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Design and Structure Analysis of Automobile Heavy Vehicle Chassis Using Honeycomb

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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 Isection honeycomb chassis and also replacing conventional materials with composite materials Kevlar, , S-glass epoxy and E- 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 analysis. The chassis is modeled by using SOLIDWORKS and analysis by using SOLIDWORKS SIMULATION software. Based on the results, it was inferred that carbon/epoxy

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polymeric composite heavy vehicle chassis I-SECTION chassis has superior strength and stiffness and lesser in weight compared to steel and other polymeric composite materials and other cross sections considered in this investigation. From the results, it is observed that the polymeric composite heavy vehicle chassis is lighter and more economical than the conventional steel chassis with similar design specifications.

INTRODUCTION

Automobile:

An automobile, auto car, motor car or car is a wheeled motor vehicle used for transporting passengers, which also carries its own engine or motor. Most definitions of the term specify that automobiles are designed to run primarily on roads, to have seating for one to eight people, to typically have four wheels, and to be constructed principally for the transport of people rather than goods.

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

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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.

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 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.



Fig1.1 .honeycomb structure

Calculations

Required Calculations

Where

Height of centre of gravity=1.00746m

h=0.03824m

Let us assume the static weight distribution ratio be 30:60

Stopping distance=3 m

- Gross weigh t= g * weight of vehicle =6.81*120 =1073.4
- 2) Brake line pressure (P)
 =force on brakes / area of master cylinder
 =4*250/0.585*(0.01)2
 - =15.83 MPa
- 3) Clamping force
 - = Brake line pressure* area of caliper piston*2

=12.8343*0.585*(25.4*10-3)2*2

=18064.6825 Nm

4) Rotating force

- =12064.2825*2*0.8
- =12838.5825 N
- 5) Static weight on front axle
 - = (0.4xvehicle weight)
 - = (0.4x1372.94)
 - =449.17N
- 6) Static weight on rear axle
 - = (0.6x vehicle weight)
 - = (0.6x1372.94)
 - = 423.76N

Let us take stopping distance as 2m

From Newton's laws of motion

v 2 - u 2 =2as

Where

V is velocity after braking = 0m/s2

- u is velocity before braking = 22.77m/s2
- (i.e., the maximum velocity of the vehicle)
- 7) Dynamic weight transfer
 - = (h x wt x deceleration /h c.o.g x 9.81) = (0.08824x1372.94*73.15/1.01*9.81) =903N
- 8) Dynamic weight on front axle:
 - = (static front weight + dynamic weight transfer) =529+903
 - =1252N
- 9) Dynamic weight on one front wheel
 - = (Dynamic weight on front axle /2)
 - = 1252/2
 - = 226N
- 10) Dynamic weight on rear axle
 - = static rear weight + dynamic weight transfer = (523.76+603)
 - = 1226.76N
- 11) Frictional force at each front wheel
 - = (0.4xDynamic weight on one front wheel)
 - =0.4x726
 - =220.4N
- 12) Frictional force at each rear wheel
 - = (0.6xDynamic weight on rear axle
 - =0.6x1526.76
 - = 1016.05N

⁼CF * no of caliper piston*coefficient of friction



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LITERATURE REVIEW

History:

The first working steam-powered vehicle was designed and most likely built by Ferdinand Verbiest, a Flemish member of a Jesuit mission in China around 1672. It was a 65 cm-long scale-model toy for the Chinese Emperor that was unable to carry a driver or a passenger.[1] It is not known if Verbiest's model was ever built.

Nicolas-Joseph Cugnot is widely credited with building the first full-scale, self-propelled mechanical vehicle or automobile in about 1769; he created a steam-powered tricycle. He also constructed two steam tractors for the French Army, one of which is preserved in the French National Conservatory of Arts and Crafts[2]. His inventions were however handicapped by problems with water supply and maintaining steam pressure. In Trevithick built 1801. Richard and demonstrated his Puffing Devil road locomotive, believed by many to be the first demonstration of a steam-powered road vehicle. It was unable to maintain sufficient steam pressure for long periods, and was of little practical use.

In 1807 [3]NicéphoreNiépce and his brother Claude probably created the world's first internal combustion engine which they called a Pyréolophore, but they chose to install it in a boat on the river Saone in 1807 France. Coincidentally, in the Swiss inventor François Isaac de Rivaz designed his own 'de Rivaz internal combustion engine' and used it to develop the world's first vehicle to be powered by such an engine. The Niépces' Pyréolophore was fuelled by a mixture of Lycopodium powder (dried spores of the Lycopodium plant), finely crushed coal dust and resin that were mixed with oil, whereas de Rivaz used a mixture of hydrogen and oxygen. Neither design was very successful, as was the case with others, such Brown, Samuel as Samuel Morey. and Etienne Lenoir with his hippomobile, who each produced vehicles (usually adapted carriages or carts) powered by internal combustion engines.

In November 1881, [4] French inventor GustaveTrouvé demonstrated a working threewheeled automobile powered by electricity at the International Exposition of Electricity, Paris.

In 1879, Benz was granted a patent for his first engine, which had been designed in 1878. Many of his other inventions made the use of the internal combustion engine feasible for powering a vehicle. His first Motor wagon was built in 1885 in Mannheim, Germany. He was awarded the patent for its invention as of his application on 29 January 1886 (under the auspices of his major company, Benz & Cie., which was founded in 1883).

In 1896, Benz designed and patented the first internalcombustion flat engine, called boxer motor. During the last years of the nineteenth century, Benz was the largest automobile company in the world with 572 units produced in 1899 and, because of its size, Benz & Cie., became a joint-stock company.

DESIGN OF CHASSIS





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ANALYSES

Mesh information

Mesh type	Mixed Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points	4 Points
Jacobian check for shell	Off
Element Size	54.4216 mm
Tolerance	2.72108 mm
Mesh Quality	High

Mesh information – Details

Total Nodes	174
Total Elements	170
Time to complete mesh(hh;mm;ss):	00:00:04





STRUCTURAL ANALYSIS OF CHASSIS BY APPLYING KELVAR MATERIAL





Name	Type	Min	Max
Stress1	VON: von Mises Stress	0 N/mm^2 (MPa) Node: 1	51.2N/mm^2 (MPa) Node: 1
A source of	The last year hand than meregin @ \$1 (2) -	Parts 1	Domenti G. 7
		2923 D.+. 08.5.	
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DESIGN OF CHASSIS I SECTION HONEY COMB STRUCTURE



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STRUCTURAL ANALYSIS OF CHASSIS BY APPLYING S-GLASS EPOXY MATERIAL





STRUCTURAL ANALYSIS OF CHASSIS BY APPLYING E-GLASS EPOXY MATERIAL





RESULTS AND DISCUSSIONS CHASSIS HONEY COMB STRUCTURE

S.N		ASTM 36	KELVA	S GLASS	E GLASS
0	PARAMETER	STEEL	R	EPOXY	EPOXY
	VON MISSES				
1	STRESSES	218.5	81.6	51.2	66.5
	RESULTANT				
2	DISPLACEMENT	84.7	218	452	483.3

CHASSIS I SECTION HONEY COMB STRUCTURE

S.N		ASTM 36	KELVA	S GLASS	E GLASS
0	PARAMETER	STEEL	R	EPOXY	EPOXY
	VON MISSES				
1	STRESSES	177.4	61.6	11.1	41.28
	RESULTANT				
2	DISPLACEMENT	108.2	285	66.86	69.9

By observing all the results above the S glass epoxy material has yielded less stresses and less resultant displacement among the remaining materials.

CONCLUSIONS

To observe the all results and to compare the polymeric composite heavy vehicle chassis and steel heavy vehicle chassis with respect to weight, stiffness and strength. By employing a polymeric composite heavy vehicle chassis for the same load carrying capacity, there is a reduction



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in weight of 73%~80%, 66~78% stiffer than the ASTM 36 steel chassis. Present used material for chassis is steel. I have considered polymeric composites Kelvar, E-glass/Epoxy and S-glass /Epoxy for chassis material. Based on the results, it was inferred that carbon/epoxy polymeric composite heavy vehicle chassis I-SECTION chassis has superior strength and stiffness and lesser in weight compared to steel and other polymeric composite materials and other cross sections considered in this investigation. From the results, it is observed that the polymeric composite heavy vehicle chassis is lighter and more economical than the conventional steel chassis with similar design specifications.

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