Use of Composite materials in different areas of automobile sector

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***Abstract*— Due to price rise and other difficulties of conventional sources it is highly preferable to use alternate products to build an automobile which must has to be cost beneficial by any means along with high strength, appreciable thermal properties as well as mechanical properties. In that course composite materials can be used which possess some good properties as well as shock resistance too.**

This study will show how the composite materials can be used in different areas of automobiles.

***Index Term*- Automobile, composite materials, fibers**

I. INTRODUCTION

Due to high market demand the numbers of motor vehicles are increasing day by day. So the car manufacturers use to keep in mind to offer best quality of materials with high profit. Now days some super facility cars are available in the market but these all are out of reach from most of people. An automobile comprises of structural design, body, chassis, security systems, brakes, shock absorber, and lots more. So as a whole it is a complex job to manufacture a car and also time consuming as well as monetary involvement is higher.

While buying a car 1st preference of a customer is the mileage of the car followed by the other facilities along with the security systems. And the customer would like to buy that car which offers all the facilities with fewer budgets. This study is about suggestion of some modification of selection of conventional materials to make it cost beneficial as well as more strength with light weight to carry larger load.

II. DISADVANTAGES OF CURRENT STATUS:

- Manufacturing cost is high
- The load carrying capacity of some cars are relatively less
- Shock absorb capacity is low in some cars
- Engine cooling fan blades that break unexpectedly causing injury to persons working on a vehicle
- Seats and/or seat backs that fail unexpectedly during normal use
- Child safety seats that contain defective safety belts, buckles, or components that create a risk of injury, not only in a vehicle crash but also in non-operational safety of a motor vehicle

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III. MODIFICATION SUGGESTED:-

A. Weight Reduction Technique

A car body is made up with variety of materials like iron, aluminum, plastic steel, glass, rubber, petroleum products, copper, steel etc. are common among them. Carbon fiber is lighter than these materials but costs high that are why these sorts of materials are only used in manufacturing of racing cars. The weight of these sorts of cars is too light so that the racing cars can be driven. Suspension components must to be adjusted in such a way that the car could be in stable condition while turning and if the weight is less than it is quite easy to make a set up like that.
The problem with carbon fiber is that the cost of carbon fiber is very high and it does not suits conditions like where no load is applied.
In that paper some alternative materials have been suggested which will make the cars more light as well as will reduce the costs. In that course if fiber glass can be used in space of carbon fiber it will result cost beneficial with some appreciable properties.

Fiberglass (S-2 glass)

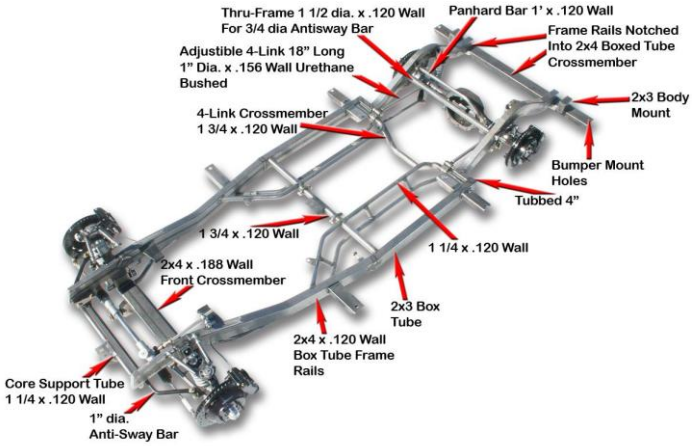
- Tensile strength MPa (ksi) : 2,358 (342)
- Lighter than carbon fiber.
- Operating temp b/w 150 and 300 centigrade
- Susceptible to damage
- Fibers made primarily from silica-based glass containing several metal
- oxides offer excellent thermal and impact resistance, high tensile strength, good chemical resistance and outstanding insulating properties, insulating properties, also keep the car's interior cool in summers and warm in winters, for longest amount of time, unlike metal's conducting properties.

S-2 glass is approximately 40-70% stronger than E-glass

Basic Calculations:
The maximum permissible width of a formula one race car is 1800 mm.
Height of vehicle = 950 mm

Height of vehicle = 1000 mm (approx.)
Area of the chassis frame= 1.71 m^2

Cost of S 2 Fiber glass ((FRP) Corrugated Sheet) of thickness 5mm/5ply = 3$ per sq. ft.
Area, A = 1840 ft^2
Cost of Fiber glass = 1840 x 3$
Or, Cost = 5521$



CHASSIS FRAME

Fiberglass (E-Glass Epoxy composite)
Properties:-

- Tensile strength MPa (ksi) : 1,770
- lighter than carbon fiber
- working temp b/w 150 and 300 centigrade
- susceptible to damage
- Fibers made primarily from silica-based glass containing several metal oxides offer excellent thermal and impact resistance, high tensile strength, good chemical resistance and outstanding insulating properties insulating properties, also keep the car's interior cool in summers and warm in winters, for longest amount of time, unlike metal's conducting properties.
- S glass is 30 % more stronger than glass composites & more stiffer than E glass too

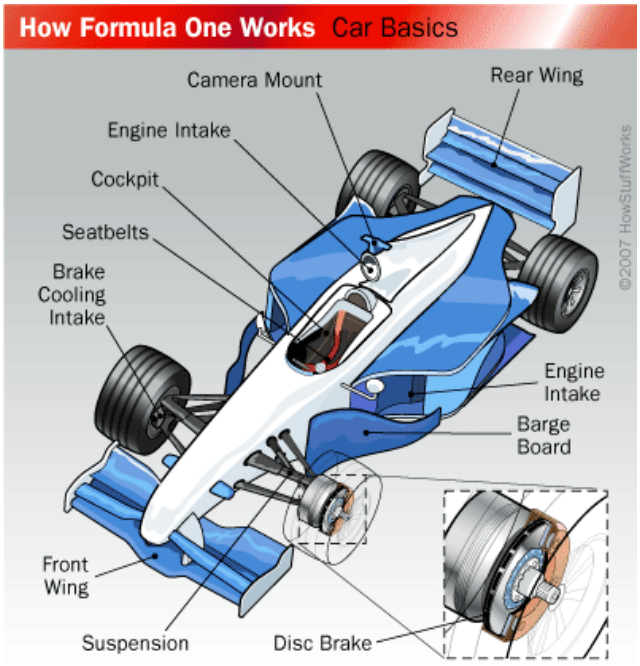
Basic Calculations:
The maximum permissible width of a formula one race car is 1800 mm.
Height of vehicle = 950 mm
Height of vehicle = 1000 mm (approx.)
Area of the chassis frame= 1.71 m2

Cost of Fiber glass (E glass Corrugated Sheet) of thickness 5mm/5ply = 18.40 $ per sq. ft.
Area, A = 1840 ft2
Cost of Fiber glass = 1840 x 18.40 $
Or, Cost = 33867$
For low E glass fiber

Cost of Fiber glass (E glass Corrugated Sheet) of thickness 5mm/5ply = 3$ per sq. ft.
Area, A = 1840 ft2
Cost of Fiber glass = 1840 x 3.25 $
Or, Cost = 5982 $

If carbon fiber is used then the cost is shown below;
Cost of Carbon Fiber of thickness 5mm/5ply = 60 $ per sq. ft.
Area, A = 18406 ft2
Cost of Fiber glass = 1840 X 60 $
Or, Cost = 110436 $

Whereas if steel fiber is used the cost becomes too high as it costs $1000 per sq. ft. so not considered.



Application of Glass fibers in general cars:

In normal cars the chassis is made of steel in general which can be compared with the other materials.
Basic Calculations:
The maximum permissible width of a car is 2400 mm.
Height of vehicle = 1200 mm (approx.)
Area of the chassis frame= 2.88m2

Cost of Fiber glass (E glass Corrugated Sheet) of thickness 5mm/5ply = 4 $ per sq. ft.
Area, A = 3100 ft2
Cost of Fiber glass = 3100*4 $
Or, Cost = 12400 $

If E glass fiber is used then:
The maximum permissible width of a car is 2400 mm.
Height of vehicle = 1200 mm (approx.)
Area of the chassis frame= 2.88m2

Cost of Fiber glass (E glass Corrugated Sheet) of thickness 5mm/5ply = 3.25 $ per sq. ft.
Area, A = 3100 ft2
Cost of Fiber glass = 3100*3.25 $
Or, Cost = 10075 $

❖ **Properties of Steel:**

Properties	Carbon Steels	Alloy Steels	Stainless Steels	Tool Steels
Density (1000 kg/m^3)	7.85	7.85	7.75-8.1	7.72-8.0
Elastic Modulus (GPa)	190-210	190-210	190-210	190-210
Poisson's Ratio	0.27-0.3	0.27-0.3	0.27-0.3	0.27-0.3
Thermal Expansion (10^{-6}/K)	11-16.6	9.0-15	9.0-20.7	9.4-15.1
Thermal Conductivity (W/m-K)	24.3-65.2	26-48.6	11.2-36.7	19.9-48.3
Specific Heat (J/kg-K)	450-2081	452-1499	420-500	
Electrical Resistivity (10^{-9}W-m)	130-1250	210-1251	75.7-1020	
Tensile Strength (MPa)	276-1882	758-1882	515-827	640-2000
Yield Strength (MPa)	186-758	366-1793	207-552	380-440
Percent Elongation (%)	10-32	4-31	12-40	5-25
Hardness (Brinell 3000kg)	86-388	149-627	137-595	210-620

❖ **Properties of Glass Fibers:**

Material	Specific gravity	Tensile strength MPa (ksi)	Compressive strength MPa (ksi)
Polyester resin (Not reinforced)[4]	1.28	55 (7.98)	140 (20.3)
Polyester and Chopped Strand Mat Laminate 30% E-glass[4]	1.4	100 (14.5)	150 (21.8)
Polyester and Woven Rovings Laminate 45% E-glass[4]	1.6	250 (36.3)	150 (21.8)
Polyester and Satin Weave Cloth Laminate 55% E-glass[4]	1.7	300 (43.5)	250 (36.3)
Polyester and Continuous Rovings Laminate 70% E-glass[4]	1.9	800 (116)	350 (50.8)
E-Glass Epoxy composite[5]	1.99	1,770 (257)	

❖ When glass fibers are exposed to water, they become eroded due to leaching. To protect the glass fibers from erosion, a moisture-resistant coating is to be employed during manufacturing. Some types of glasses perform better than others when exposed to acids or bases. Both C-glass and S-2 glass offer good corrosion resistance when exposed to hydrochloric or sulfuric acid

❖ Density of glass fibers is measured and either as formed or as bulk annealed samples. ASTM C 693 is one of the test methods used for density determinations. The fiber density is less than the bulk annealed value by approximately 0.04 g/cc at room temperature.
❖ Tensile strength of glass fibers are normally 20 to 30% due to surface defects introduced during the strand-forming
❖ Due to moisture content an increase of 50 to 100% in strength over a measurement at room temperature in 50% relative humidity air.
❖ The maximum strength of S-2 Glass fibers at liquid nitrogen temperatures is around 11.6 GPa for a 12.7 mm gauge length, 10 µm diameter fiber.
❖ The Young's modulus of elasticity of un-annealed silicate glass fibers ranges from about 52 GPa to 87 GPa.
❖ High strength S-2 Glass fibers annealed properties measured at 20°C are as follows:

Young's Modulus 93.8 GPa
Shear Modulus 38.1 GPa
Poisson's Ratio 0.23
Bulk Density 2.488 g/cc Thermal Properties

Glass Fiber

IV. CONCLUSION

- Fiber glass is flexible
- Fiber glass is less costly compare to carbon fiber and even can be applied in normal cars apart from the high speed racing cars
- The speed can be increased as the weight of the vehicle decreases by application of fibers
- The mileage could be achieved more
- The car will move lesser distance due to perfect pressure to weight ratio due to application of suitable materials

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