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Research Paper

STRUCTURAL ANALYSIS OF HEAVY VEHICLE CHASSIS USING HONEY COMB STRUCTURE

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Automotive chassis can be considered as the backbone of any vehicle its principle function is to safely carry the maximum load for all designed operating conditions. This paper describes design and analysis of heavy vehicle chassis. Weight reduction is now the main issue in automobile industries. Traditionally most common material for manufacturing vehicle chassis has been mild steel, in various forms. Over time, other materials have come into use, the majority of which have been is steel and Aluminium. In this paper traditional materials are replaced with composite materials [S-glass epoxy and E-glass epoxy]. Using reverse engineering method. (Existing model, modified model, honey comb model). For validation the design is done by applying a single vertical loads acting on the chassis. And then Structural and, fatigue analysis will be carried out on three models to all materials and select the best material Impact analysis can also be done for the selection material in all models Software's used in this work solid works for modeling ANSYS 14.5 for analysis.

Keywords: Heavy vehicle chassis, Mild steel, E-glass epoxy, S-glass epoxy structural and fatigue analysis, Impact analysis, Honey-comb structure

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 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

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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:

Ladder Chassis: Ladder chassis is considered to be one of the oldest forms of automotive chassis or automobile chassis that is still used by most of the SUVs till today. As its name connotes, ladder chassis resembles a shape of a ladder having two longitudinal rails inter linked by several lateral and cross braces.

Backbone Chassis: Backbone chassis has a rectangular tube like backbone, usually made up of glass fiber that is used for joining front and rear axle together. This type of automotive chassis or automobile chassis is strong and powerful enough to provide support smaller sports car. Backbone chassis is easy to make and cost effective.

Monocoque Chassis: Monocoque Chassis is a one-piece structure that prescribes the overall shape of a vehicle. This type of automotive chassis is manufactured by welding floor pan and other pieces together. Since monocoque chassis is cost effective and suitable for robotised production, most of the vehicles today make use of steel plated monocoque chassis.

SPECIFICATION OF THE PROBLEM

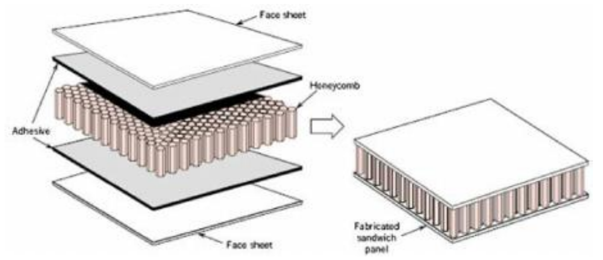
Chassis is one of the major part in vehicle construction. Generally chassis is made of mild steel, these type of chassis models are due to heavy weight vehicle is giving less mileage and also cost of the chassis is high.

HONEY COMB STRUCTURE

Honey Comb structures are used for design and construction of lightweight transportation systems such as satellites, aircraft, missiles, high speed trains. Structural weight saving is the major consideration and the sandwich construction is frequently used instead of increasing material thickness. This type of construction consists of thin two facing layers separated by a core material. Potential materials for sandwich facings are aluminum alloys, high tensile steels, titanium and composites depending on the specific mission requirement.

Several types of core shapes and core material have been applied to the construction of sandwich structures. Among them, the honeycomb core that consists of very thin foils in the form of hexagonal cells perpendicular to the facings is the most popular.

Figure 1: Honey Comb Sand Wich Panel



This paper deals with the design and structural analysis of heavy vehicle chassis with honeycomb core structure. The honeycomb sandwich construction is one of the most valued structural engineering innovations developed by the composites.

MATERIALS SELECTION

The honeycomb sandwich construction can comprise an unlimited variety of materials and panel configurations. The composite structure provides great versatility as a wide range of core and facing material combinations can be selected. The following criteria should be considered in the routine selection of core, facing, and adhesive.

Structural Considerations

Strength: Honeycomb cores and some facing materials are directional with regard to mechanical properties and care must be taken to ensure that the materials are orientated in the panel to take the best advantage of this attribute.

Stiffness: Sandwich structures are frequently used to maximize stiffness at very low weights. Because of the relatively low shear modulus of most core materials, however, the deflection calculations must allow for shear deflection of the structure in addition to the bending deflections usually considered.

Adhesive Performance: The adhesive must rigidly attach the facings to the core material in order for loads to be transmitted from one facing to the other. Suitable adhesives include high modulus, high strength materials available as liquids, pastes or dry films. As a general rule, a low peel strength, or relatively brittle adhesive should never be used with very light sandwich structures which may be subjected to abuse or damage in storage, handling or service.

Cell Size: A large cell size is the lower cost option, but in combination with thin skins may result in telegraphing, i.e., a dimpled outer surface of the sandwich. A small cell size will give an improved surface appearance, and provides a greater bonding area, but at higher cost.

Cell Shape: Normally supplied with hexagonal cell shapes, a few honeycomb types can be supplied with rectangular cell shapes

STRUCTURAL ANALYSIS

Static analysis calculates the effects of steady loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by time-varying loads. A static analysis, however, includes steady inertia loads (such as gravity and rotational velocity), and time-varying loads that can be approximated as static equivalent loads (such as the static equivalent wind and seismic loads commonly defined in many building codes

Modeling is done through by using solid works in existing model, after that modified model and later honey comb model is designed later on completion of modeling. Analysis will be carried out through using Ansys 14.5. A single vertical load will act on a existing model, modified model, and on honey comb model also with three materials and structural analysis, fatigue analysis will be carried out with three materials mild steel, S glass Epoxy, glass Epoxy.

STRUCTURAL AND FATIGUE ANALYSIS ON EXISTING

Table 1: Material Properties

S. No.	Properties	Units	Steel	Carbon Epoxy	E-Glass Epoxy
1.	Young's Modulus E11	N/mm^2	2.068 e^{11}	1.34 e^{11}	50 e^9
2.	Density	kg/m^3	7830	1600	2000
3.	Poisson Ratio	–	0.3	0.3	0.3

CHASSIS FRAME WITH THREE MATERIALS

Mild Steel

Figure 2: Displacement Distribution

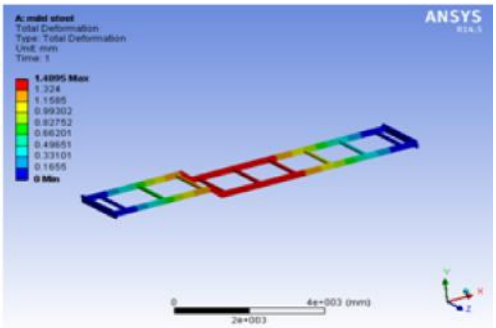


Figure 3: Stress Distribution

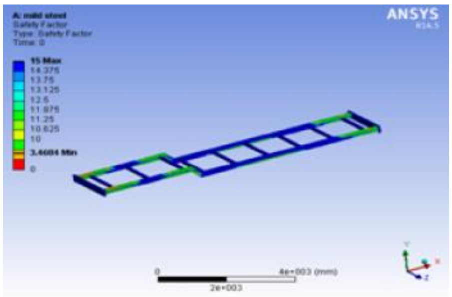


Figure 4: Strain Distribution

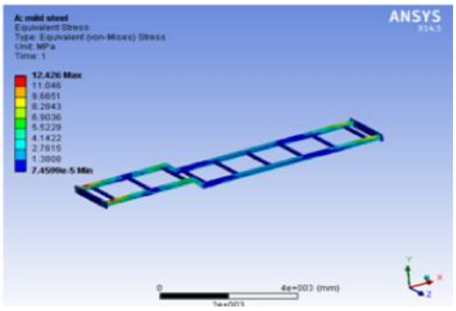


Figure 5: Safety Factor

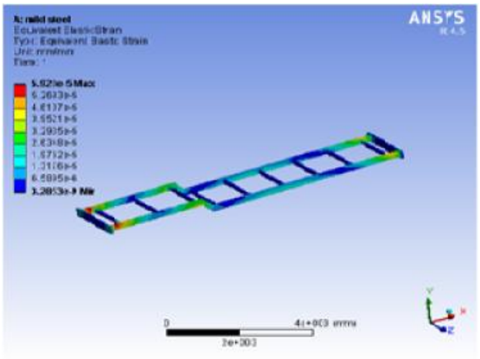


Figure 6: Biaxiality Indication

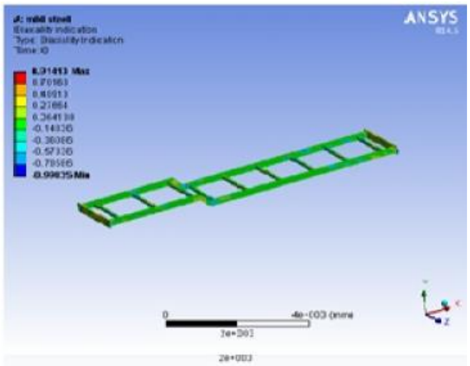
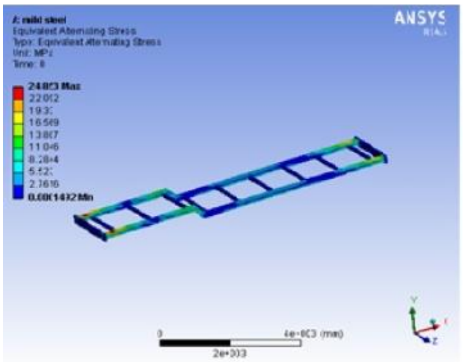


Figure 7: Alternating Stress



S-Glass Epoxy

Figure 8: Displacement Distribution

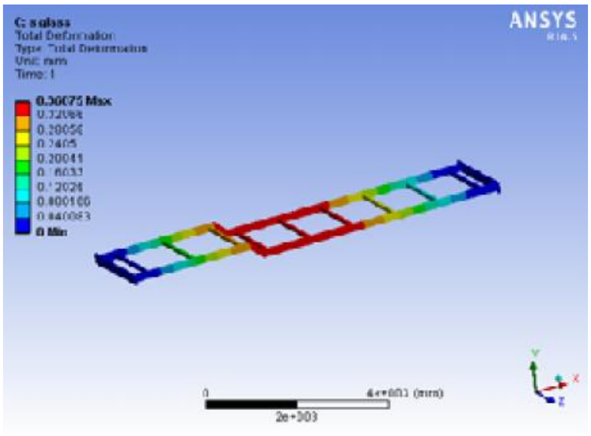


Figure 9: Stress Distribution

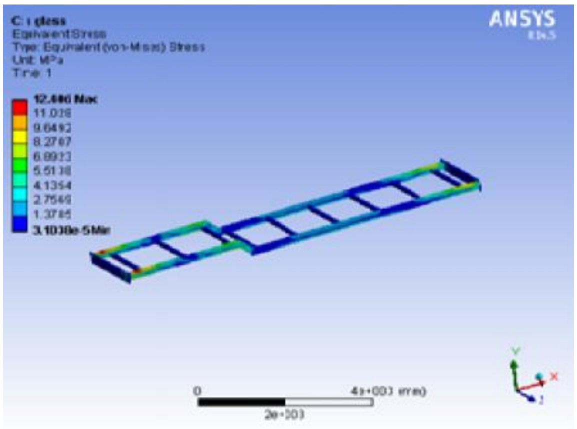


Figure 10: Strain Distribution

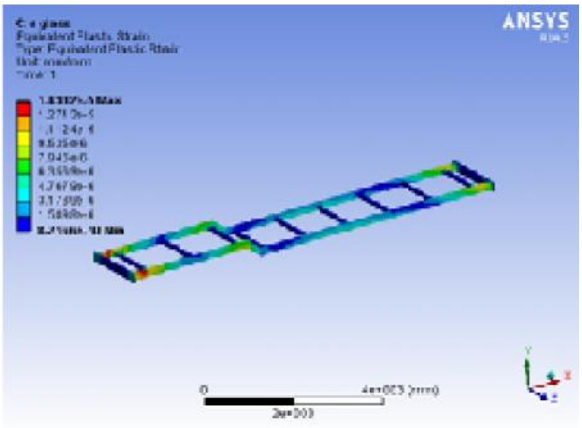


Figure 11: Safety Factor

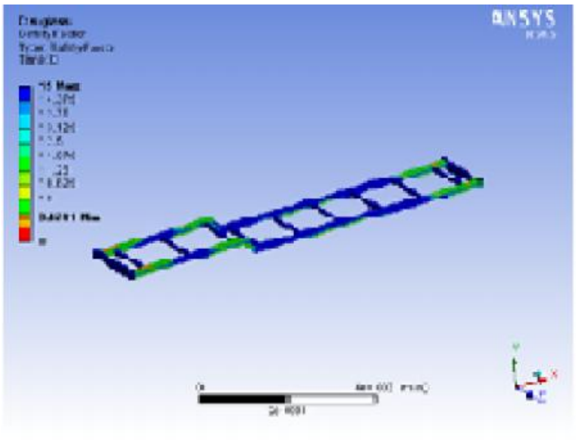


Figure 12: Biaxiality Indication

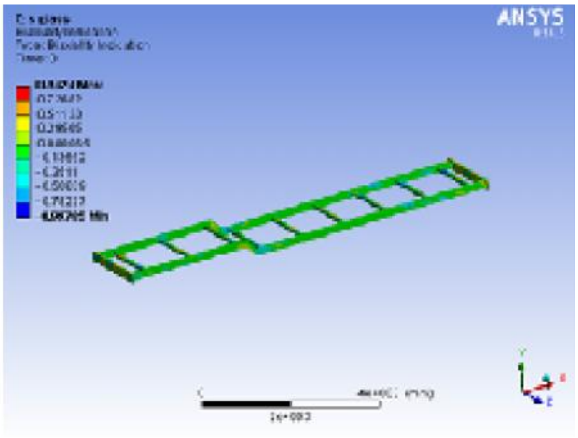
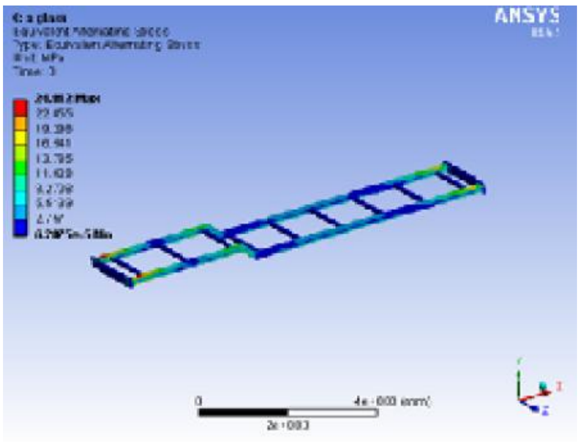


Figure 13: Alternate Stress



E-Glass Epoxy

Figure 14: Displacement Distribution

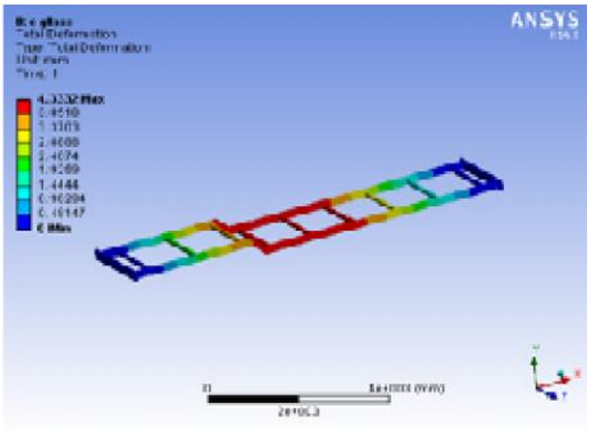


Figure 15: Stress Distribution

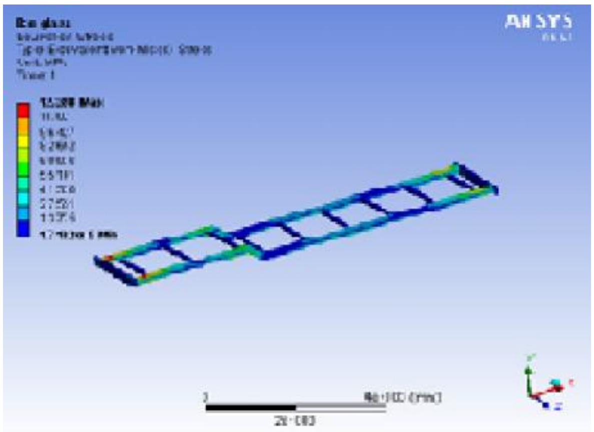


Figure 16: Strain Distribution

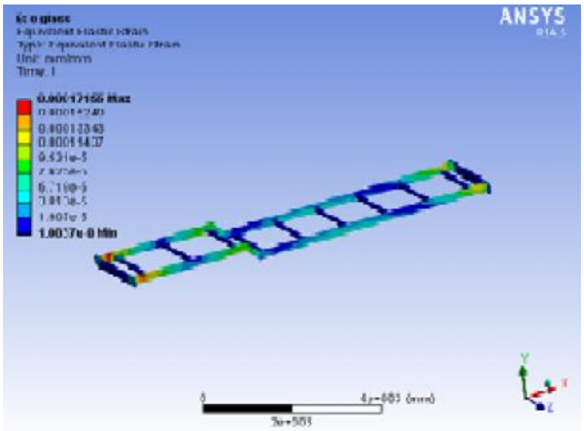


Figure 17: Safety Factor

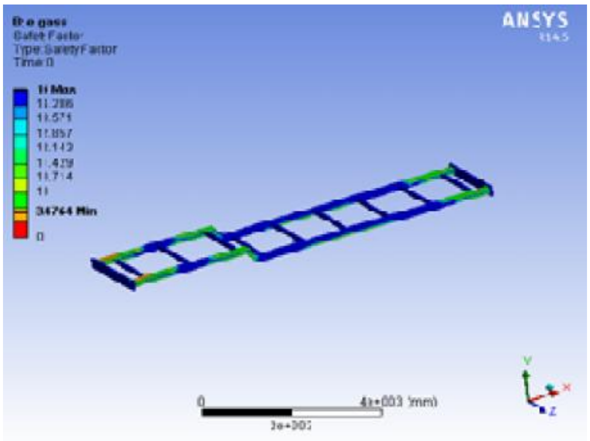


Figure 18: Biaxiality Indication

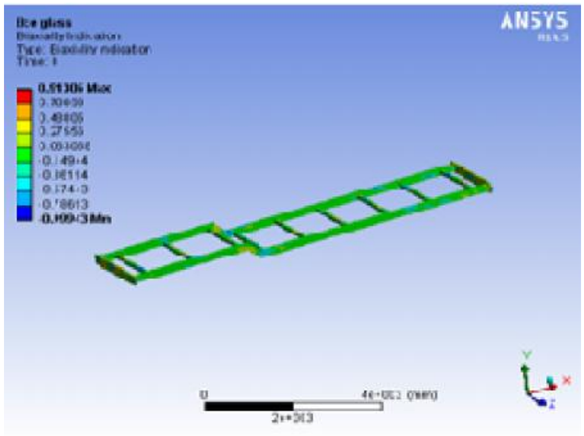
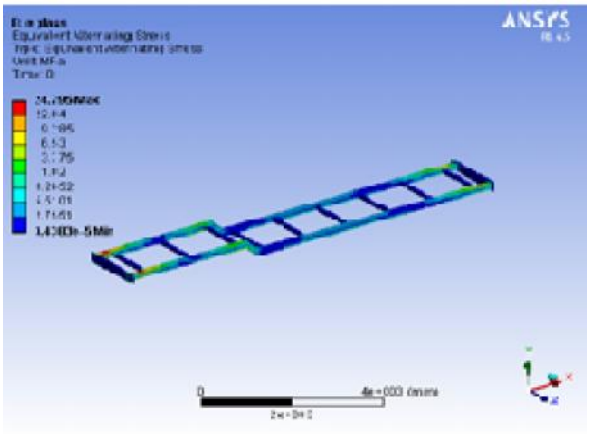


Figure 19: Alternate Stress



In the same manner static and fatigue analysis is done for modified chassis and honey comb model chassis.

Later Impact analysis is done for all 3. Models chassis, i.e., Existing model, Modified model, Honey comb chassis.

IMPACTANAYLSIS

Exisiting Model

Figure 20: Displacement Distribution

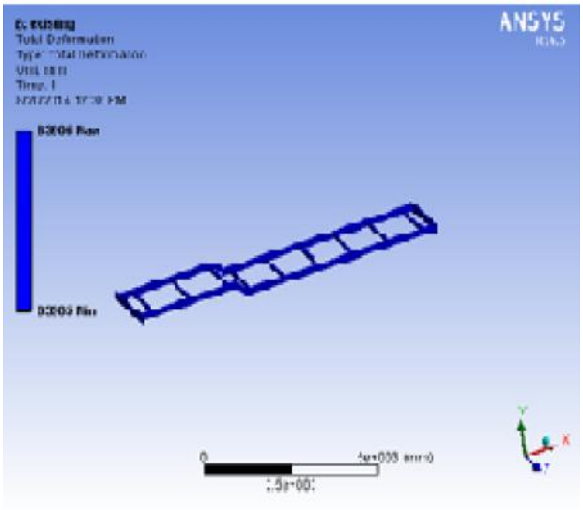


Figure 21: Stress Distribution

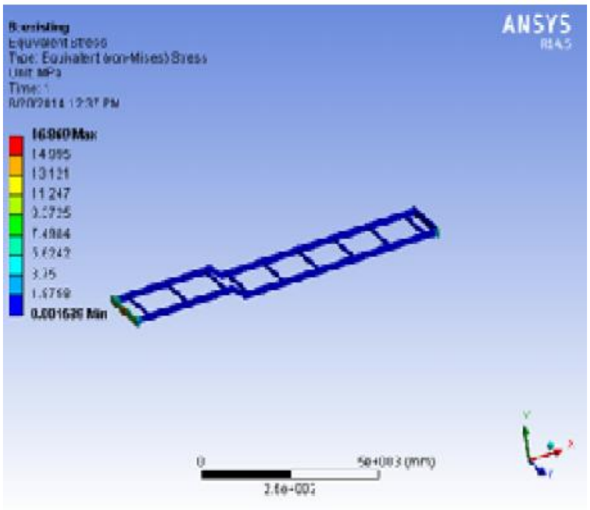


Figure 22: Strain Distribution

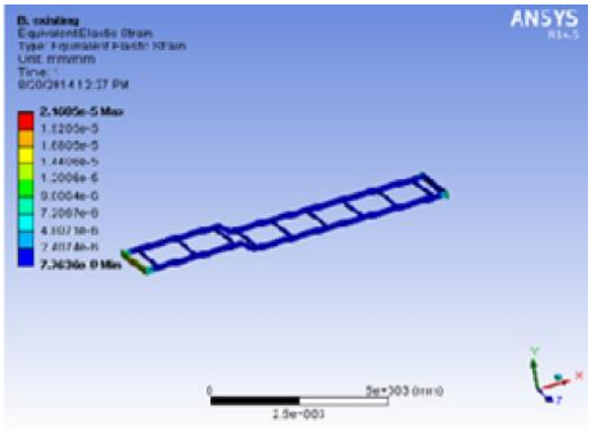
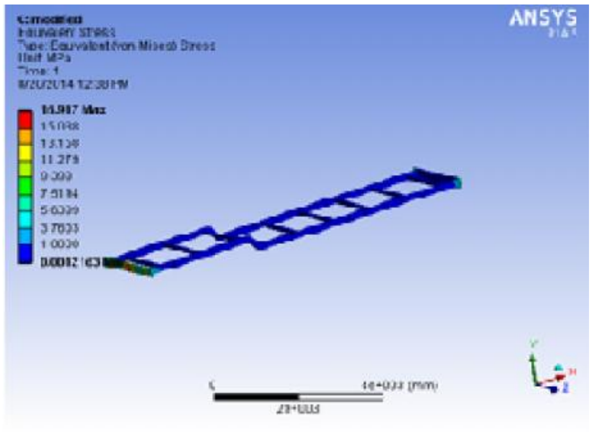


Figure 23: Strain Distribution



Modified Chassis

Figure 24: Displacement Distribution

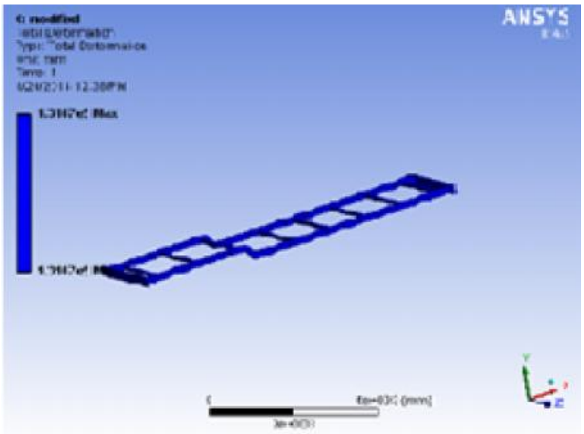
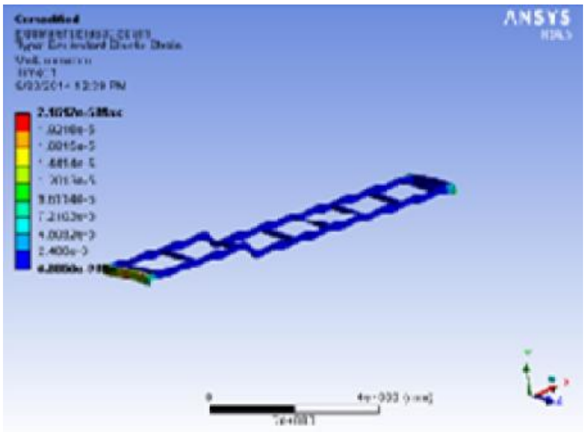


Figure 25: Strain Distribution



Honey Comb Chassis

Figure 26: Displacement Distribution

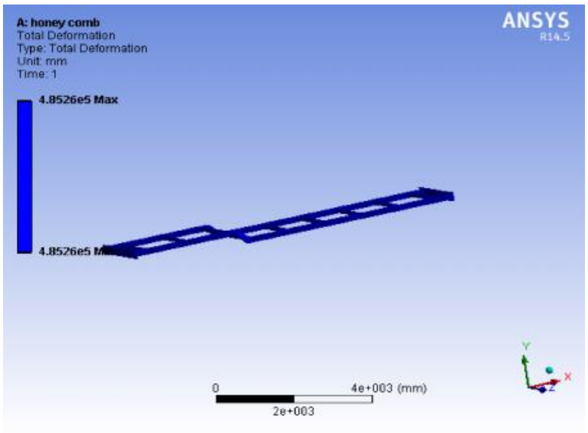


Figure 27: Stress Distribution

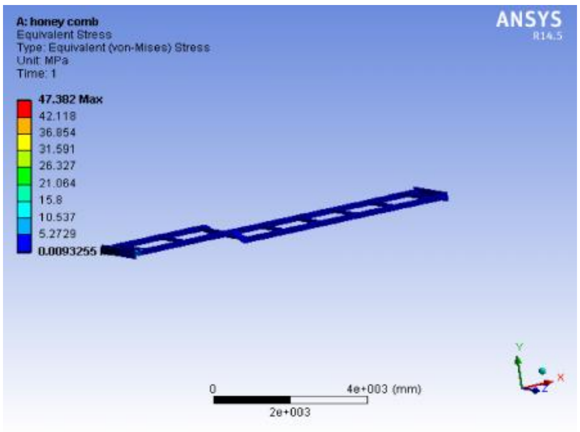
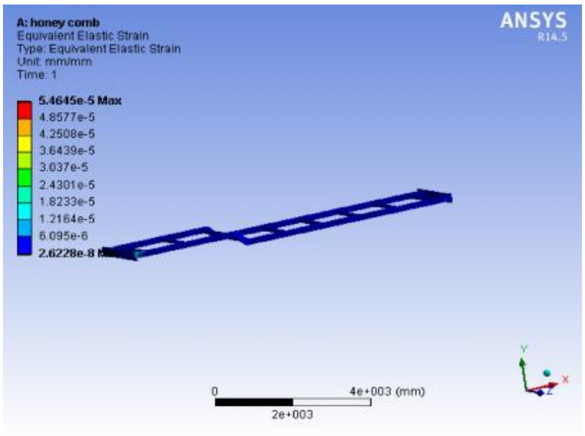


Figure 28: Strain Distribution



RESULTS

Table 2: Structural and Fatigue Analysis On Existing Design of Chassis

	Existing		
	Mild Steel	**E-Glass**	**S-Glass**
Displacement	1.489	4.333	0.360
Stress	12.426	12.398	12.406
Strain	$5.928e^{-5}$	0.0001715	$1.4305\ e^{-5}$
Safety Factor = Yield Strength/ Stress	44.262	40.329	369.57
Biaxiality Indication	0.914	0.913	0.9242
Alternative Stress	24.853	24.795	24.812

Table 3: Structural and Fatigue Analysis on Modified Design of Chassis

	Modified		
	Mild Steel	**E-Glass**	**S-Glass**
Displacement	1.640	4.7729	0.39734
Stress	12.509	12.644	12.531
Strain	$6.377\ e^{-5}$	0.000190	$1.5744\ e^{-5}$
Safety Factor = Yelid Strength/ Stress	43.968	39.544	365.89
Biaxiality Indication	0.99532	0.992	0.9961
Alternative Stress	25.017	25.289	25.2062

Table 4: Structural and Fatigue Analysis on Honey Comb Design of Chassis

	Honey Comb		
	Mild Steel	**E-Glass**	**S-Glass**
Displacement	3.4035	9.9334	0.8634
Stress	39.594	40.381	40.154
Strain	0.000194	0.000573	4.7511 e^{-5}
Safety Factor = Yelid Strength/ Stres	13.890	12.382	114.18
Biaxiality Indication	0.9966	0.99516	0.9969
Alternative Stress	79.188	80.763	80.309

Impact Anaylsis

Table 5: Material: S2-Glass Epoxy

Material	**Existing**	**Modified**	**Honey Comb**
Displacement	83905	1.3107e5	4.8526e5
Stress	16.869	16.917	47.382
Strain	0.000021605	0.000021617	0.000054645

CONCLUSION

In this work, modeled a chassis used in a heavy vehicle using Solid Works. Structural and fatigue analysis are done on the chassis using ANSYS 14.5. The analysis is done using three materials MILD STEEL, S-GLASS EPOXY and E-GLASS EPOXY is done. On three models existing, modified, honeycomb. Present used material for chassis is mild steel. Structural and fatigue analysis was conducted to find stress locations ,factor of safety and fatigue level's (Alternating stress) using mild steel, FRP and CRPF along with honey comb structure. Impact test was conducted to find Impact Resistance using S2-Glass. As per analytical results Honey comb structure chassis along with S2-Glass (CRPF) is the best choice. By using composites instead of mild steel, S2-Glass along with honey comb structure weight is reduced up to 75% and quality is improved by 87% than by using steel because density of steel is more than the composites. So better to us above suggested model and material. So it is better to take S2-Glass chassis manufacturing is very easy while compared with Mild steel.

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