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Modeling and Analysis of Automobile Chassis Using Honeycomb Sandwich Structure

Seelam Sreekanth Reddy
M.Tech Student,
Department of Mechanical Engineering,
Annamacharya Institute of Science and Technology,
Rajampet.

G.Amarnath
Assistant Professor,
Department of Mechanical Engineering,
Annamacharya Institute of Science and Technology,
Rajampet.

ABSTRACT :

Automotive chassis is the important component of an automobile. The chassis works as a frame work for supporting the body and different parts of the automobile. Also, it should be stiff and rigid to withstand the shock, twist, vibration and stresses. Along with strength, an important consideration in chassis design is to have adequate bending stiffness for better handling characteristics. So, maximum equivalent stress, equivalent strain, deformation, safety factor & etc are important criteria for the design of the chassis. Weight reduction is the main problem in Automobile industries. Generally chassis is made of steel and aluminum. These types of chassis models are rigid type and heavy weight due to more densities through giving less mileage and more mechanical losses.

The objective of this project is to reduce chassis weight by replacing the rigid solid chassis with I-section honeycomb chassis and also replacing conventional materials with composite materials Kevlar, Carbon fiber, S2-glass epoxy. The chassis weight is reduced since the densities of the materials are less than that of conventional materials thereby improving load withstanding capacity, minimizing the fuel consumption & improving total performance of the vehicle. The Modeling and Analysis of automobile chassis is done and compared for original chassis and chassis with honeycomb structure. Which type of chassis is in less weight is find out and best material suitable among three materials is analyzed by performing static structural, modal, random vibrational analysis. The chassis is modeled by using PRO-E and analysis by using ANSYS software.

Introduction:

INTRODUCTION TO CHASSIS:

Chassis is considered to the one of significant structures of an automobile. It is usually made of a steel frame, which holds the body and motor of an automotive vehicle. Many automotive chassis or automobile chassis is a skeletal frame on which various mechanical parts. At the time of manufacturing, the body of a vehicle is flexible molded according to the structure of chassis. Automobile chassis is generally made of light sheet metal or composite plastics. It provides strength needed for supporting vehicular components and different loads applied on it. Automotive chassis helps keep an automobile rigid, stiff and unbending. Auto chassis ensures less noise, mechanical vibrations and harshness throughout the Automobile. A chassis consists of an internal framework that supports a man-made object in its construction and use.

1.1 INTRODUCTION TO HONEYCOMB STRUCTURE:

Honeycomb structures are natural (or) man-made structures that have the geometry of a honeycomb to allow the minimization of the amount of used material to reach minimal weight and minimal material cost. The main advantages are rigidity and shock ,fatigue resistance ,resistance to weather ,chemicals and fire ,recyclability ,isolation.

1.2 APPLICATIONS OF HONEYCOMB STRUCTURE:

LED lightings, Automotives, satellites, aircraft, missiles, high speed trains. In the rail industry for forming doors, floors, energy absorbers/bumpers, and

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furniture Air, water, fluid, and light directionalisation and the marine industry for constructing commercial vessels and naval vessel bulkheads, wall ceiling, partition panels, furniture, and several other applications.

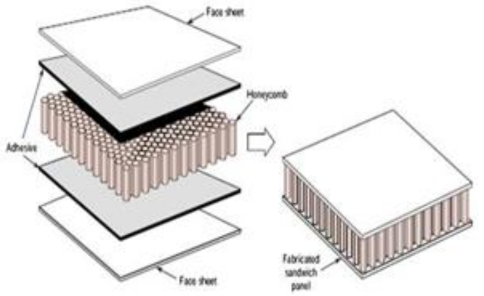


Fig .honeycomb structure

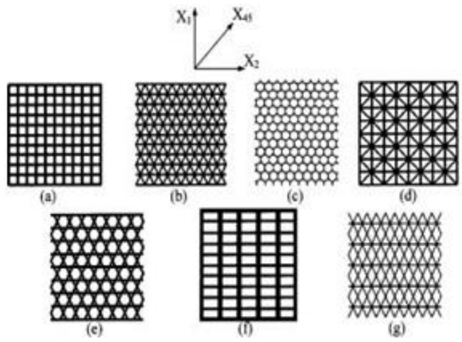


Fig. different types of core shapes

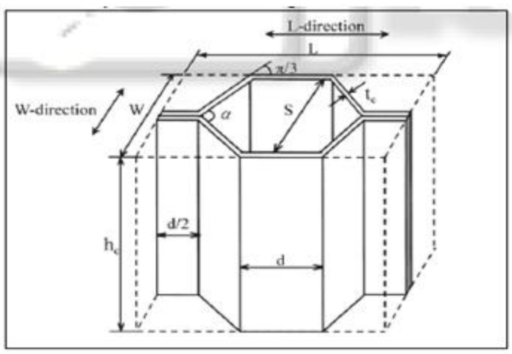


Fig.schematic layout of honeycombcell

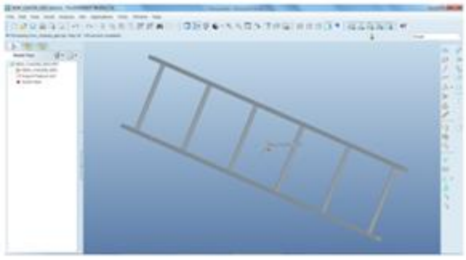
2. SPECIFICATION OF THE PROBLEM:

Weight reduction is now the main issue in automobile industries. Because if the weight of the vehicle increases the fuel consumption increases. At the same time as the weight of the vehicle increases the cost also increases which becomes a major issue while purchasing an automobile.

Chassis is one of the major part in vehicle construction. Generally chassis is manufactured with Structural Steel. These types of chassis models are due to heavy weight vehicle is giving less mileage. These are the main problems of steel and these are compensated by introducing honeycomb structural chassis is to reduce weight and improving total performance and improving the mileage and also improving load withstanding capacity for different composite materials like Kevlar, carbon fiber, s2-glass materials.

3. MODELING OF CHASSIS

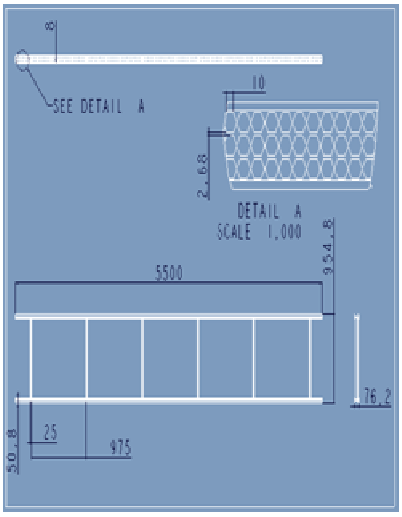
3.1 MODELING OF CHASSIS WITH HONEYCOMB STRUCTURE



CHASSIS DIMENSIONS

Chassis length = 5500mm (side bars)
Chassis width =954.8mm
Chassis height=76.2mm

3.2 2D VIEWS



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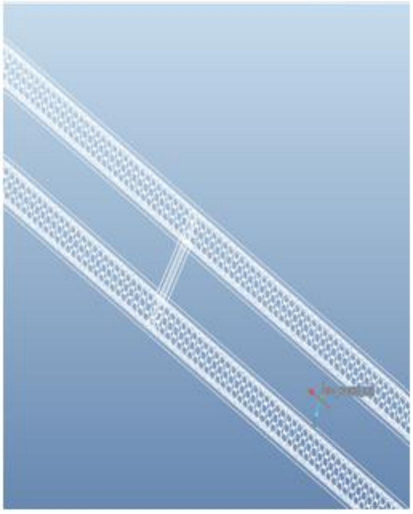
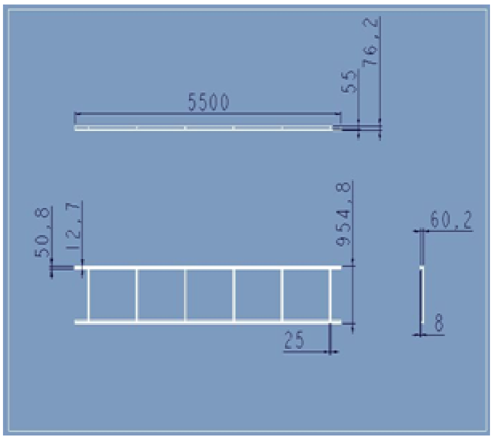


3.3 CHASSIS WITHOUT HONEYCOMB STRUCTURE



4. CHASSIS PARAMETERS
CHASSIS WITH& WITHOUT HONEYCOMB

Properties	With Honeycomb	Without Honeycomb
Volume	1.7381482×10^7 mm^3	2.0338245×10^7 mm^3
Area	6.2307×10^6 mm^2	4.6918×10^6 mm^2
Weight	8489.32 N	9933.44 N

MATERIAL PROPERTIES

MATERIAL	YOUNG'S MODULUS (MPa)	POISSON'S RATIO	DENSITY (kg/m^3)
KEVLAR	70500	0.36	1440
S2-GLASS	86900	0.28	2460

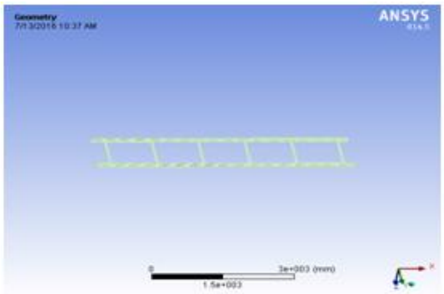
5.BASIC LOAD CALCULATIONS

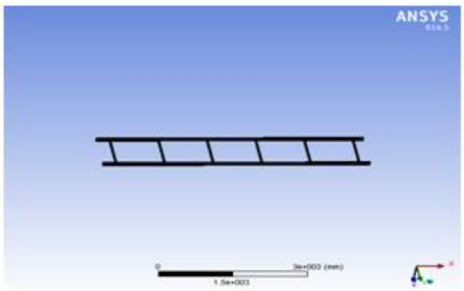
Capacity of truck = 8tonnes
= 8 x 1016kgf (1ton = 1016 kgf)
= 8128kgf
= 8128 x 9.81N (1kgf = 9.81N)
= 79735.68N

Capacity of chassis:

Capacity of truck with 1.25% = 79735.68 x 1.25
= 99669.6 N
Weight of the Body & Engine = 2 tonnes
= 2 x 1016kgf
= 2032kgf
= 2032 x 9.81N
= 19933.92N
Total load acting on the chassis = capacity of chassis + weight of the body & engine
= 99669.6 + 19933.92
= 119603.52N
Chassis has two bars, So load acting on each beam is half of the total load acting on the chassis
Load acting on single beam = (119603.52)/2
= 59801.76N

6. ANALYSIS WITHOUT HONEYCOMB
6.1 STATIC STRUCTURAL ANALYSIS
IMPORTED MODEL
MESHED MODEL





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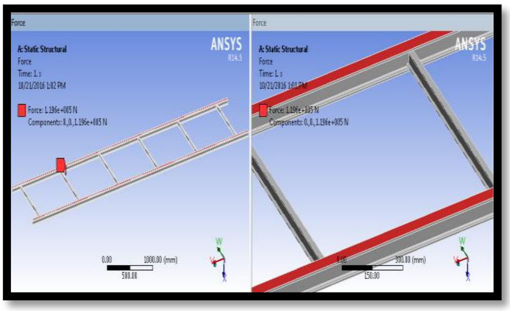
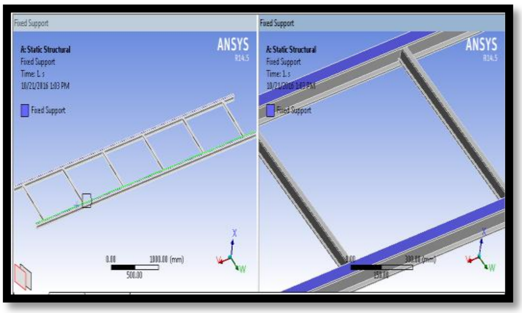
Number of bodies	1645
Number of active bodies	1645
Number of nodes	623485
Number of elements	95019

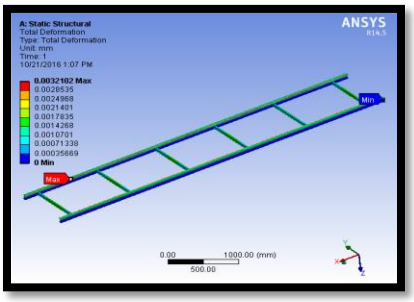


Fixed support

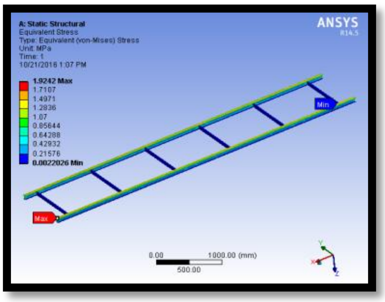


Force

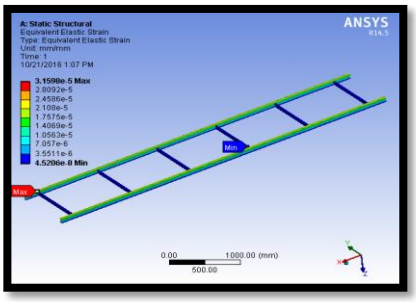
Material-kevlar



Total deformation

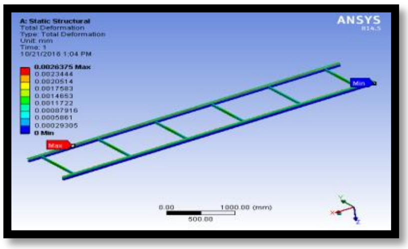


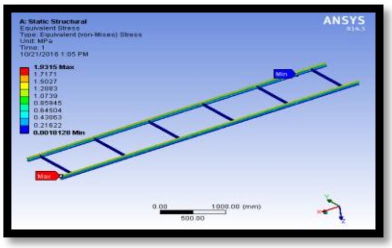
vonmises stress

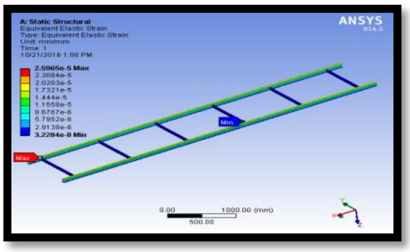


equivalent strain

Material –s2-glass

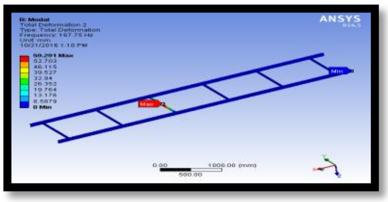






6.2 MODAL ANALYSIS

Material –kevlar



mode 1

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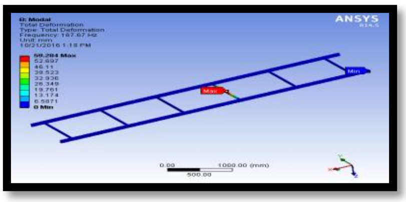
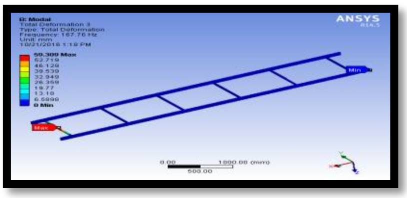
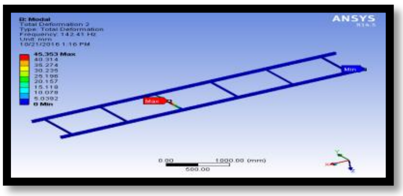


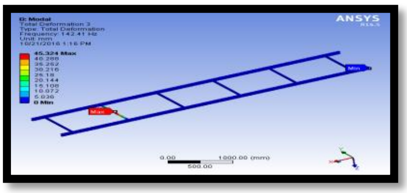
mode 2

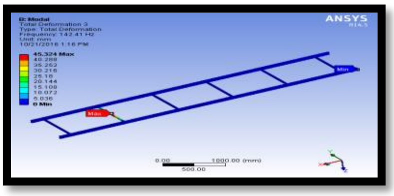


mode 3

Material –S2 glass

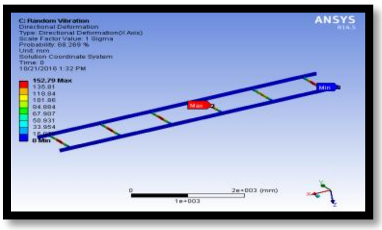




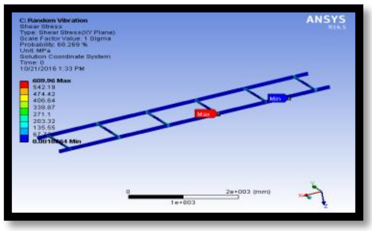


6.3 RANDOM VIBRATIONAL ANALYSIS

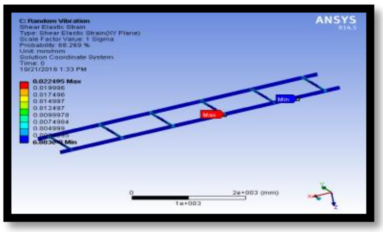
Material –kevlar



Directional deformation

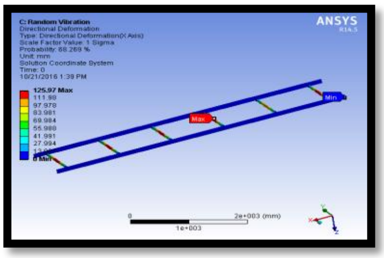


shear stress

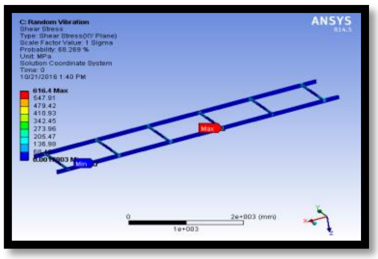


shear strain

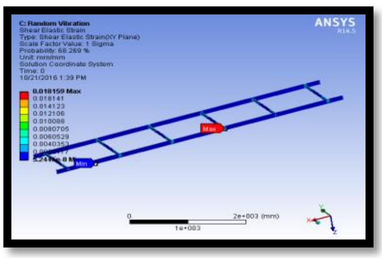
Material-s2 glass



Directional deformation



shear stress



shear strain

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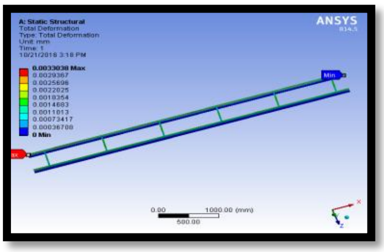
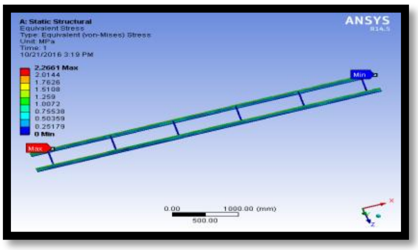
7.ANSYS WITH HONEYCOMB

7.1 STRUCTURAL ANALYSIS

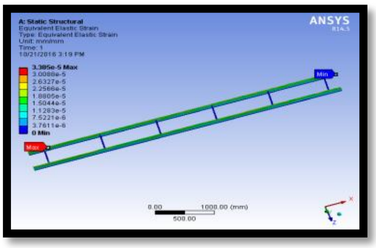
Material –kevlar



Total deformation

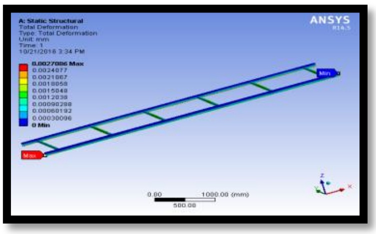


vonmises stress

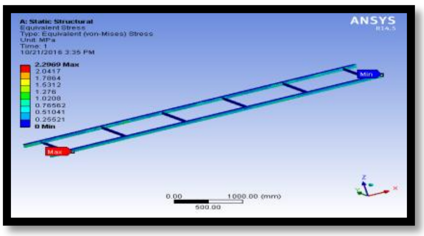


equivalent elastic strain

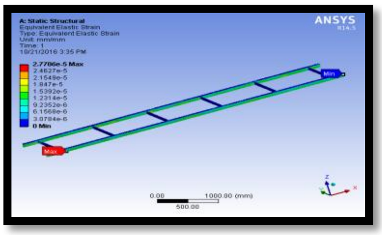
Material –s2-glass



Total deformation



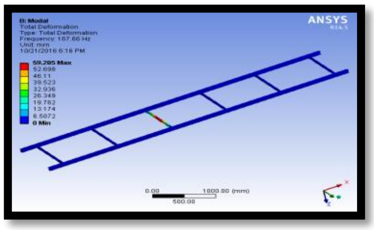
vonmises stress



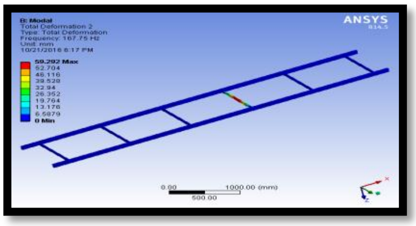
equivalent elastic strain

7.2 MODAL ANALYSIS

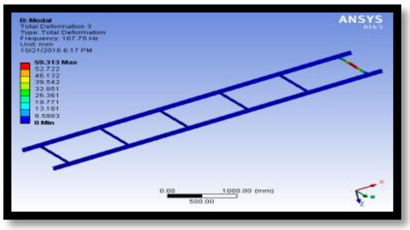
Material –kevlar



Mode 1

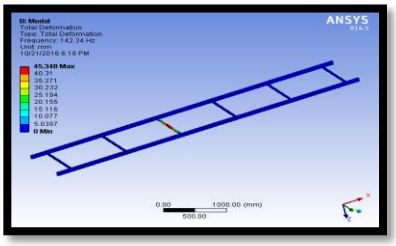


Mode 2



Mode 3

Material –s2-glass



Mode 1

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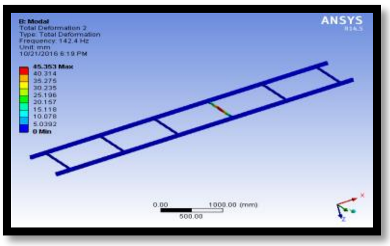

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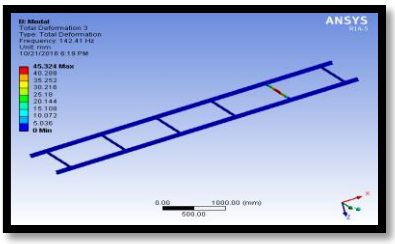
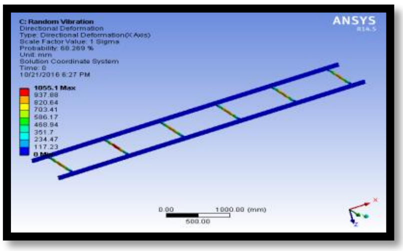


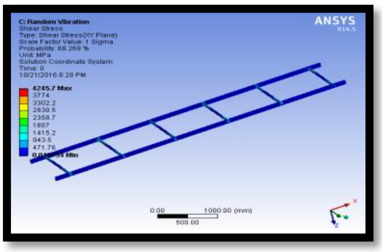
Mode 3

7.3 RANDOM VIBRATIONAL ANALYSIS

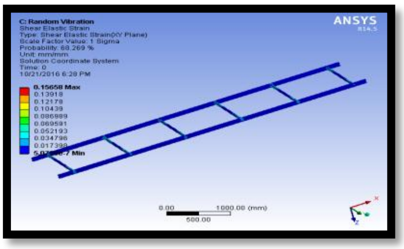
Material –kevlar



Directional deformation

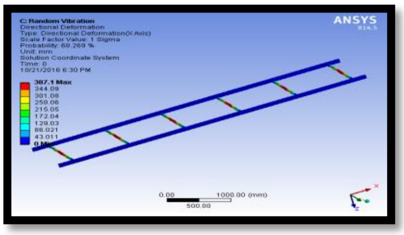


shear stress

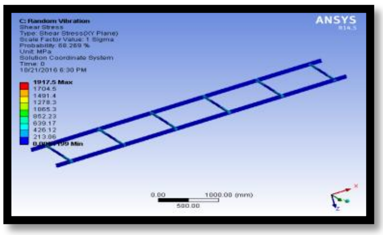


shear strain

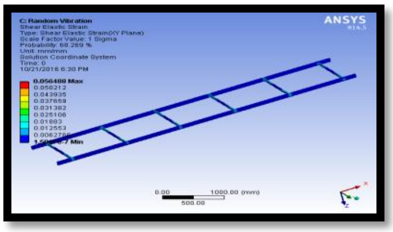
Material –s2glass



Directional deformation



shear stress



shear strain

8.COMPARISON OF RESULTS

8.1 STRUCTURAL ANALYSIS RESULTS

Models	Materials	Total deformation (mm)	Equivalent (von-mises) Stress(MPa)	Equivalent elastic Strain
Without honeycomb	Kevlar	0.0032102	1.9242	$3.159x10^{-5}$
	S2-glass	0.00263	1.9315	$2.5965x10^{-5}$
With honeycomb	Kevlar	0.0033038	2.2661	$3.385x10^{-5}$
	S2-glass	0.0027086	2.2969	$2.7706x10^{-5}$

8.2 MODAL ANALYSIS RESULTS

Models	Materials	Mode1		Mode2		Mode3	
		Deformation(mm)	Frequency(Hz)	Deformation(mm)	Frequency(Hz)	Deformation(mm)	Frequency(Hz)
Without honey comb	Kevlar	59.284	167.67	59.291	167.75	59.039	167.76
	S2-Glass	45.348	142.34	45.353	142.41	45.324	142.41
With honey Comb	Kevlar	59.285	167.66	59.292	167.75	59.313	167.75
	S2-Glass	45.348	142.34	45.353	142.4	45.324	142.41

8.3 RANDOM VIBRATIONAL ANALYSIS

Models	Materials	Directional deformation (mm)	Shear Stress (Mpa)	Shear Strain
Without honey comb	Kevlar	152.79	609.96	0.022495
	S2-Glass	125.97	616.45	0.018159
With honeycomb	Kevlar	1055.1	4245.7	0.156583
	S2-Glass	387.1	1917.5	0.056488

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9.CONCLUSION:

- In this project, chassis is modeled with honeycomb structure and without honeycomb structure. Cross section of the chassis is I-section. It is used with composite materials like Kevlar and S2 Glass.
- By observing the structural analysis results, the stress and deformation, strain values are nearly equal for chassis with and without honeycomb chassis.
- By observing modal analysis results, the deformation and natural frequency values are nearerly equal for with and without honeycomb structure chassis.
- By observing random vibrational analysis results, the directional deformation, shear stress, shear strain values are slightly more for with honeycomb structure chassis compared to without honeycomb structure chassis.
- Finally, based on results it is concluded that weight reduction is the major consideration of the chassis is reduced nearerly to 15% using honeycomb structure chassis compared to without honeycomb chassis. By reducing the weight, mileage of the vehicle is increased.
- By analyzing with different composite materials finally it is concluded that Kevlar is the best composite material.

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