International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 07, July 2015
Available at http://internationaljournalofresearch.org

Design Evaluation of a Heavy Vehicle Chassis by Using Materials E- Glass Epoxy & S-2 Glass

K.Shirisha [1] & B.Phani Shankar[2]

[1]M.tech student, Department of mechanical engineering Aurora's scientific, technological and research academy Bandlaguda,hyderabad-500005.

[2]Head of the department Department of mechanical engineering Aurora's scientific, technological and research academy Bandlaguda,hyderabad-500005.

ABSTRACT

Vehicles chassis consists of an assembly of all the essential parts of a truck (without the body) to be ready for operation on the road. Composite material is a material composed of two or more distinct phases (matrix phase and dispersed phase) and having bulk properties significantly different from those of any of the constituents. Different types of composite material are available and one of it is Polymer matrix composite. It is very popular due to their low cost and simple fabrication methods. It has the benefits of high tensile strength, high stiffness and good corrosion resistance etc. At present this polymer matrix composite materials are used in aerospace, automobile industries due to it high strength to low weight ratio.

In this paper we design and model the heavy vehicle chassis by using Pro/Engineer software, by taking the data from the L & T heavy vehicle model by reverse engineering processes. Present used material for chassis is steel. The main aim is to replace the chassis material with E- GLASS EPOXY & S-2 GLASS. By using steel, the weight of the chassis is more compared with E- GLASS EPOXY & S-2 GLASS, since its density is more. Structural and Modal analysis is done on chassis for optimizing above parameters under 10tons load.

Software used for modeling ***Pro/Engineer*** *and for analysis* ***ANSYS***

INTRODUCTION

A chassis consists of an internal framework that supports a man-made object. It is analogous to an animal's skeleton. An example of a chassis is the under part of a motor vehicle, consisting of the frame (on which the body is mounted) with the wheels and machinery.

FOR EXAMPLE: Car Chassis:

The main structure of a car is known as chassis. Car chassis functions as a support for the different car parts. Automotive parts like engine, suspension & steering mechanism, braking system, auto wheels, axle assemblies and transmission are mounted on the car chassis.

CAR CHASSIS CONSTRUCTION

Chassis have to be stiff enough so that they withstand the forces applied to them. This is point really important in the suspension settings. If the chassis bends a little the car in not going to behave as expected (as linear) because the ride is being modified, in short, the suspension settings are modified. However, you can not make the chassis completely stiff. That would cause it to be brittle. There will start to appear weak points and it would end breaking throw the weakest. So you need to reach a point where it is neither too stiff nor too weak.

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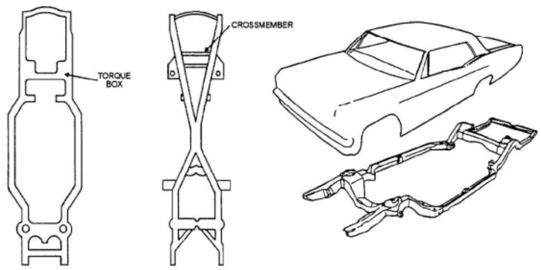
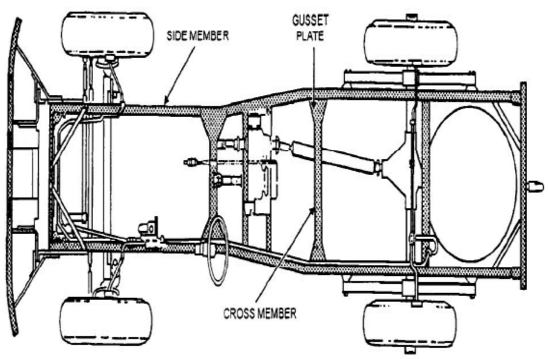
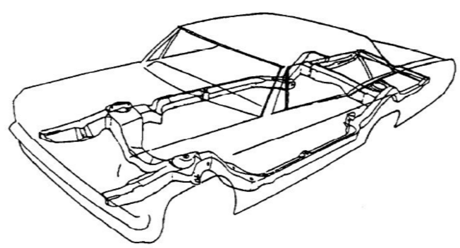
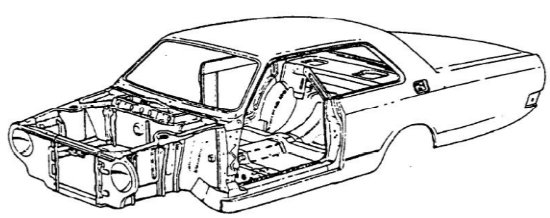
These materials are joined in various ways: riveted, bolted, welded, glued…









CHASSIS IMPROVEMENTS

As standard, most chassis are designed to meet a minimum set of requirements at a reasonable price - as such, there are usually improvements that can be made for vehicles that are going to be used for heavy duty applications and racing.

MATERIAL CHOICE

If possible, one of the best ways to improve upon a design is to ensure that the most suitable materials are being used. Steel, for example, is available in various grades, and rebuilding a chassis using a higher grade will give strength benefits - In drag racing, the chassis of a competing vehicle must be built from a minimum grade of metal in order to run in certain classes.

Another good example of this is in tubing; the cheapest way to make tubing is to take a flat sheet of metal, roll it into shape, and then weld the seam (such tubes are referred to as electrical resistance welded, or ERW - the picture on the left shows a machine used to do this on an industrial scale). However, this seam can be a weak point, and so extruding out a tube in one (seamless) piece is preferable. Given that most of the time, a space frame chassis is built for a specialised purpose, seamless tubing will be used, this is more relevant when building additional components such as rollcages (below).

Remember - as we said in the section on chassis materials, completely different materials cannot be interchanged without redesigning the structure to suit their different properties. A steel chassis rebuilt to exactly the same specifications from aluminium or titanium will be far lighter, but much more susceptible to flexing.

BRACING

Additional bracing can be fitted to stiffen up a chassis, and to reinforce things like mounting points. During the sixties, the sports versions of Ford Escorts used different body shells to the regular versions, with the addition of small reinforcement panels at critical points. These not only made the shell stiffer, but also strengthened it with a view to competition use. Tubular bracing is often used to triangulate across areas of the chassis that have been left open to allow for other components - engine bays etc. A common modification to monocoque body shells is to run a brace between the tops of the suspension mounts, to prevent flexing.

Again, this is not because of any inherent inadequacies with the original design, but due to the fact that a chassis is designed with a balance between cost and performance - a balance that changes depending on whether you are dealing with a family hatchback or a sportscar. Additional bracing adds cost, and can also reduce practicality (access for servicing, for example), and so if you can get away without it, it's generally not included on a production model.

Care needs to be taken when designing extra bracing that it does not cause loads to be transferred onto points that aren't designed to cope with the forces involved. As such, most bracing runs between points that are already load-bearing, and uses plates to spread the loads where required.

ROLLCAGES

A rollcage is basically a space frame chassis designed with protection in mind, which is retro-fitted to an existing chassis primarily for added reinforcement in the event of a roll-over or other serious accident. Rollcages (properly referred to as "roll-over protection devices") vary from a simple bent tube behind the driver's seat to a fully welded-in frame mounting to a dozen or more points on the car.

Properly-designed rollcages also give the same stiffening advantages as fitting bracing, and are often linked up to suspension mounting points etc. The rollcages fitted to a professional rally or touring car offer enough reinforcement to render the original monocoque almost obsolete.

WELDING IMPROVEMENTS

As most bodyshells are manufactured by spot welding the panels together, a simple way to stiffen them up is to either stitch or seam weld them instead. As with welding during construction of a chassis, care must be taken to avoid problems due to excessive heat. Normally, additional welding is concentrated on specific areas, such as suspension mounting points or the engine bay, as it is quite a labour intensive technique. Most of the time, a full rollcage would be fitted instead of additional welding, but in some instances where a cage is not going to be used, full welding of the entire shell can take place.

FUTURE DESIGNS

Design modifications in the future will be based on the overall aerodynamic package of the car. Driver safety is always a major concern when regulations are changed in the CART series. One area of concern is the drivers helmet. The drivers helmet is exposed to airflow in excess of 200mph. Severe buffeting can not only effect the aerodynamics of the car, but can jeaopardize the driver's safety in the event of a frontal impact. Helmets are now being designed with aerodynamic aids mounted on the back of the helmet. According to Simpson Race Products (safety helmet designer), the aerodynamic aid performs three separate functions:

- It prevents the helmet from lifting at high speeds.
- It stops the buffeting effect (on the drivers head and neck).
- It helps clean up the airflow from the helmet going back to the car's rear wing.

In a few hours you could have a big laugh and say, 'No we're going to go back like we thought we should'." Or maybe it would bring about a whole new chassis design that would be:

- Adapatable to different engines.
- Adapatable to the different race ciruits.
- Aerodynamically efficient.

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IJR
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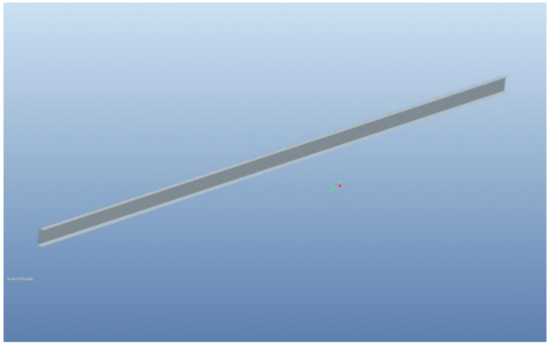
MODEL OF CHASSIS BY PRO-E



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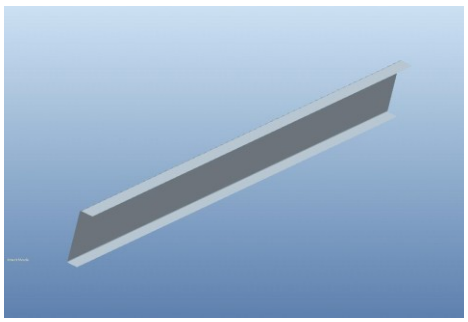

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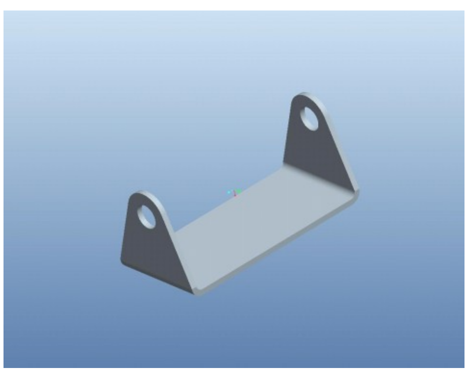

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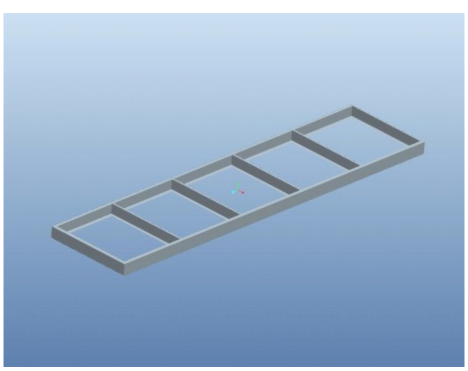
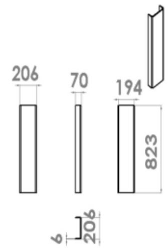


ASSEMBLY

2D DRAWINGS



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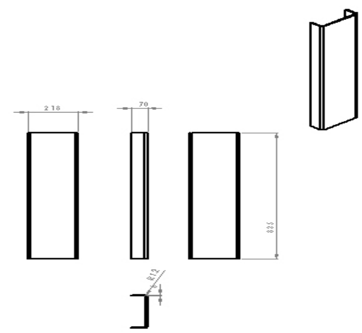

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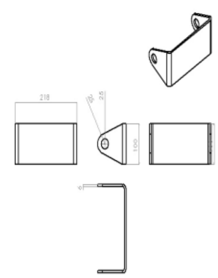

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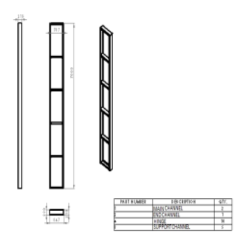

ASSEMBLY

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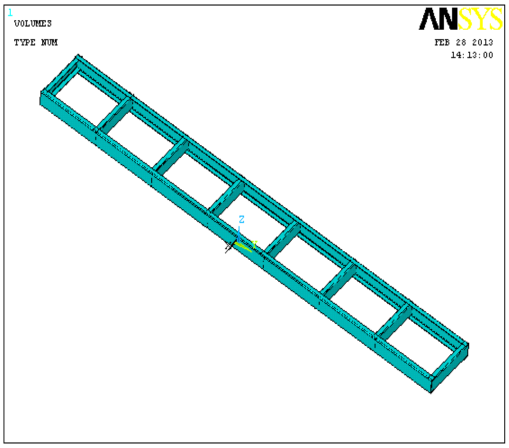
STRUCTURAL AND MODAL ANALYSIS OF CHASSIS BY ANSYS



Imported Model

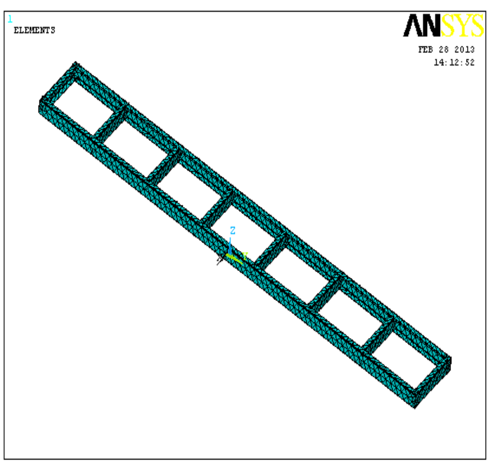
Element Type: Solid 20 node 95

Material Properties:

Youngs Modulus (EX) : 205000N/m

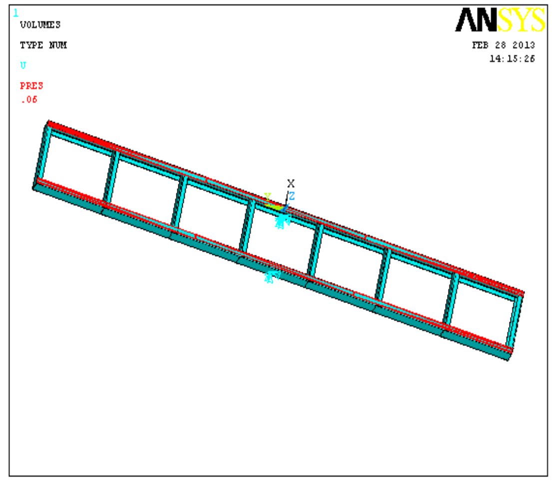
Poissons Ratio (PRXY) : 0.29

Density : 0.000007850 kg/mm^3



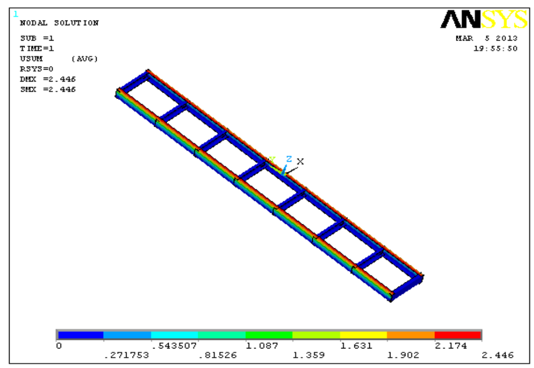
Meshed Model

Pressure – 0.06N/mm^2

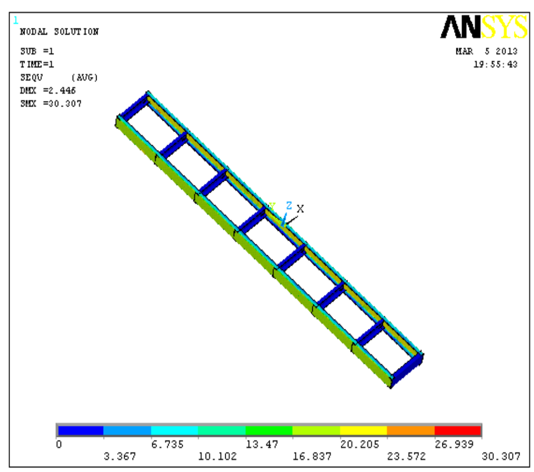


Load

RESULTS



DISPLACEMENT



STRESS

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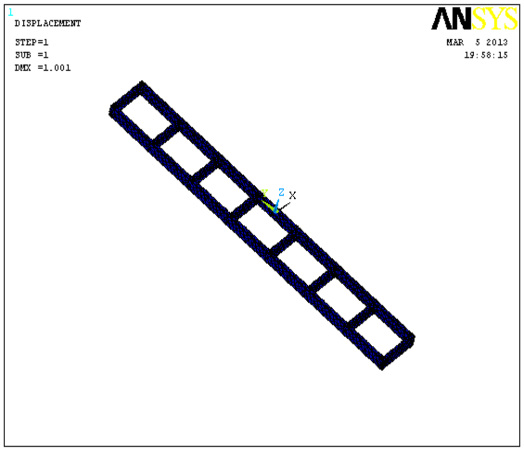
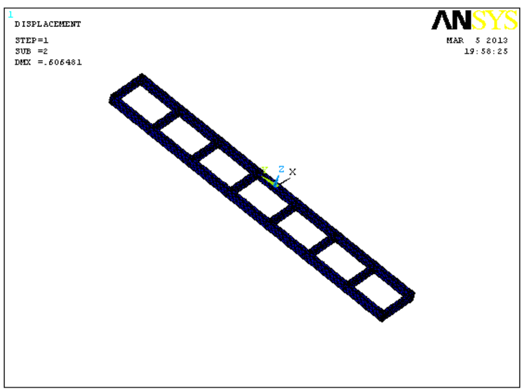
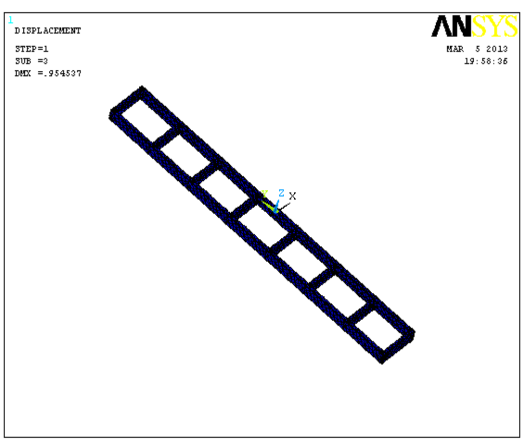
MODE SHAPES



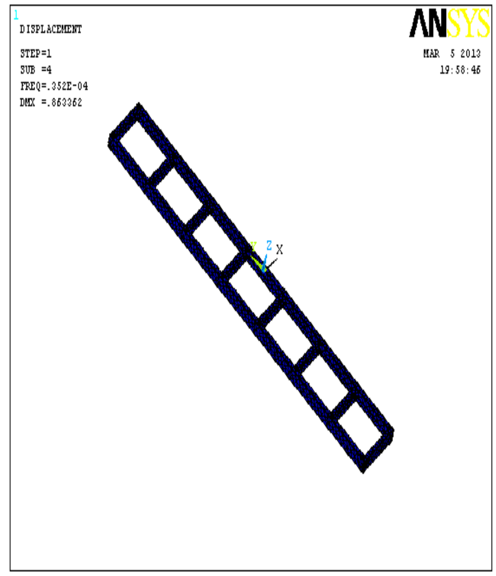
MODE1



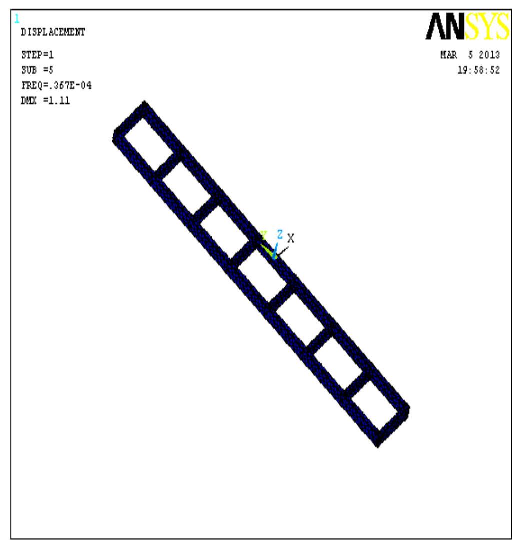
MODE2



MODE3



MODE4



MODE5

ANALYSIS RESULTS

		STEEL	E – GLASS EPOXY	S2 GLASS EPOXY
DISPLACEMENT (mm)		1.001	4.077	2.446
STRESS (N/mm^2)		29.403	29.257	30.307
MODE 1	**FREQUENCY (Hz)**	-	-	-
	DEFLECTION (mm)	0.422718	1.068	1.001
MODE 2	**FREQUENCY (Hz)**	-	-	-
	DEFLECTION (mm)	0.45	1.166	0.606
MODE 3	**FREQUENCY (Hz)**	$0.519e^{-4}$	-	-
	DEFLECTION (mm)	0.434	1.201	0.954
MODE 4	**FREQUENCY (Hz)**	$0.606e^{-4}$	$0.212e^{-4}$	$0.352e^{-4}$
	DEFLECTION (mm)	0.512	0.7634	0.863
MODE 5	**FREQUENCY (Hz)**	$0.7e^{-4}$	$0.429e^{-4}$	$0.367e^{-4}$
	DEFLECTION (mm)	0.448	1.061	1.11

CONCLUSION

In this paper we have designed a chassis used in heavy vehicles. Present used material for chassis is steel. We are replacing the material with composite materials E Glass Epoxy and S2 Glass Epoxy. Since the density of composite materials is less than that of steel, the weight of chassis reduces using composite materials than steel. And also the strength of the composites are more than that of steel.The weight of the chassis assembly by using steel is 356.73Kg, using E Glass Epoxy is 90.904Kg and using S2 Glass Epoxy is 111.844Kg.Structural and Modal analyses are done on the chassis by using all the three materials. By observing the analysis results, the stress values are less than their respective permissible values. So using all three materials is safe under the given load condition.When we compare the results for all three materials, the stress value is less for E Glass Epoxy and also its weight is less compared with other two materials.So we can conclude that using E Glass Epoxy is better.

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