Design and Analysis of Heavy Vehicle Composite Chassis at Various Loads

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Abstract— Designing and modeling the heavy vehicle chassis is done using Pro/Engineer software, taking the data from the L & T Heavy vehicle model by reverse engineering processes. The shear strength of chassis is determined theoretically and compared with FEA analysis. The shape of the heavy vehicle chassis is optimized by taking C – Channel, Box Section and I Section. And also optimization is done to reduce the weight of frame on the chassis. Present used material for chassis is Carbon steel. Replacing the chassis material with Kevlar fiber and S+R (Strength+Rigidity) Glass. By using steel, the weight of the chassis is more compared with Kevlar fiber and S+R Glass Epoxy, since its density is more. FEA analysis is done on chassis for optimizing above parameters under 10 tons load.
Key words: Vehicle Composite Chassis, FEA analysis

I. INTRODUCTION

Automotive chassis is a skeletal frame on which various mechanical parts like engine, tires, axle assemblies, brakes, steering etc. are bolted. The chassis is considered to be the most significant component of an automobile. It is the most crucial element that gives strength and stability to the vehicle under different conditions. Automobile frames provide strength and flexibility to the automobile. The backbone of any automobile, it is the supporting frame to which the body of an engine, axle assemblies are affixed. Tie bars, that are essential parts of automotive frames, are fasteners that bind different auto parts together. Automotive frames are basically manufactured from steel. Aluminum is another raw material that has increasingly become popular for manufacturing these auto frames. In an automobile, front frame is a set of metal parts that forms the framework which also supports the front wheels. It provides strength needed for supporting vehicular components and payload placed upon it. Automotive chassis is considered to be one of the significant structures of an automobile. It is usually made of a steel frame, which holds the body and motor of an automotive vehicle. More precisely, automotive chassis or automobile chassis is a skeletal frame on which various mechanical parts like engine, tires, axle assemblies, brakes, steering etc are bolted. At the time of manufacturing, the body of a vehicle is flexibly molded according to the structure of chassis. Automobile chassis is usually made of light sheet metal or composite plastics. It provides strength needed for supporting vehicular components and payload placed upon it. Automotive chassis or automobile chassis helps keep an automobile rigid, stiff and unbending. Auto chassis ensures low levels of noise, vibrations and harshness throughout the automobile. The different types of automobile chassis include:

A. 2d Chassis Models C Section

Fig. 1:

B. Chassis Main Section

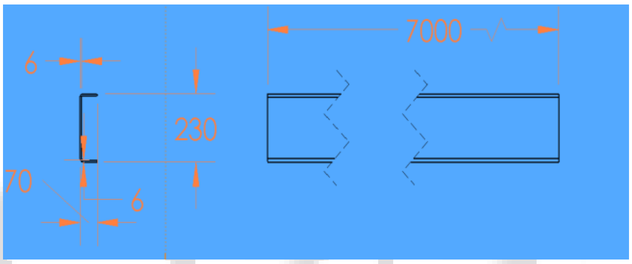

Fig. 2:

C. Assembly

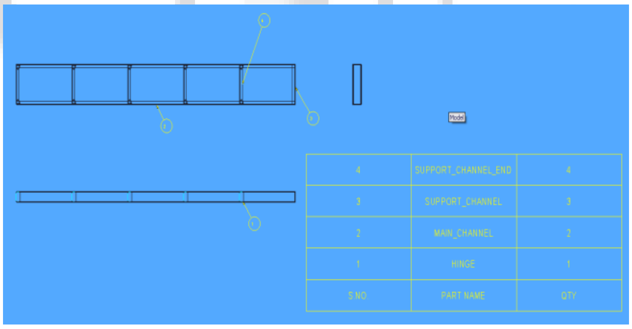

Fig. 3:

D. 3d Box Section

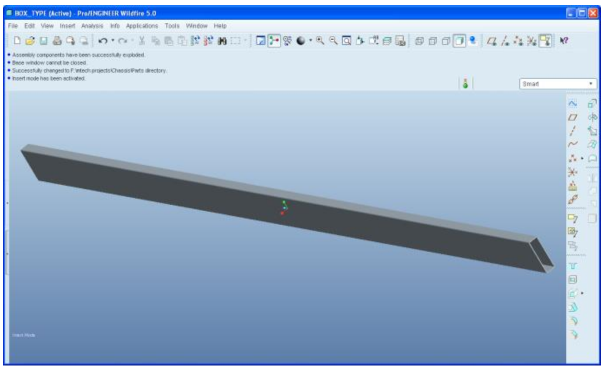

Fig. 4:

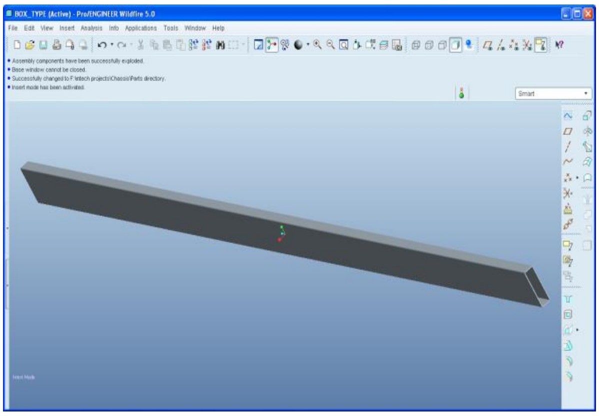

Fig. 5:

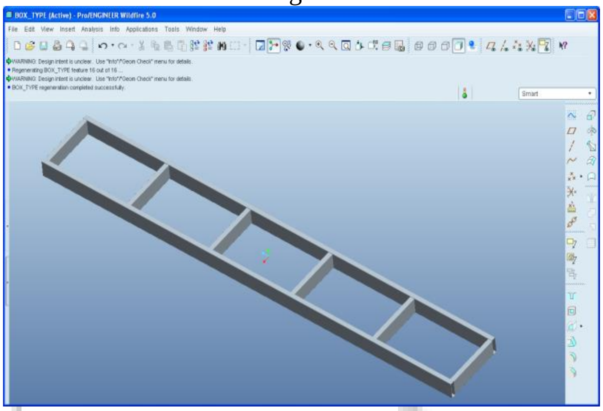

Fig. 6:

E. 3d I Section Of Chassis

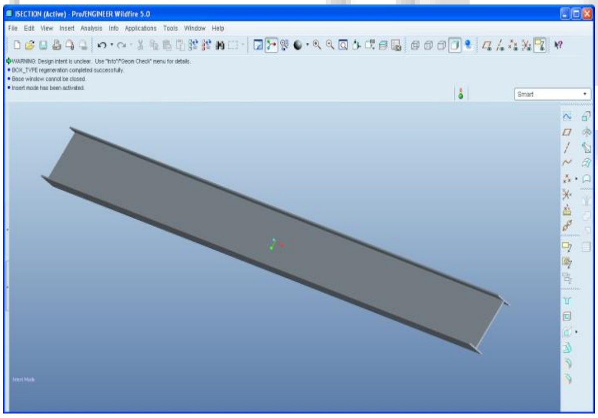

Fig. 7:

F. 3d C Section of Chassis

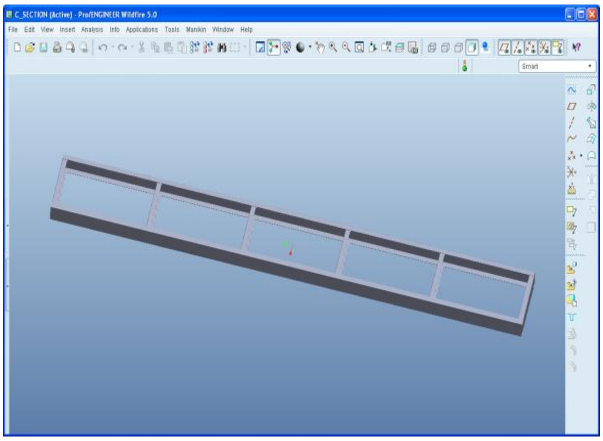

Fig. 8:

G. Assembly

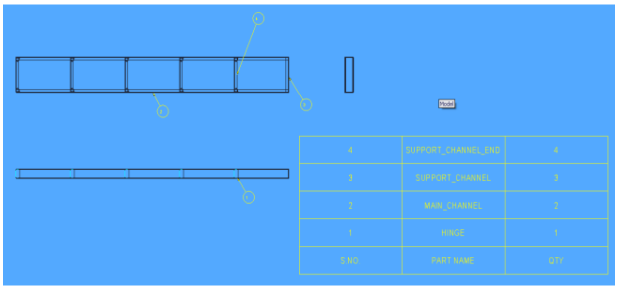

Fig. 9:

II. Structural and Modal Analysis of Chassis

A. Carbon Steel

Imported Model from Pro/Engineer
Element Type: Solid 20 node 95
Material Properties: Youngs Modulus (EX) : 205000N/mm^2
Poissons Ratio (PRXY) : 0.29
Density: 0.000007850 kg/mm^3

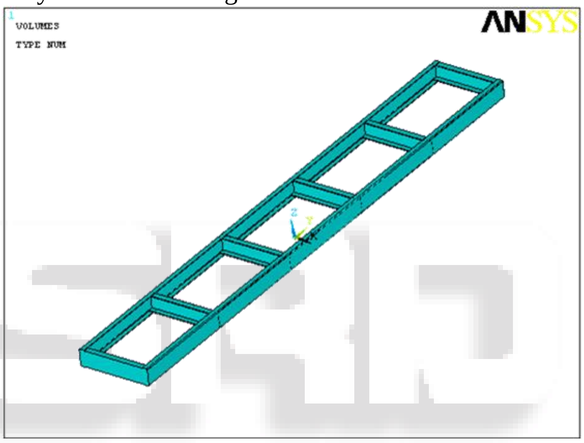

Fig. 10: Meshing Of Chassis

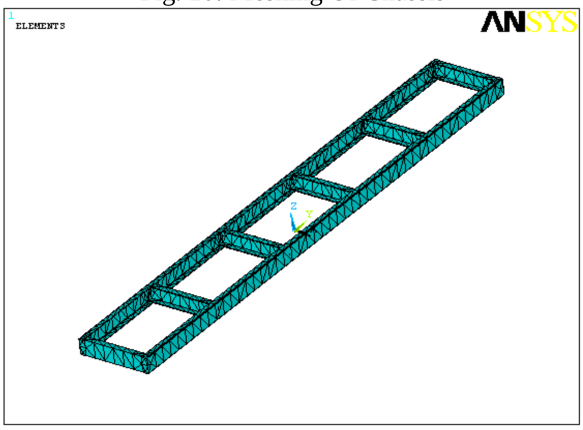

Fig. 11: Solution Displacement Vector Sum

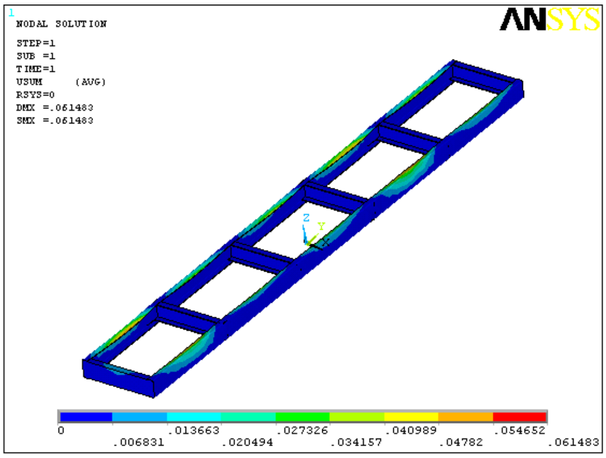

Fig. 12: Von Mises Stress

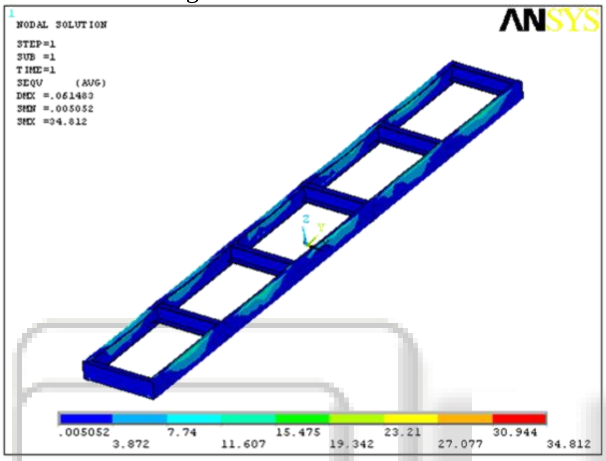

Fig. 13:

B. S R-Glass Epoxy

Element Type: Solid 20 node 95
Material Properties:
Youngs Modulus (EX: 395000N/mm^2
Poissons Ratio (PRXY): 0.3
Density: 0000018 kg/mm^3
Solution Displacement Vector Sum

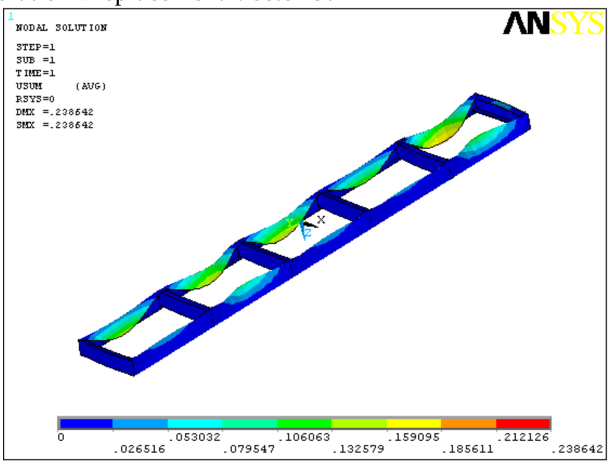

Fig. 14: Von Mises Stress

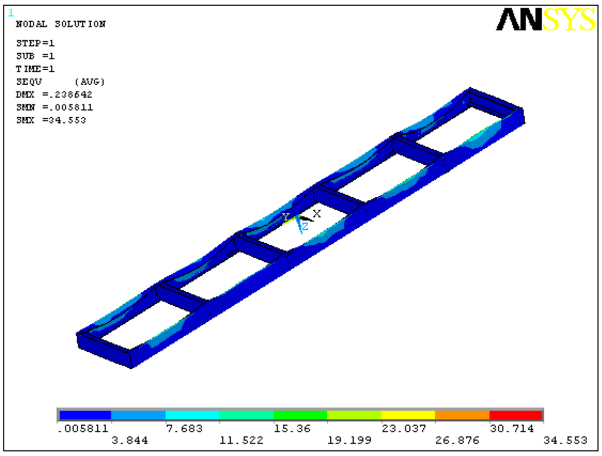

Fig. 15:

III. KEVLAR FIBRE

Element Type: Solid 20 node 95
Material Properties:
Youngs Modulus (EX) : 112000N/mm^2
Poissons Ratio (PRXY): 0.36
Density: 0.0000014 kg/mm^3
Solution Displacement Vector Sum

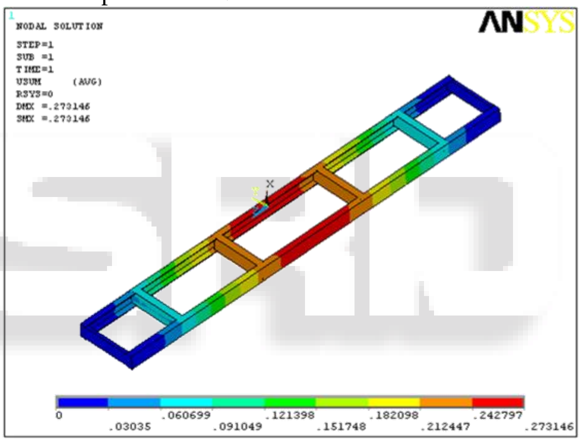

Fig. 16: Von Misses Stress

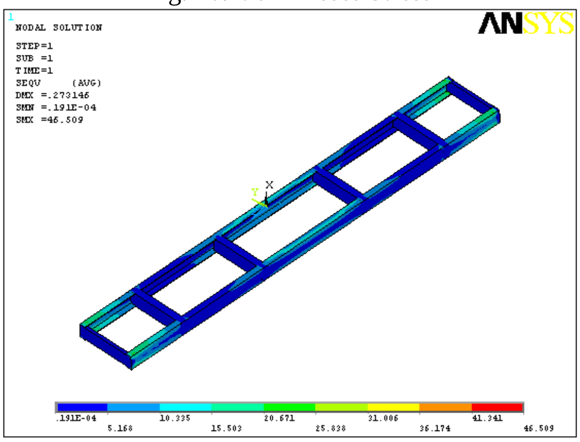

Fig. 17:

IV. RESULTS TABLE FOR I SECTION

A. Structural Analysis

	CARBON STEEL	SR-GLASS EPOXY	KEVLAR
STRESS	34.812	34.553	46.509

DISPLACEMENT	0.061483	0.238642	0.273146

Table 1:

B. Modal Analysis

		CARBON STEEL	SR GLASS EPOXY	KEVLAR
Mode 1	Frequency (Hz)	3.854	10.403	6.349
	Displacement (mm)	0.186606	0.389692	0.441767
Mode 2	Frequency (Hz)	3.757	10.905	6.65
	Displacement (mm)	0.201308	0.42058	0.478646
Mode 3	Frequency (Hz)	4.094	11.88	7.235
	Displacement (mm)	0.20854	0.435704	0.49586
Mode 4	Frequency (Hz)	4.188	12.155	7.408
	Displacement (mm)	0.217264	0.454081	0.518297

Table 2:

V. CONCLUSION

I this work I had changed the cross section of chassis to Box and I section. Present used material for chassis is steel. I am replacing the material with composite materials SR Glass Epoxy and Kevlar Fiber. Since the density of composite materials is less than that of steel, the weight of chassis reduces using composite materials than steel. I have done analysis on all the 3 sections using three materials Steel, SR Glass Epoxy and Kevlar Fiber. By observing the analysis results, for every section, the stress values are less for Kevlar Fiber than other materials. And also its weight is less. When we compare the results between the cross sections, the stress values are less for I section and also using this section the weight of the chassis is also less. So I conclude that using Kevlar Fiber for I section cross section is better for chassis.

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