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DESIGN AND FABRICATION OF HYBRID SOLAR CAR

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Abstract-The proposed project is to reduce the cost of travel and keep the environment pollution free. This project is designed and is fabricated to give a better performance than the conventional Solar and Battery operated cars.

The main problem of all the conventional solar and battery operated vehicles are that they weigh a lot. This reflects on the performance of the vehicle on the number of hours and the power consumption from the source (Solar or Battery).

The design of a solar vehicle is severely limited by the amount of energy input into the car. Most solar cars have been built for the purpose of solar car races. Since 2011 solar-powered cars have been designed for daily use on public roads.

The project is designed for the pure purpose for commercial use and for the idea of green environment.

The objective of this project is to design a vehicle for pure commercial purpose and to fabricate a vehicle that can be used in the recent future as a green vehicle as it runs only on electric and solar power and does not emit any harmful gases to the atmosphere.

1.1 MATERIAL USED

The material used in this project are abundantly available in the market and the cost of the material purchased are cheap. The materials bought are as follows

1) M.S. A106 Grade B round rod
2) M.S. A106 Rectangular cross section
3) Seamless steel rod
4) Sheet metal

1.1.1 M.S. A106 Grade B round rod

This material is selected for its properties of less weight and high stiffness with 0.30% of carbon content in the material. The specifications of this round rod is 25.4 mm of outer diameter and 21.4 mm of inner diameter. This material is used for constructing the frame of the vehicle. The tensile strength of the material is 30GPa and its compressible strength is more compared to other mild steels. The material also is a very well adjustable for bending and other processes.

1.1.2 M.S. A106 Grade B rectangular cross section

This material is selected for its properties of less weight and high stiffness with 0.30% of carbon content in the material. The tensile strength of the material is 30GPa and its compressible strength is more compared to other mild steels. This is used for providing cross links to the vehicle for withstanding the weight of the total assembled vehicle. The cross section of the vehicle is 1.5 inch to 1 inch.

1.1.3 Seamless steel rod

These are classified as austenitic, and are hardenable only by cold working methods. These grades of stainless have chromium (approx. 18 to 30%) and nickel (approx. 6 to 20%) as their major alloying additions. They are used as shafts for mating the front wheels of the vehicle. They are used for their high tensile strength and ability to withstand load.

1.1.1.3 Sheet Metal

The sheet metal is used to cover the vehicle or finish the fabrication of the vehicle and used to place the batteries and the solar panel. It is also used to provide the seating arrangement for the vehicle. Sheet metal is the most apt material for the finish. The specifications of the sheet is 3mm thick. Its is both used to cover in the bottom and the top of the vehicle.

Sheet metal is metal formed by an industrial process into thin, flat pieces. It is one of the fundamental forms used in metalworking and it can be cut and bent into a variety of shapes. Countless everyday objects are constructed with sheet metal. Thicknesses can vary significantly; extremely thin thicknesses are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered plate.

There are many different metals that can be made into sheet metal, such as aluminum, brass, copper, steel, tin, nickel and titanium.

1.2 INNOVATIONS

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1.2.1 Wheels with motor

The wheel hub motor (also called wheel motor, wheel hub drive, hub motor or in-wheel motor) is an electric motor that is incorporated into the hub of a wheel and drives it directly.

Hub motor electromagnetic fields are supplied to the stationary windings of the motor. The outer part of the motor follows, or tries to follow, those fields, turning the attached wheel. In a brushed motor, energy is transferred by brushes contacting the rotating shaft of the motor. Energy is transferred in a brushless motor electronically, eliminating physical contact between stationary and moving parts. Although brushless motor technology is more expensive, most are more efficient and longer-lasting than brushed motor systems.

A hub motor typically is designed in one of three configurations. Considered least practical is an axial-flux motor, where the stator windings are typically sandwiched between sets of magnets. The other two configurations are both radial designs with the motor magnets bonded to the rotor; in one, the inner rotation motor, the rotor sits inside the stator, as in a conventional motor. In the other, the outer-rotation motor, the rotor sits outside the stator and rotates around it. The application of hub motors in vehicular uses is still evolving, and neither configuration has become standard.

Electric motors have their greatest torque at startup, making them ideal for vehicles as they need the most torque at startup too. The idea of "revving up" so common with internal combustion engines is unnecessary with electric motors. Their greatest torque occurs as the rotor first begins to turn, which is why electric motors do not require a transmission. A gear-down arrangement may be needed, but unlike in a transmission normally paired with a combustion engine, no shifting is needed for electric motors.

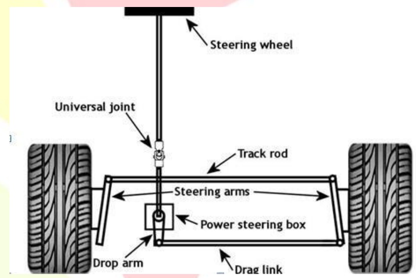
Wheel hub motors are increasingly common on electric bikes and electric scooters in some parts of the world, especially Asia.

These are used at the rear of the vehicle for the propulsion of the assembled vehicle. The power is directly transmitted directly to the wheels that has the motor inside the hub. The specifications of the motor is 48 volts with 880 amps/hour.

1.2.2. STEERING

1.2.2.1 Ackerman Steering Mechanism

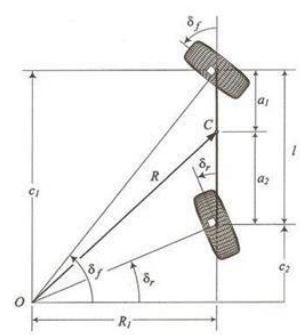
With perfect Ackermann, at any angle of steering, the perpendicular line through the centre point of all the wheels will meet at a common point. But this may be difficult to arrange in practice with simple linkages.Hence, modern cars do not use pure Ackermann steering, partly because it ignores important dynamic and compliant effects, but the principle is sound for low speed manoeuvres.



1.2.2.2 Turning Radius

The turning radius or turning circle of a vehicle is the diameter of the smallest circular turn (i.e. U-turn) that the vehicle is capable of making.

Turning circle radius = (track/2) + (wheelbase/ sin (average steer angle



Using the geometry shown in the bicycle model, where, 'R' is Turning Radius

a_1 a_2' is distance between instantaneous centre and axis of wheels

From the works of K. Lohith, M.S Ramaiah School of Advanced Studies it can be stated that, Assuming standard turning radius of two wheel steering is 4.4m, Turning Radius for Four Wheel Steering is 2.596m which is found from the above

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equation of 'R'.

1.3 BRAKES

1.3.1 Drum brakes

A drum brake is a brake that uses friction caused by a set of shoes or pads that press against a rotating drum-shaped part called a brake drum.

The term drum brake usually means a brake in which shoes press on thinner surface of the drum. When shoes press on the outside of the drum, it is usually called a clasp brake. Where the drum is pinched between two shoes, similar to a conventional disc brake, it is sometimes called a pinch drum brake, though such brakes are relatively rare. A related type called a band brake uses a flexible belt or "band" wrapping around the outside of a drum.

1.4 POWER TRANSMISSION

1.4.1 Battery

An automotive battery is a type of rechargeable battery that supplies electric energy to an automobile. An automotive SLI battery (starting, lighting, ignition) powers the starter motor, the lights, and the ignition system of a vehicle

Automotive SLI batteries are usually lead-acid type, and are made of six galvanic cells in series to provide a 12-volt system. Each cell provides 2.1 volts for a total of 12.6 volts at full charge. Heavy vehicles, such as highway trucks or tractors, often equipped with diesel engines, may have two batteries in series for a 24-volt system or may have parallel strings of batteries.

Lead-acid batteries are made up of plates of lead and separate plates of lead dioxide, which are submerged into an electrolyte solution of about 38% sulfuric acid and 62% water. This causes a chemical reaction that releases electrons, allowing them to flow through conductors to produce electricity. As the battery discharges, the acid of the electrolyte reacts with the materials of the plates, changing their surface to lead sulfate. When the battery is recharged, the chemical reaction is reversed.

1.4.2 Solar Cell

A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Solar cells are the building blocks of photovoltaic modules, otherwise known as solar panels.

Working

- Photons in sunlight hit the solar panel and are absorbed by semiconducting materials, such as silicon.
- Electrons are excited from their current molecular/atomic orbital. Once excited an electron can either dissipate the energy as heat and return to its orbital or travel through the cell until it reaches an electrode. Current flows through the material to cancel the potential and this electricity is captured.
- An array of solar cells converts solar energy into a usable amount of direct current (DC) electricity.
- An inverter can convert the power to alternating current (AC)

Efficiency:

Solar cell efficiency may be broken down into reflectance efficiency, thermodynamic efficiency, charge carrier separation efficiency and conductive efficiency. The overall efficiency is the product of these individual metrics.In addition to this, sun's inclination angle also plays a vital role in calculating efficiency of solar panel. The sun's rays with maximum intensity will fall on noon time and it will be minimum on morning and evening.

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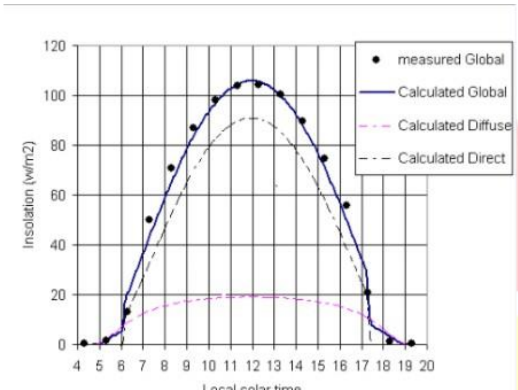
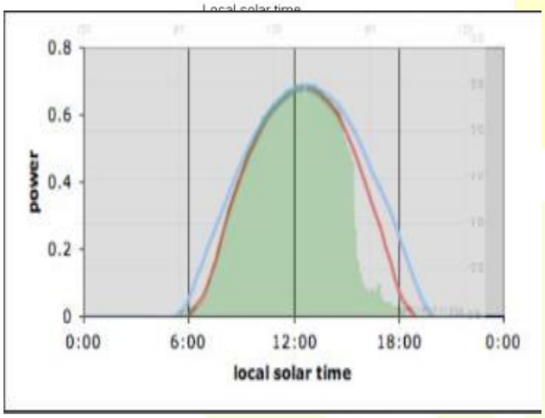
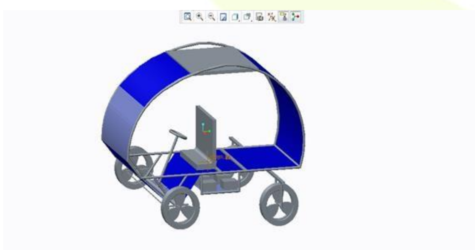
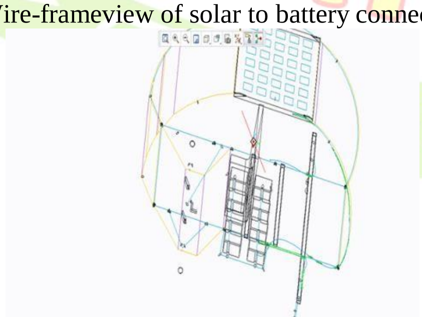




2.Design of car:



2.1Wire-frameview of solar to battery connections



3.Design Calculations:

Braking Calculation:

Assumptions:

$\mu = 0.25$

$C_{braking} = 0.8$

$C_d = 0.43$

$C_{rr} = 30 \times C_d = 12.9$

$V = 30$kmph $= 8.33$ m/s

$A = 2.2m^2$

$r = 225$ mm

Braking Torque $T = F \times r$

Where F is the total force, N

r is the effective radius, m

$F = F_{braking} + F_{drag} + F_{rr}$

$F_{braking} = -\mu \times C_{braking}$

$= -0.25 \times 0.8$

$= -0.4$ N

$F_{drag} = 0.5 \times C_d \times A \times \rho \times V^2$

$= 0.5 \times 0.43 \times 2.2 \times 1.29 \times 8.33^2$

$= 42.34$ N

$F_{rr} = -C_{rr} \times V$

$= -12.9 \times 8.33$

$= -107.46$ N

$F = -0.4 + 42.34 - 107.46$

$= -65.52$ N

[*(-)ve sign for opposite direction]

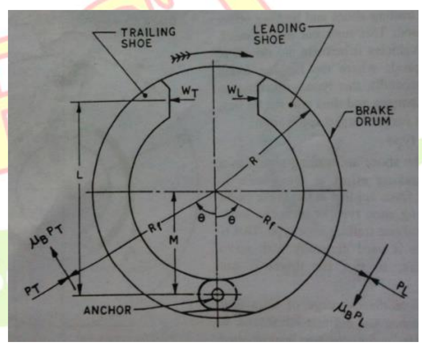
$T = 65.52 \times 225$

$= 14742$ N-mm

Required braking torque = 14742 N-mm

The obtained torque is a theoretical one. In order to get desired braking effect in the given time a torque which is approximately 1.5 times of the obtained torque is needed.

To find analyse the torque produced in trailing and leading shoes let us assume the dimensions of drum from standard values according to the design diagram



$R = 60$mm $R_f = 70$mm, $M = 50$mm

$W = 80$ lbs $= 356$N, $L = 80$mm , $\mu_b = 0.5$

$\theta = 90^\circ$

$$T_l = \frac{W x L x \mu_b x R_f}{M - \mu_b x R_f}$$

$$= \frac{356x80x0.5x70}{50 - 0.5x70}$$

$T_l = 21.151$N-m

$$T_t = \frac{W x L x \mu_b x R_f}{M + \mu_b x R_f}$$

$$= \frac{356 \times 80 \times 0.5 \times 70}{50 + 0.5 \times 70}$$

= 18.12 N-m

$$\text{Brake force} = \frac{\text{Brake torque}}{\text{Rolling radius}}$$

$$= \frac{21151}{225} = 94N$$

$$\text{Braking deceleration} = \frac{2 \times \text{brake force}}{\text{Vehicle weight}}$$

$$= \frac{2 \times 94}{160}$$

$$= 1.13\ m/s^2$$

Half Steering Calculations:

Assuming average steer angle to be 65̊

Turning circle radius = (track/2) + (wheelbase/ sin (average steer angle))

= 1200/2 + 1200/sin 65̊

= 1.924 m

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