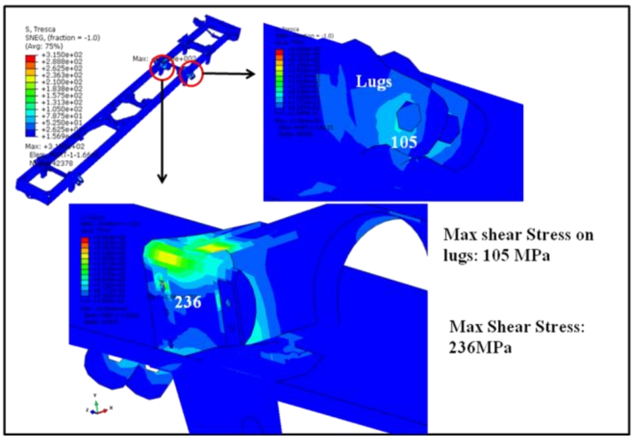

Fig- 4.4.3: Shear stress

From figure 4.4.3, showing shear stress at junction of cross members it is observed that maximum shear stress is 236MPa during lifting load in downward direction.

Table4.1

Strength analysis report									
Sl.No	Applied Loads on the structure			Reaction force at fixed points			Yield Stress (MPa)	Max Stress (MPa)	FOS
	X	Y	Z	X	Y	Z			
LC1	0	-95157	0	0	95157	0	699	217	3.22
LC2	0	0	95157	0	0	-95157	699	103	6.79
LC3	-71367	0	0	71367	0	0	699	320	2.18
LC4	0	-95157	0	0	95157	0	699	236	2.96

Table4.2

Strength analysis report						
Sl.No	Stress (MPa)			Yield Stress (MPa)	Max Stress (MPa)	FOS
	Von-misses	Max-Principal	Shear			
LC1	193	217	217	699	217	3.22
LC2	91	94	103	699	103	6.79
LC3	280	287	320	699	320	2.18
LC4	205	230	236	699	236	2.96

5. Observation and conclusion

From the result summary table, The maximum stress in the chassis structure among the four load cases is observed in the breaking load condition. The maximum stress observed is 320MPa. So the design modification considerations should be considered based on the cornering load condition. Since the stress is lower than the yield strength of 699MPa, the chassis structure is safe and can be recommended for manufacturing.

5.1. Future scope

1. The stresses are well below the yield strength of the material. The cross section /thickness of the cross members and C- section channels of chassis can be varied to reduce the weight of the chassis. This analysis can be taken as topology which deals with the reduction of weight without affecting the FOS.

2. The chassis can be analyzed for dynamic analysis by conducting frequency response analysis / buckling (buckling is equal to check the stiffness).

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