Fabrication of Light Weight Car

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Abstract— Passenger transportation accounts for 60 to 70% of energy consumption from transportation activities. The private car is the dominant mode but has a poor energetic performance/ efficiency, although this performance has seen substantial improvements since the 1970s, mainly due to growing energy prices and regulations. Only 12% of the fuel used by a car actually provides momentum, this is purely because of heavy design of vehicles. Heavy design and less occupancy of the car is also one of the major reasons for traffic jam in major cities. In most of the cities heavily designed cars (size & mass wise) are being used by a single person to reach his work place, where most of the energy being generated by the engine/ motor is used to drag self-weight of the car itself and also contributing to traffic conge station on roads. By replacing heavily designed cars with small cars designed for a single/ two persons, can Increase the fuel efficiency of the car by increasing the ratio of mass of human to car and can also reduce traffic problems. This in turn results in less dependence on foreign import fuels and less vehicular pollution in cities. The project involves Design, Procurement, Fabrication, Painting and Testing of a small (single seater) car body, steering gear, seats, break system etc., which is suitable for Electric / Solar energy drive system.

Key words: Fabrication, Design, Electric Energy, Solar Energy, Brake System

I. INTRODUCTION

An automobile or car is a wheeled vehicle that carries its own power generator and transports passengers. Automotive production down the ages has required a wide range of energy-conversion systems. These include electric, steam, solar, turbine, rotary, and different types of piston type internal combustion engines. The reciprocating piston internal combustion system, operating on a four stroke cycle, has been the most successful for automobiles, while diesel engines are widely used for trucks and buses.

The gasoline engine was originally selected for the automobile due to its flexibility over a wide range of speeds. Also, the power developed for a given weight engine was reasonable; it could be produced by economical mass-production methods; and it used a readily available, moderately priced fuel--gasoline. Reliability, compact size, and range of operation later become an important factor.

II. PROBLEM DESCRIPTION

In general the presently using automobiles has more weight and has more rotating, reciprocating parts, by this disadvantage the efficiency of automobiles is decreasing and there by the consumption of fuel is increasing. As the world is now facing fuel deficiency so it is important to reduce the consumption of fuel and also by the more consumption of fuel it releases the harmful gases into the air where it is increases the pollution in air. So by reducing the vehicle's self weight or the density of material of the vehicle and reducing the car's weight by only 10 percent can improve fuel economy by 6 to 8 percent. By keeping above problems our objective is to

– Reduce self-weight of the car.
– Having less rotating and reciprocating parts where it decreases the energy consumption which causes less harm to pollution compared to presently using fuel propelled vehicles.
– Reduce the drag force.
– Reduce the frictional force.
– Reducing the required power

1) *Estimation car weight is 150kg*

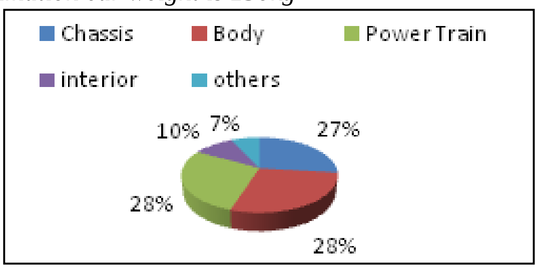

Fig. 1: General Car Weight

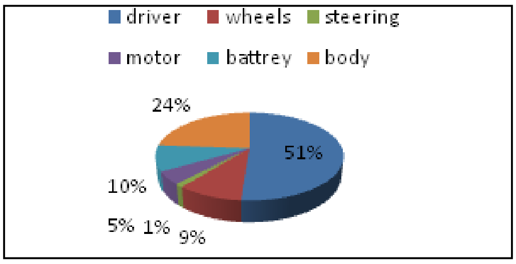

Fig. 2: Estimated Car Weight

III. EXPERIMENTAL PROCEDURE

A. Chassis:

A vehicle without body is called Chassis. The components of the vehicle like Power, Transmission System, Axles, Wheels and Tyres, Suspension, Controlling Systems like Braking, Steering etc., and also electrical system parts are mounted on the Chassis frame. It is the main mounting for all the components including the body. So it is also called as Carrying Unit.

B. Main Components of Chassis:

The following main components of the Chassis are

– Frame
– Power source
– Transmission system
– Steering system
– Breaks
– Wheels

1) Frame:

It is made up of long two members called side members riveted together with the help of number of cross members.

a) Specifications:

Material used	Mild Steel
Cross section	L
Cross sectional dimensions	40*40
Young's modulus	200GPa

Table 1: Specifications of Frame

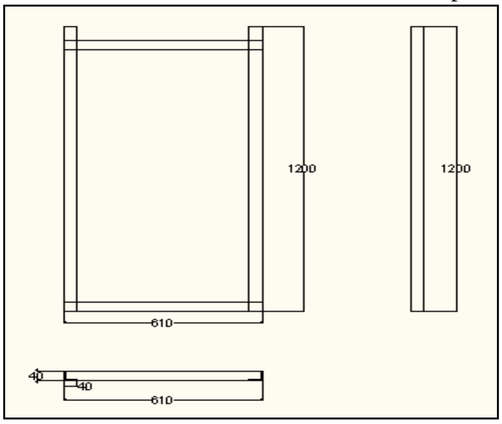

Fig. 3: Frame Structure

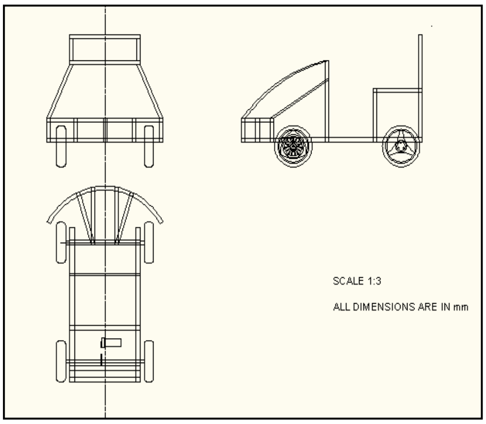

Fig. 4: Chassis Structure

Fig. 5: Chassis Construction

2) Power Source:

The vehicle can be propelled either by heat engine or by the electricity. In heat engines the vehicle is propelled by converting chemical energy into mechanical energy. In electrically powered vehicles the electric power stored in batteries is converted into mechanical energy by using motor.

a) Batteries:

A battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. Here Dry batteries are used in the present work.

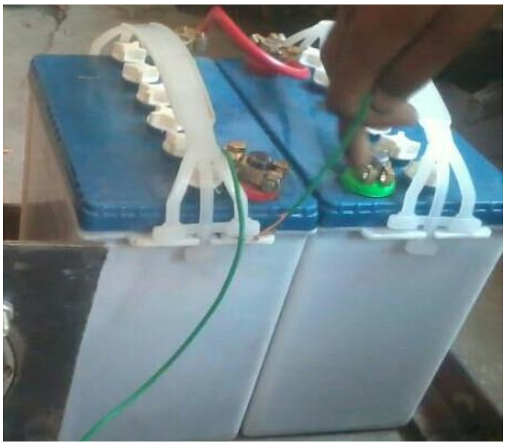

Fig. 6: Batteries

3) Transmission System-Motor:

The Motor or an electrical motor is a device that has brought about one of the biggest advancements in the fields of engineering and technology ever since the invention of electricity. A Motor is nothing but an electro-mechanical device that converts electrical energy to mechanical energy.

In shunt motor the field winding is connected in parallel with the armature . the current through the shunt field winding is not the same as the armature current. Shint field windings are desingned to produce the necessary m.m.f. by means of a relatively large number of turns of wire having high resistance. Therefore, shunt field current is relatively small compared with the armature current.

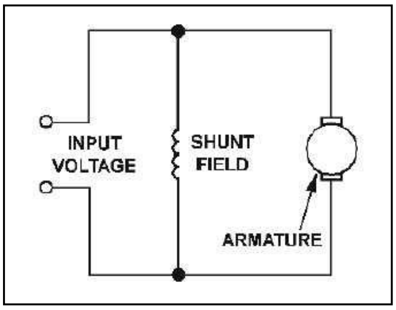

Fig. 7: Shunt Motor

Motor (DC shunt motor)	Description
Voltage	24 volts
Current	12 amps
Power	½ hp

Table 2: Motor Specifications

a) Chains and Sprockets:

Speed ratio calculations:

Pitch circle diameter of the sprocket mounted on the motor shaft (d3) = 5cm
Pitch circle diameter of the sprocket mounted on the shaft (d2) = 25cm
No.of teeth on the sprocket mounted on the motor shaft (T1) = 12
No.of teeth on the sprocket mounted on the shaft (T2) = 60

Speed ratio = T1/T2 = 60/12

Speed ratio = 5

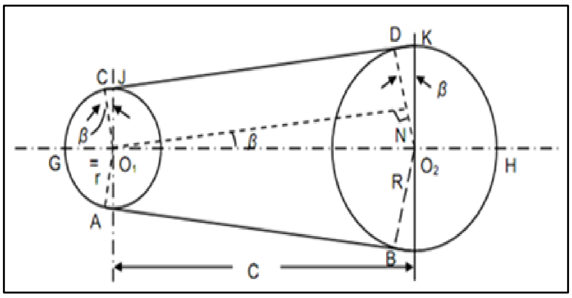

Fig. 8: Sprockets and Transmission system

Length of chain calculations (L) = kP

Where k =No.of chain links

P = pitch of the chain

K= (T1+T2)/2+ (2x)/p+ ((T2-T1)/2π)^{2}P/x
Where x=center distance between the sprockets
X=27cm
K= (12+60)/2+(2*27)/0.6+((60-12)/2π)^2*0.6/27
K=127.298
Length of the chain = k*p =127.29*0.6
Length of the chain =76.38cm

4) Steering Mechanism:

Generally, lighter, sportier cars have lower steering ratios than larger cars and trucks. The lower ratio gives the steering a quicker response you don't have to turn the steering wheel as much to get the wheels to turn a given distance which is a desirable trait in sports cars. These smaller cars are light enough that even with the lower ratio, the effort required to turn the steering wheel is not excessive.

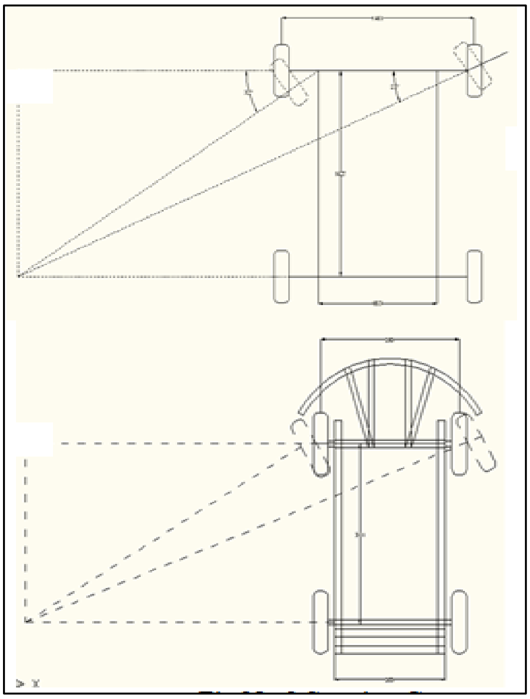

Fig. 8: Steering Geometry

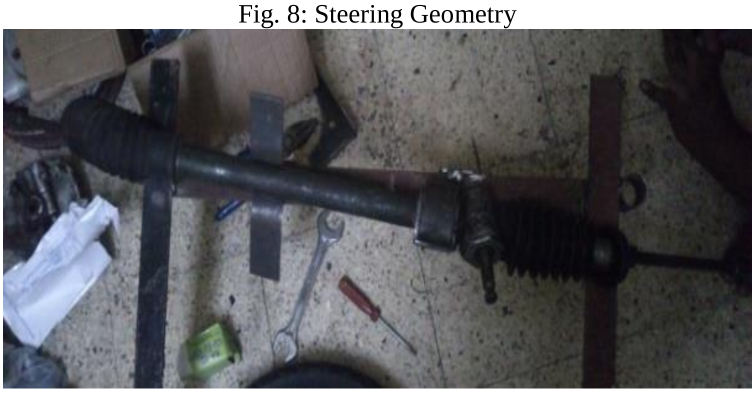

Fig. 9: Steering Rod

Fig. 10: Steering Gear Rack and Pinion

Fig. 10: Hooke's joint showing the speed irregularities across a

Checking for correct steering:
a=wheel track=640mm
b =wheel base=925mm
c= distance between the pivots A and B of the front axle=610mm
IP=925mm
BP=1045mm
AP=BP+BA =1045+610
AP=1655mm, now from triangle IBP
cotθ = BP/IP =1045/925
cotθ=1.12, from triangle IAP,
cotØ = AP/IP, cotØ= 1655/925
cotØ=1.78, c/b=610/925 =0.65
cotØ-cotθ=1.78-1.12
cotØ-cotθ=0.66
cotØ-cotθ=c/b=0.6

If the above condition is satisfied, there will be no skidding of the wheels, when the vehicle takes a turn. This geometry results in the inside wheel turning through a smaller radius than the outside wheel. This allows the vehicle to travel around a curve without scrubbing the tyres. In practice the steering linkage doesn't need to produce true Ackerman. It is achieved by a combination of the steered angle and the slip angle produced by the cornering force.The slip angle on the outside wheel is greater than that of the inner and this produces varying degrees of dynamic Ackerman effect.

a) Steering gear specifications:

Type of gear = helical gear
Teeth profile = involute teeth
Helix angle = 20^0
Pitch of the teeth = 0.5cm
No of revolutions for complete rotation = 2½ rotations
Distance moved by the rack for 2½ rotations =10cm

b) Steering ratio:

The steering ratio is the ratio of how far you turn the steering wheel to how far the wheels turn. For instance, if one complete revolution (360 degrees) of the steering wheel results in the wheels of the car turning 20 degrees, then the steering ratio is 360 divided by 20, or 18:1. A higher ratio means that you have to turn the steering wheel more to get the wheels to turn a given distance. However, less effort is required because of the higher gear ratio.

Rotation of steering wheel =360^0
Rotation degrees made by wheels =30^0
Steering ratio = 30/360
Steering ratio = 1:12

Application	Description
Type	Rack and Pinion
Tooth profile	Involute
Type of Gear	Helical Gear
Helix Angle	20^0
Total No. of steering wheel rotations	2½ rotations
Steering Ratio	1:12

Table 3: General Steering Gear Specifications

5) Brakes:

The material used for the brake lining should have the following charecteristics:

- It should have high coefficient of friction with minimum fading. In other words, the coefficient of friction should remain constant with change in temperature.
- It have low wear rate.
- It should have high heat resistance.
- It should have high heat dissipation capacity.
- It should have adequate mechanical strength.
- It should not be affected by moisture and oil.

6) Wheels:

Wheel specifications:
Size: 2.15×16
Outer Diameter: 433mm
Wheel Weight: 1,250g

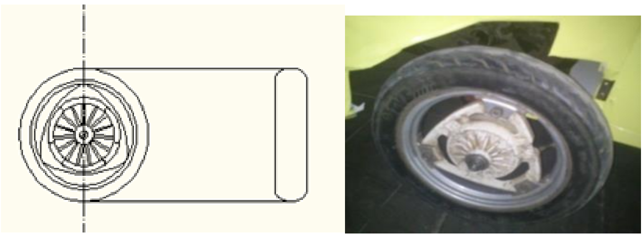

Fig. 11: Wheels

C. Material for Car Body:

1) Aluminium

Physically, chemically and mechanically aluminium is a metal like steel, brass, copper, zinc, lead or titanium. It can be melted, cast, formed and machined much like these metals and it conducts electric current. In fact often the same equipment and fabrication methods are used as for steel.

Fig. 12: Car Body with Al Sheet

Description	Values
Vehicle Dimensions L/W/H	1600/820/80 mm
Weight	90kg
Maximum load capacity	150kg
Maximum speed	30kmph
Emission	No Emissions
Drive Type	Front wheel drive
Steering Gear	Rack and Pinion s
Drive motor	DC shunt motor (1/2 hp)
Batteries	Wet cell batteries 12v
Distance between 2 wheels	925mm
Brakes	Internal Expanding Brakes (Drum Brakes)
Man to Car Ratio	1.5

Table 4: Specifications of the car:

IV. RESULT

A. Test for Bending Moment:

1) Loads Acting on the beam:

A beam is normally horizontal and the loads vertical. Other cases which occur are considered to be exceptions. A Concentrated load is one which can be considered to act at a point, although in practice it must be distributed over a small area. A Distributed load is one which is spread in some manner over the length, or a significant length, of the beam. It is usually quoted at a weight per unit length of beam. It may either be uniform or vary from point to point.

When applied loads act along a beam, an internal bending moment which varies from point to point along the axis of the beam is developed. A bending moment is an internal force that is induced in a restrained structural element when external forces are applied. Failure by bending will occur when loading is sufficient to induce a bending stress greater than the yield stress of the material. Bending stress increases proportionally with bending moment.

It is possible that failure by shear will occur before this, although while there is a strong relationship between bending moments and shear forces, the mechanics of failure are different. A bending moment may be defined as "the sum of turning forces about that section of all external forces acting to one side of that section and quota;. The forces on either side of the section must be equal in order to counter-act each other and maintain a state of equilibrium. For systems allowed to rotate, then the equivalent force would be referred to as torque.

Moments are calculated by multiplying the external vector forces (loads or reactions) by the vector distance at which they are applied. When analyzing an entire element, it is sensible to calculate moments at both ends of the element, at the beginning, centre and end of any uniformly distributed loads, and directly underneath any point loads. Of course any within a structure allow free rotation, and so zero moment occurs at these points as there is no way of transmitting turning forces from one side of the other.

If clockwise bending moments are taken as negative, then a negative bending moment within an element will cause and a clockwise moment will cause & it is therefore clear that a point of zero bending moment within a beam is a point of contra flexure - that is the point of transition. Here the calculations are done manually to get the Moment of Inertia; other load calculations are also performed.

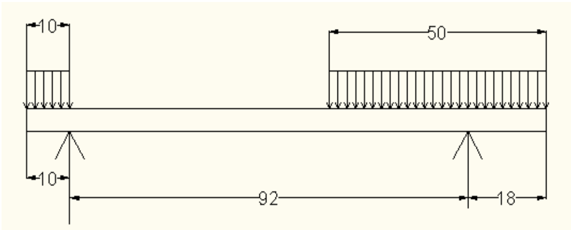

Fig. 13: Load Diagram on frame

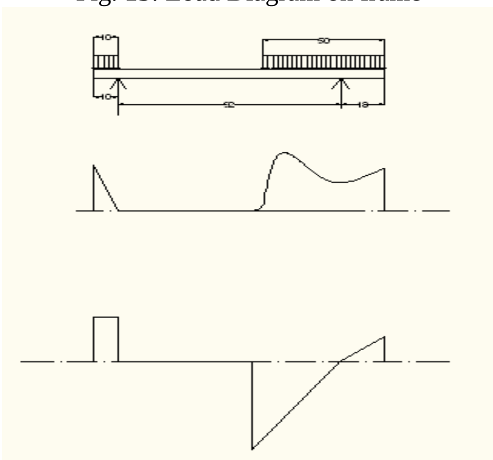

Fig. 14: Bending Moment Diagram

Name	Weight (kg)
Driver	60
Wheels	12
Steering	2
Motor	7
Battery	12
Body	31
Frame	26
Total Weight	150
The calculated Factor of safety	=5

Drag type	% of C_p	Caused by	Way of Reduction and Measures
Fore body drag	65%	Overpressure on the front face.	Reduction of overpressure by accelerating the flow: rounding up of upper horizontal and vertical leading edges, slanting the front face.
Base drag	34.9%	Depression on the rear end.	Increase of pressure: boat-tailing, tapering the rear part of the body, rounding up of trailing edges.
Side wall, roof and underbody drag	0.1%	Shear stresses over the walls, roof and underbody	Decrease of shear stresses: reduction of roughness, decrease of the velocity in the underbody gap.

Table 5: Components of the drag of a body and their reduction

V. CONCLUSION

The original vehicle weight producing same power is 130kg-150 kg, was reduced to 90 kg, which is decreased to 19-percent. Structural performance of light weighted vehicles can be summarized as:

- From this experiment we are able to reduce the original weight of the vehicle to 10%. So that we are able to increase fuel economy to 6-8%.
- The deceleration of a vehicle was more likely to be dependent on the vehicle stiffness and crash mechanisms, rather than vehicle mass reduction.
- The best material for the car body is aluminum that is because of the reasonable price, there is possibility to repair the car in case of any accidents. It is light weight material and handling and forming aluminum is relatively easy.
- The most significant drag reduction can be achieved by rounding up the vertical and upper horizontal leading edges on the front face.
- Relatively small amendments can result considerable drag reduction.
- The drag reduction of front spoiler is large if its use is combined with rounded leading edges.

To have a 30-percent content of plastics and composites in the development of a, additional applications of plastics and composites to the vehicle structural components, especially occupant compartment and closures, would be required. Investigation of Opportunities for Lightweight Vehicles Using Advanced Plastics and Composites Based on the front NCAP simulations of five light weighted vehicles,

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