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Design And Fabrication Of Foldable Tri-Scooter

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ABSTRACT
The basic aim behind our project was to make an environmental friendly portable automobile which would be easy to handle by both the sexes and would emit 0% emission. We have used D.C motor as our main power source due to which there is no emission at all and also the problem of fuel consumption is solved. Also keeping in mind the parking problems now days, we decided to make a triscooter which can be folded easily, so after the use one can fold the triscooter and can carry it along with him/her. Our design allows users to easily transport the triscooter using less space when it is "folded" into a compact size. We have made this design with our own innovative ideas and by referring some books and websites .Our project is unique and no foldable triscooter is available in market till now. The versatility of a folding triscooter is also appropriate for air travel and inadequate storage and at places where bike theft is a significant concern.
While designing we have concentrated on power, economy, ease and comfort of riding and low maintenance cost .Also we have concentrated on ergonomics factor to give the user a comfortable ride.
Keywords – portable, environment friendly, economic, no emission

I. INTRODUCTION

Main aim of our project was to design a portable automobile which should be very easy to carry as well as easy to handle by both the sexes with equal ease. The aim was also that it should be environmental friendly and should be non-polluting

II. OBJECTIVE

2.1 Folding ease: Folding should be easy, stress-free, and take no more than 10 minutes after user becomes familiar with the tri-scooter.

2.2 Portability: It should be easily transportable for both women and men. It should be easy to handle and should be portable.

2.3 Reliability: It should have a stable ride, confident feel, and similar performance to a conventional bike. Fit various sized people, should be easy to maintain and reliable.

2.4 Retailer Network: Program should offer two to three price points such as a 'good, better and best' philosophy. Sales and service should be very convenient and available to users via local retailer networks.

III. COMPONENTS

"FOLDABLE TRISCOOTER" is the electrically operated consisting of the following different sub-components:-
D.C. Motor, Frame, Charger, Battery, Wheels, Drive, Tricycle.

3.1 D.C. Motor: The motor is having 250 watt capacity with maximum 800 rpm with torque capacity of 50 Nm. Its specifications are as per the following:-

- Current rating - 14 Ampere
- Voltage rating - 24 volts D.C.
- Cooling - air cooled
- Bearing - single row ball

3.2 Frame: It is made from the mild steel body along with some of the light weight components, welded in suitcase shape which serves as the base to hold all the accessories such as motor, weight of the load to be conveyed and the weight of the person driving the unit. Also it should be able to overcome the stresses, which are coming due to different driving and braking torques and impact loading across the obstacles in the traveling ways. It is with the linkage and wheels to propel it and the platform plates. It is drilled and tapped enough to hold the support plates.

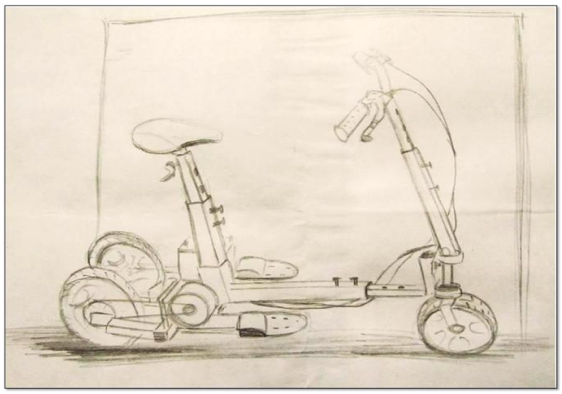

Fig 3.1: Predesign concept

3.3 Platform: It is the robust base for holding the uniformly or concentrated load along with the weight of the driving person. It is manufactured from the mild steel SQ pipe welded in suitcase shape with top sheet of 3 mm thickness. Platform is directly bolted and welded to the framed platform; the alignment of the platform is always kept perfectly horizontal while it is loaded or un-loaded.

3.4 Battery: It is the accumulator of electric charge. It must store the electrical energy produced by the generator by the electrochemical transformation and give it back again on demand. E.g. while starting.

3.4.1 Construction: The basic element of battery is the cell. It contains the plate block which consists of a set of positive plates and a set of negative plates. The individual plates are separated from one another by separators placed in between. The cell is filled with the mild sulphuric acid. The block cases e.g. of a 12V battery, is divided in to six cells that are mutually sealed and are tightly closed at the top by the block case cover. The individual cells are connected in series by the cell connector. At the first and the last set of plates, the end poles are welded.
Following are the different components of battery:-

- Block case, block cover:

It is manufactured from acid resistant insulation material, partly from the hard rubber, mostly from plastic e.g. polypropylene.

- Plates:

These are manufactured from lead grid with embedded highly porous effective mass from very small lead particles (positive plates). The effective mass is chemically transformed while charging and discharging.

- Separators:

Micro porous insulation plates from acid-resistant plastic. They prevent contact between positive and negative plates, but must allow the electrolyte to pass through.

- Electrolyte:

It is the Mixture from chemically pure sulphuric acid (H2SO4) and desalinated or distilled water. The electrolyte should not be made impure by the mineral salts of water.

The sulphuric acid is separated into columns of positive H ions and negative SO4 ions by mixing with water. If the poles of the cell are connected by a load (incandescent lamp), electrons flow from the negative pole to the positive pole. Due to the scarcity of electrons at the negative pole, bivalent positive lead is produced from the neutral lead which combines with the bivalent negative SO4 group to form lead sulphate PbSO4.

At the positive pole, bivalent positive lead is produced from the quadrivalent positive lead of the oxide through the electron supply. The combination with O2 is therefore ruled out and a combination with SO4 is introduced, leads sulphate PbSO4, and is likewise produced. The oxygen atoms released combine with the hydrogen atoms of the electrolyte to form water. The density of the battery decreases.

3.4.2 Discharged condition: Positive plates, effective mass lead sulphate PbSO4 negative plates, effective mass lead sulphate PbSO4, Acid density 1.12 kg/dm3, Acid density in degree160, Cell voltage, unloaded 1.75 V.

High current discharge while discharging with high currents, e.g. while starting, it is to be noted that the water formed in the inside of the plates must mix with the remaining acid. The battery therefore needs relaxation pauses during high current discharges.

3.4.3 Deep discharge: Complete discharge of a battery must be avoided since the resulting lead sulphate has a larger volume and therefore there is the danger of breakage of the effective mass from the plate grid. Deep discharged batteries should be immediately recharged.

IV. DESIGN CALCULATIONS

4.1 Choosing the DC Motor:

In order to choose the required DC motor that can do the job, we conducted a theoretical study that aims to help us choose the optimal type and size of DC motors.
R: Incline reaction to cycle weight.
Ƒx: friction force.
W: cycle weight
Predefined parameters,
Maximum mass of cycle with person = 90 Kg
This mass accounts for both the mass of the cycle approximated to be equal to 30 Kg, and the mass of a standard user which is about 60 Kg.
• g = 9.81m/s2

- Maximum angle of inclination: αmax = 37°. According to the international laws for transportation the maximum slope angle should not exceed 37°.
- Coefficient of friction: μ = 0.5 - 07, we will assume the value μmax = 0.7, to account for the worst possible conditions.
- Wheel Radius: R = 21cm = 0.21 m
- Wheel perimeter: P wheel = πd =0.66 m
- Assuming the required acceleration: ax = 1 m/s2
- The average velocity of the cycle is: V avg = 5 km/h = 1.39 m/s

Weight of the Cycle W= M × g = 90 × 9.81 = 883 N
Reaction of the incline R = W cos (37°) = 705 N
Friction force Fx = μmax × R = 0.7 × 705 = 493 N
Weight in the direction of the movement Wx = W sin (α) = 883 sin (37°) = 531 N
At equilibrium,
∑ FX = F - *f*x - Wx = 0
F = *f*x + Wx = 493 + 531 = 1024 N
Propulsion force (initial force),
Propulsion force F = 1024 N
Torque at the wheel, T = F × R = 1024 × 210/2 = 1075 N.mm

Calculation of rpm,
V = 20 km/hr. = 5.5m/sec
V= πdN/60
N= 60 x v/πxd
N= 454 rpm
T = 1075 N.mm
Available dc motor in market 250W & 2500 rpm so we have to design transmission to achieve torque of 1075 Nm at 454 rpm:
To find new torque T'
T' =P x 60/2πN
= 250 x 60/2π x 2500
T'= 0.95 N-m
T = 950 N mm
Transmission ratio=5
Final torque = 950 x 5= 4750 N-mm
& new rpm = 2500/5 = 500 rpm
Hence final speed v = π x 0.21 x 500/60
V=5.49 m/sec = 19.78 = 20 km/hr.

As generated torque and speed is more than required value so design of motor is safe[2].

4.2 Design of shaft:

Shaft subjected to twisting moment
T= (π/16) x τ x d^3
Hence d = 3√ ((T x 16)/(π x 300))
Hence d=4.32 mm ---- (i)

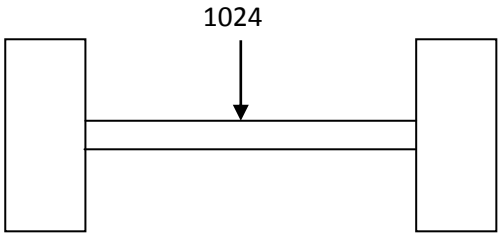

Fig 4.1: Shaft

Shaft subjected to bending movement,
M=WL/4 = (1024 x 400)/4 = 102400 N-mm
Bending stress for shaft material, fb = 620 N/mm2
Hence fb = M/Z
Fb = M/ ((π/32) xd3
Hence, d = 11.59 mm i.e. 12 mm (approx. for standard design)
So we select bigger size for shaft i.e. 12 mm[5].

V. EXPERIMENTAL ANALYSIS

5.1 Known Values:

Road condition: 1 km plain surface with no turns
Battery condition: fully charged
Weight of driver: 75kg
Motor rpm: 2500
Output rpm: 454
Tire inflation: 20 psi

5.2 Observations:

Initial time = 00:00:00,
Final time = 00:02:34.
So, Time required for 1 km run = 2 minutes 34 sec
=154 sec

5.3 Calculations:

Speed = distance/time = 1/154
= 0.006493 km/sec
= 23km/hr.

5.4 Conclusion:

The theoretical speed and the practical speed were found to be nearly equal.
Theoretical speed=20km/hr.
Practical speed =23km/hr.

VI. ADVANTAGES:

6.1 Advantages:

6.1.1 Easy to handle by both the sexes
6.1.2 It travels a kilometer less than a rupee
6.1.3 Portable and compact
6.1.4 40-45% reduction in diameter is observed
6.1.5 No pollution, it emits 0% emission
6.1.6 It is environmental friendly
6.1.7 Requires less parking space
6.1.8 It is noise free

6.2 Disadvantages:

6.2.1 It is heavy as the material used is mild steel
6.2.2 Battery charging takes more time
6.2.3 Small tires so easy wear and tear

VII. MAINTENANCE

7.1 It is required to grease the sliding parts.
7.2 The wheels shaft is to be replaced if worn out.
7.3 The level of dilute chemical H2SO4 in the battery should be kept up to the prescribed mark.
7.4 The wheel bearings are replaced if it gets worn out, are sometimes reconditioned.
7.5 It is required to color if color is damaged periodically.
7.6 The nut bolts are required to be replaced when it is damaged.
7.7 The shaft-bush is replaced after periodic use if the play occurs in the wheel shaft.
7.8 Circuit components are cleaned periodically to keep it free from the dust or should be replaced if not working properly.
7.9 The lead plates in the battery are to replace periodically after it loses the capacity to store the energy.
7.10 Periodically check the tension in chain.
7.11 The welding of different parts should check periodically.
7.12 Oiling of rotating parts should done once a week

Following general safety precautions are required to be taken:-

- Do not touch the transformer circuit when circuit is in operation.
- Do not apply excessive load on the tricycle more than its capacity, for this particular model or else some component may get damaged.

It is easy for the maintenance and service as only oiling and greasing is required for the sliding parts. It requires very less skill for its operation because anybody can drive the vehicle. Emission is zero as it works on a dc motor.

While running the vehicle, it does not produce noise so it is totally ecofriendly. As there are no gears and clutch in this vehicle, it is extremely reliable, safe and easy to handle also easy to drive in traffic areas. It can be handled by both the sexes with equal ease. They are ideal for 'start- stop' conditions. 40 – 45 % reduction in diameter is observed after folding the vehicle.

VIII. CONCLUSION

The running cost of the vehicle is approx. less than a rupee per kilometer as the power source is on electricity. The vehicle can run on an average of 7-8 km on a single charge.

REFERENCES

Following different references we have taken to make our project a successful creation. We have collected the literature from the following:-

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