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Designing and Structural Analysis of Vehicle Chassis Made Of Composite Material

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ABSTRACT

The skeleton layout outlines the establishment of a staggering vehicle; its rule work is to safely pass on the most outrageous load for all arranged working conditions. This paper depicts plan and examination of overpowering vehicle body. Weight reducing is right now the essential issue in auto organizations. In the present work, the estimations of a current significant vehicle suspension of a TATA 2515EX vehicle is taken for exhibiting and examination of a staggering vehicle case with three particular composite materials particularly, Carbon/Epoxy, E-glass/Epoxy and S-glass/Epoxy subjected to an indistinct weight from that of a steel skeleton. The blueprint impediments were stresses and redirections. The three unmistakable composite overpowering vehicle skeleton have been shown by thinking about three different cross-regions. For endorsement the arrangement is done by applying the vertical weights following up on the even novel cross sections. Writing computer programs is used as a piece of this work CATIA V5 for illustrating, ANSYS 14.5 for examination.

Catchphrases: overpowering vehicle skeleton, Static examination, Carbon/Epoxy, E-glass/Epoxy and S-glass/Epoxy,

1.1 INTRODUCTION

The landfill truck utilized for transporting free materials in mining and development. A regular dump truck is outfitted with a using pressurized water - worked suspension with shut box structure skeleton, a body which is situated at the highest point of the case. The undercarriage bolstered at the front and back side suspension of the truck. The motivation behind the body is lifted back side of the vehicle, which is to store the materials on the ground. Skeleton is a vital piece of the heap conveying individual from a back dump truck over which the whole gear is organized. Frame going about as an auxiliary help for control prepare components and furthermore empowers the landfill body conveying full payload. The frame is neither a functional nor a replaceable part the extent that the life expectancy of the vehicle is concerned. The life expectancy of a skeleton must be equivalent to or in excess of 30,000 running hours under typical working state of the vehicle. To expand the weariness life and its proliferation over the suspension and to maintain a strategic distance from split, it is totally important to have a discretionary plan to withstand the total load under typical conditions. For this reason, it is important to fortify the edge and to expand the wellbeing variable of the case for an expanded weariness life. 2 The case improvement forms in the car and transport hardware enterprises are

The cost and unpredictability of this approach makes its application unrealistic for low volume "extraordinary" vehicles. It has been that shown direct static 3 push appropriation, straightforward weakness estimations and static limited component examination, can be utilized to accomplish satisfactorily precise exhaustion life forecast of a car frame.

1.2 CLASSIFICATION OF TRUCK

By and large, truck vehicles are intended for conveying or pulling loads. It is a car vehicle reasonable for pulling. Definitions differ contingent on the sort of truck and its application.

Table 1.1 Truck Classifications

Category	Gross vehicle weight	Representative vehicles
Light duty truck	Between 1 to 7 Ton	Car, Auto and Van
Medium duty truck	Between 10 to 20 Ton	Bus & Lorry
Heavy duty truck Above	30 Ton	Dumper & Motor Grader

Trucks can be classified as Light duty truck, Medium duty truck and Heavy duty truck. They are presented in Table 1.1.

1.2.1 Standard Dump Truck

The standard dump truck is a full truck chassis with a dump body mounted onto the frame. The dump body is raised by a hydraulic ram lift that is mounted forward of the front bulkhead, normally between the truck cab and the dump body. The standard dump truck also has a front axle, and one or more rear axles, which normally have dual wheels on each side. The common configurations for standard dump trucks are six and ten wheelers.

1.2.2 Transfer Dump Truck

The transfer dump truck is easily recognizable through the noise made during transfer. A standard dump truck pulls a separate trailer which can be loaded with sand, asphalt, gravel, dirt, etc. The box or aggregate container on the trailer is powered by an electric motor, which rides on wheels and rolls off of the trailer and into the main dump box. The biggest advantage of this configuration is that payload capacity maximized manufacturability of the short and nimble dump truck standards.

1.2.3 Semi Trailer Dump Truck

The semi end dump truck is a tractor trailer combination where the trailer itself contains the hydraulic hoist. The average semi end dump truck has a 3 axle tractor that pulls a 2 axle semi trailer. The rapid unloading is the main advantages of semi trailer dump truck.

1.2.4 Semi Trailer Bottom Dump Truck

A bottom dump truck is a 3 axle tractor that pulls a 2 axle trailer with a clam shell type dump gate in the belly of the trailer. The biggest advantage of a semi bottom dump truck is its ability to lay material in a wind row unlike the double and triple trailer configurations. This type of truck is also maneuverable in reverse as well.

1.2.5 Double and Triple Bottom Dump Truck

The double and triple bottom dump trucks consist of a 2 axle tractor pulling a semi axle semi trailer and an additional trailer. These types of dump trucks allow the driver to lay material in wind rows without the material having to leave the cab or stop the truck. However biggest disadvantage is the difficulty in going in reverse.

COMPOSITE MATERIALS:

A composite material is defined as a materialcomposed of two or more constituents combined on amacroscopic scale by mechanical and chemical bonds.Composites are combinations of two materials inwhich one of the material is called the “matrix phase” is inthe form of fibers, sheets, or particles and is embedded inthe other material called the “reinforcing phase”. Another unique characteristic of many fibrereinforced composites is their high interal damping capacity. This leads to better vibration energy absorption within the material and results in reduced transmission ofnoise to neighboring structures. Many composite materials offer a combination of strength and modulus thatare either comparable to or better than any rational metalicmetals. Because of their low specific gravities, the strengthto weight-ratio and modulus to weight-ratios of these composite materials are markedly superior to those ofmettalic materials.

REVIEW OF LITERATURE

Smita, C.Saddu [1] et. al Weight reduction is now day's main issue in the automobile industry. Reducing weight while increasing or maintaining strength of product is getting to be highly important. The automobile industry has shown increasing interest in the replacement of steel spring with composite leaf spring due to high strength to weight ratio. Advanced composite materials offer significant advantages in strength, stiffness, high natural frequency and light weight relative to conventional metallic materials. This paper describes the analysis of steel and composite material leaf spring. Then these results are compared with that of the experimental results.

Juvvi Siva Nagaraju U. HariBabu [2] et. al In the case of vehicles, the term chassis means the frame plus the "running gear" like engine, transmission, driveshaft, differential, and suspension.

Over time, other materials have come into use, the majority of which have been is Steel &Aluminum. In this paper traditional materials are replaced with composite materials[Carbon Epoxy and E- glass epoxy].

SandipGodseD.A.Patel[3] et. Al Chassis is a major component in a vehicle system. This work involved static analysis todetermine key characteristics of a chassis. The staticcharacteristics include identifying location of high stress area.Mathematical calculations were carried out to validate the staticanalysis.

K.Rajasekar,R.SaravananP[4] et. Al Chassis is the mostimportant structural member in the On-Road vehicles. In order toovercome more failure in the chassis structure and ensure thesafety, the variable section chassis structure has to be designedbased on the variable loads along the length of the vehicle. Thepresent study reviewed the literature on chassis design andpresented the findings in the subsequent sections.

SPECIFICATIONOF EXISTING HEAVY

The details of processing of the Polymeric composites and the experimental procedures followed for their mechanical characterization. The Polymeric composites materials used inthis work are

1. E-glass/Epoxy
2. S-glass /Epoxy
3. Steel
4. Carbon/Epoxy

E-glass /Epoxy

E-glass or electrical grade glass was originally developed for standoff insulators for electrical wiring. It was later found to have excellent fiber forming capabilities and is now used almost extensively as the reinforcing phase in the material commonly known as fiber glass.

3.1VEHICLE CHASSIS:

Table 1 shows the specifications of a TATA 2515EX OF STEEL HEAVY vehicle. The typical chemical composition of the material is 0.565C, 1.8% Si, 0.7%Mn, 0.045%P and 0.045% S.

Table: 1 Specifications of heavy vehicle chassis

Sl.no	Parameters	Value
1	Total length of the chassis(Eye to Eye)	9200 mm
2	Width of chassis	80 mm

3	Thickness of chassis	5.5 mm
4	Front cabin chassis length	2400 mm
5	Front cabin chassis area	492800 mm2
6	Front cabin chassis	20620 N
	applying load	
7	Backbody chassis length	5900 mm
8	Backbody chassis area	1200000 mm2
9	Backbody chassis applying	206200
	Load	N
10	Young's Mod Chassis	2.1e5 N/mm2
11	Density of steel chassis	7.86*10-6 N/mm2

INTRODUCTION TO CAD/CAM/CAE

The Modern world of design, development, manufacturing so on, in which we have stepped can't be imagined without interference of computer. The usage of computer is such that, they have become an integral part of these fields. In the world market now the competition in not only cost factor but also quality, consistency, availability, packing, stocking, delivery etc. So are the requirements forcing industries to adopt modern technique rather than This penetration of technique concern has helped the manufacturers to

a) Increase productivity

b) Shortening the lead-time

c) Minimizing the prototyping expenses

d) Improving Quality

e) Designing better products

CAD: Computer Aided Designing (Technology to create, Modify, Analyze orOptimize the design using computer.

CAE: Computer Aided Engineering (Technology to analyze, Simulate or Studybehaviour of the cad model generated using computer.

CAM: Computer Aided Manufacturing (Technology to Plan, manage or controlthe operation in manufacturing using computer.

DESIGNING

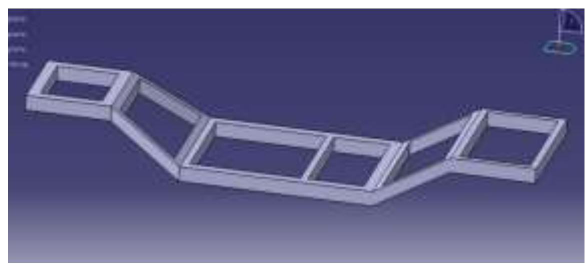

Figure1 VEHICLE CHASSIS 3d design

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Figure2VEHICLE CHASSIS side view

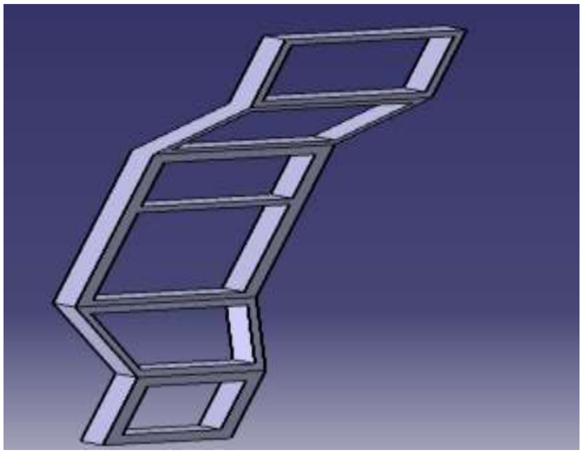


Figure3VEHICLE CHASSIS muliti section

INTRODUCTION TO FEA

Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, The paper centered on the "stiffness and deflection of complex structures". By the early 70's, FEA was limited to expensive mainframe computers generally owned by the aeronautics, automotive, defense, and nuclear industries. Since the rapid decline in the cost of computers and the phenomenal increase in computing power, FEA has been developed to an incredible precision. Present day supercomputers are now able to produce accurate results for all kinds of parameters.

TABLENO.1.PROPERTIESOFEGLASS/EPOXY

. No	'roperties	
	Applying vertical force on a cabin	
	Applying vertical force on body	9417 N
	Tensile modulus along X-direction (E_X), Mpa	39000
	Tensile modulus along Y-direction (E_Y), Mpa	8600
	Tensile modulus along Z-direct ion (E_Z), Mpa	8600
	Tensile strength of the material, Mpa	1080
	Co mpressive strength of the material, Mpa	890
	Shear modulus along XY-direct ion (G_{XY}), Mpa	3800
	Shear modulus along YZ-d irection (G_{YZ}), Mpa	3800
0	Shear modulus along ZX-d irection(G_{ZX}), Mpa	3800
1	Poisson ratio along XY-d irection (NU_{XY})	0.28
2	Poisson ratio along YZ -direction (NU_{YZ})	0.06
3	Poisson ratio along ZX-direction (NU_{ZX})	0.28
4	^{3} Mass density of the material (ρ),	$^{-6}$ 2.1x10

TABLE NO. 2. PROPERTIES OF S GLASS/EPOXY

S.No	Properties	Value
1	Applying vertical force on a cabin	6278 N
2	Applying vertical force on body	9417 N
3	Tensile modulus along X-direction (E_X), Mpa	43000
4	Tensile modulus along Y-direction (E_Y), Mpa	8900
5	Tensile modulus along Z-direct ion (E_Z), Mpa	8900
6	Tensile strength of the material, Mpa	1280
7	Co mpressive strength of the material, Mpa	690
8	Shear modulus along XY-direct ion (G_{XY}), Mpa	4500
9	Shear modulus along YZ-d irection (G_{YZ}), Mpa	4500
10	Shear modulus along ZX-d irection (G_{ZX}), Mpa	4500
11	Poisson ratio along XY-d irection (NU_{XY})	0.27
12	Poisson ratio along YZ -direction (NU_{YZ})	0.06

13	Poisson ratio along ZX-direction (NU_{ZX})	0.27
14	Mass density of the material (ρ), 3	2x10 -6

ANALYS IS OF PRESS URE CALCULATIONS

Cabin chassis Pressure Calculations:

Assumptions of load calculations Tata ace self weight =600 kgs

Self weight +carriage weight load = 600+1000=1600 kgs Ribs area =600*120=7200 mm^2

3ribs area =72000* 3=216000 mm^2 Rails area =1960*120 =235200 mm^2 2rails area =235200*2 =470400 mm^2

3ribs area + 2rails area =470400+216000=6864000

Total body pressure =9417.65/ 686400=0.01372 N/ mm^2

Body chassis Pressure Calculations:

Body chassis pressure calculations Body load =960*9.81=9417.6 N

Body total area=body 3ribs area=body rails area

Cabin chasis pressure calculations

Cab in load =640kgs =640*9.81=6278.4 N

Cab in total area =cabin two ribs area +cabin two rails area Cab in two ribs area =(400*120)*2=96000mm^2

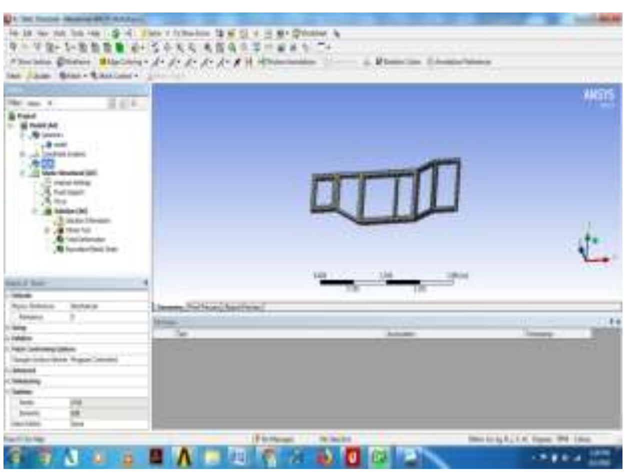
Cabin t wo rails area =530*240 =127200 mm^2

Cab in total area =96000+127200 =223200 mm^2

Cabin total pressure =cabin load /cabin total area =6278.4/ 223200 =0.028129 N/ mm2

Total body pressure =9417.65/ 686400=0.01372 N/ mm^2

ANALYSIS STEEL



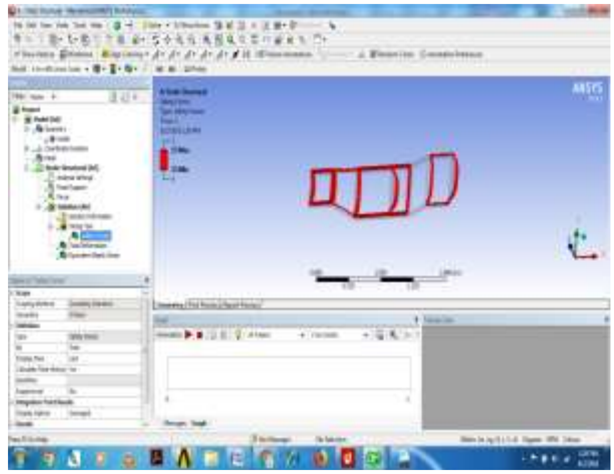


Figure.1. stress pattern for steel chassis

The unifo rm load is applied at the edges of the chassis. And the maximum m value is 394.803 N/ mm^2 and min imu m value is 43.8711N/ mm^2.

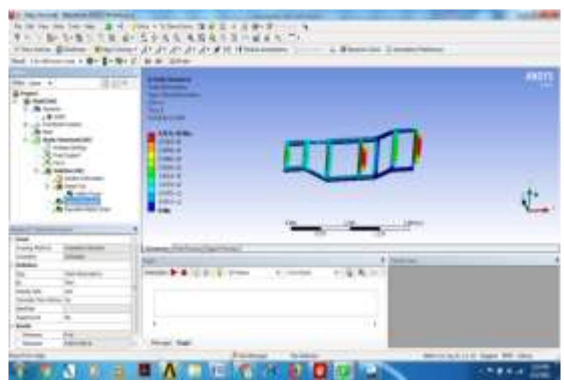


Figure. 2. Dis placement pattern for steel chassis

The unifo rm load is applied at the edges of the chassis. And the maximu md is placement value is 394.803 N/ mm^2 and min imu misplacement value is 43.8711N/ mm.

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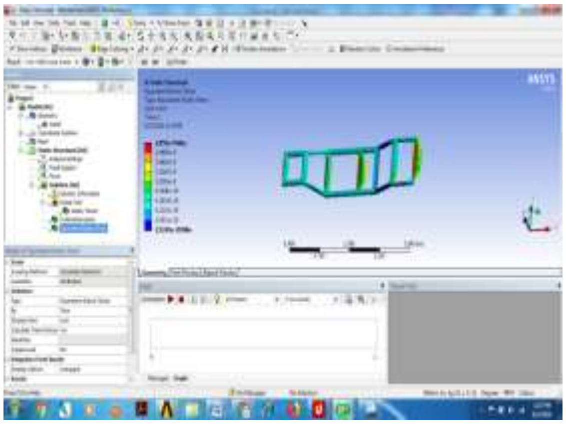


Analysis e-glass/epoxy

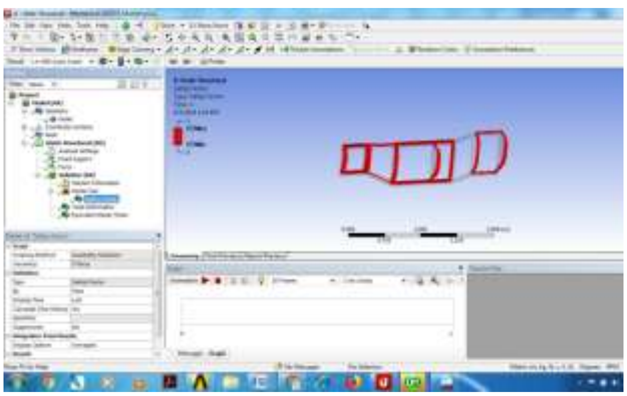


Figure..Stress pattern for E-glass-epoxy chassis

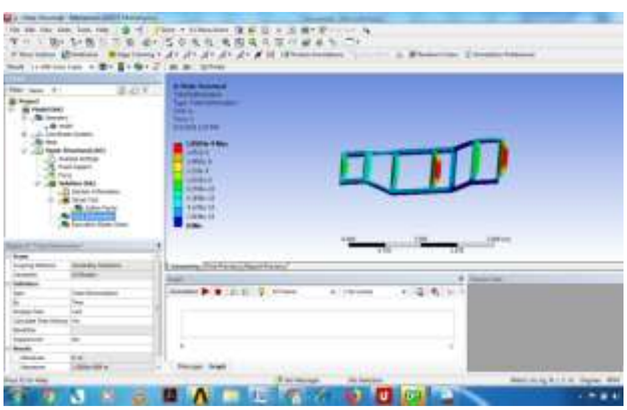
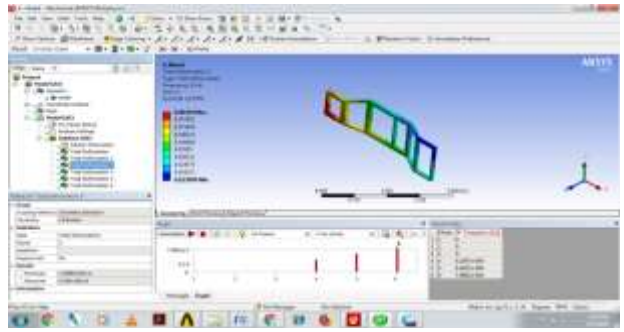


Figure.6. stress pattern for E-glass/epoxy chassis

The unifo rm load is applied at the edges of the chassis.And the maximu m displacement value is 19.25 mm and min imu m d displacement value is 2.139 mm.

analysis carbon/epoxy



Stress for CARBON/EPOXY chassis

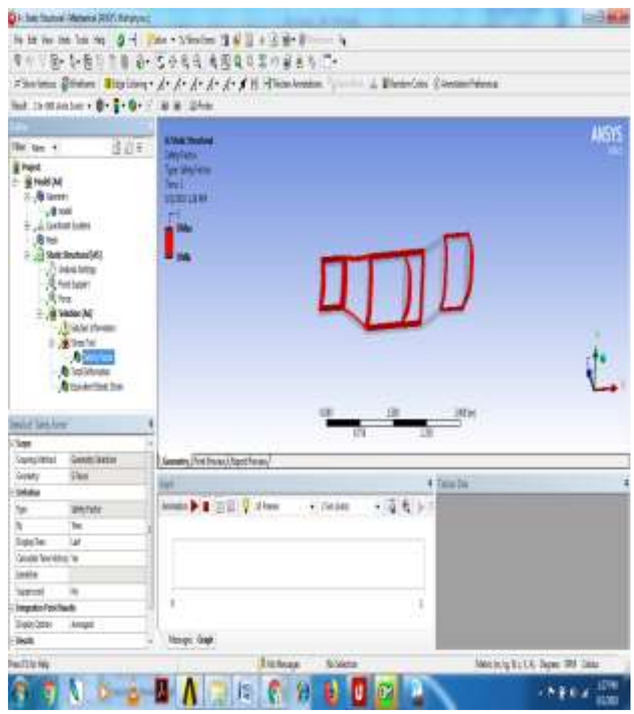


Figure..Stress pattern for CARBON/EPOXY chassis

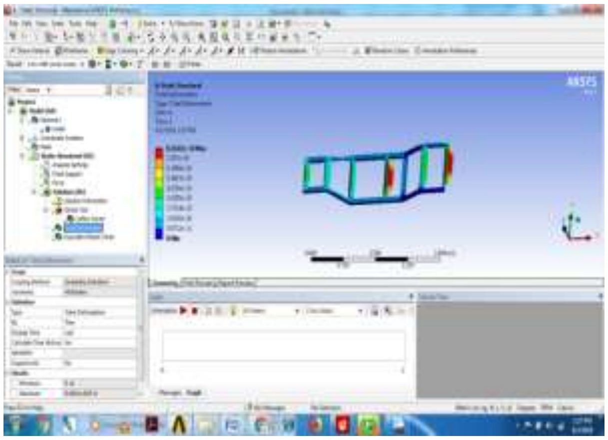
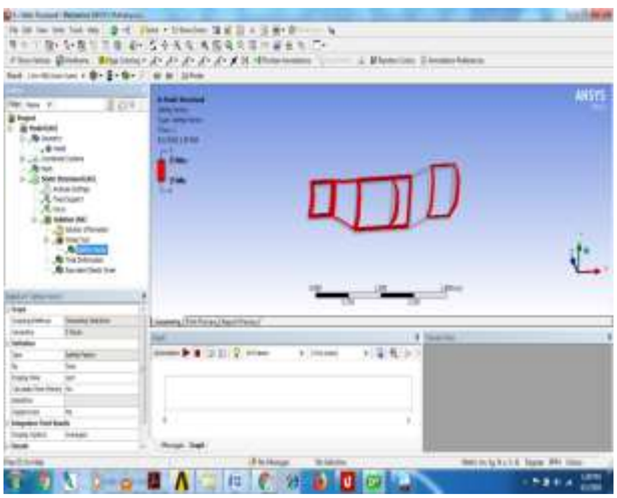


Figure. stress pattern for chassis analysis s-glass/epoxy



Stress pattern for S-Glass chassis

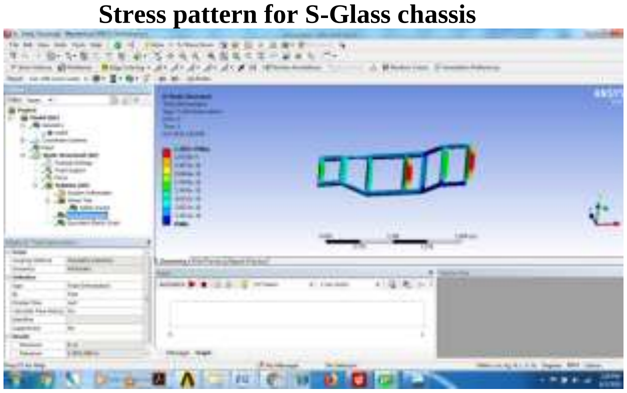


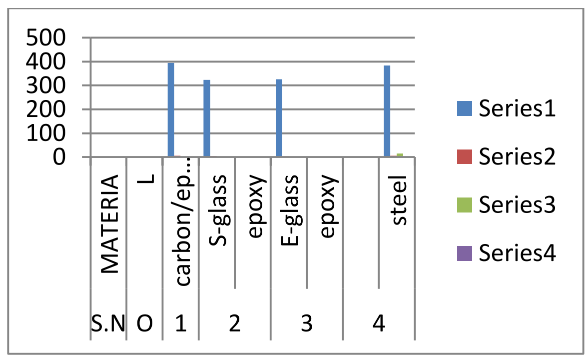
Figure.3. Stress pattern for S-Glass chassis

. The unifo rm load is applied at the edges of the chassis.And the maximu m strees value is 323.488 N/ mm^2 and min imu m strees value is 35.96N/ mm^2

.

Table.3. RES ULTS OBTAINED FROM ANS YS

S.N O	MATERIA L	STRES S	F.O. S	DISPLA CEM E NT
1	carbon/epox y	394	6	14 mm
2	S-glass epoxy	323	4	17 mm
3	E-glass epoxy	326	3	19 mm
4	steel	384	5	15



GRAPHS:RES ULTS OBTAINED FROM ANS YS

Table 3. Comparative analysis of steel heavy vehicle chassis& and polymeric composite heavy vechicle chassis

S.N O	Parameter	Stee l	Polymeric composite materials		
			Comp 1	Comp 2	Com p 3
1	Weight (kg)	608. 35	122. 28	162. 53	154. 71
2	Stress(N/mm	162.	55.1	34.5	34.3

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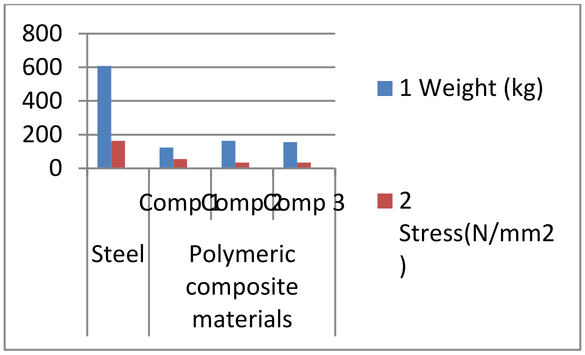
	^{2})	89	51	06	22
3	Displacement(mm)	2.628	1.512	1.512	2.404



GRAPHS: Comparative analysis of steel heavy vehicle chassis& and polymeric composite heavy vechicle chassis

CONCLUSIONS

This experimental investigation of mechanical behavior of the Steel, E -Glass/Epoxy, S Glass/Epoxy carbon/epoxy Polymeric composites Chassis leads to the following conclusions:

1. Observe the all results and to compare the polymeric composite light vehicle chassis and steel light vehicle chassis with respect to weight, stiffness and strength.
2. By employing a polymeric composite light vehicle chassis for the same load carrying capacity, there is a reduction in weight of 30%~35.8%, natural frequency of polymeric composite light vehicle chassis are 35.82%~38.8% higher than steel chassis and 30~33.8% stiffer than the carbon/epoxy chassis.
3. From the results, it is observed that the polymeric composite heavy vehicle chassis is lighter and more economical than the conventional carbon/epoxy chassis with similar design specifications.

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