

## **DEVELOPMENT OF A CYCLE RICKSHAW ASSISTED WITH BATTERY POWER**

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A battery operated DC motor drive for better comfort, and pollution free transport system for a cycle rickshaw is described. Six versions of cycle rickshaws were fabricated with changes in main frame, power transmission, seating capacity and speed control system. All the vehicles have been fitted with two lead acid batteries and DC series motors. Provisions are made to use any type of high energy density battery.

### **INTRODUCTION**

The world is facing the problem of scarcity of fossil fuel, and the automobiles using petrol or diesel are also causing noise and air pollution. The pollutants emitted from the engines in automobiles cause severe problems to human health. Recent reports indicate that the scientists have noted the evidence of global atmospheric changes due to the emission of pollutants from automobiles [1,2]. The estimated petroleum reserve in India is 300 million tons [3]. With the increasing rate of consumption of petroleum products, the reserve may last for twelve more years only. For the future requirements it may be necessary to import petroleum products from other countries. The air pollution on one side and the escalating price of petroleum on the other side are threatening the public transport, which is one of the major consumers of petroleum products. Hence the development of a suitable transport system which is free from pollution and independent of fossil fuels has become must in the near future. In this Institute, a project on 'Battery powered electric vehicle' is going on with the aim of developing an electric vehicle for the transport of passengers. This paper mainly deals with the design and fabrication of a battery assisted cycle rickshaw which is suitable for suburban road conditions.

#### **Pedal operated cycle rickshaw**

In India, pedal operated cycle rickshaws are more popular in suburban areas. The design configuration most commonly used is the tricycle, with two wheels at the back and a front wheel with steering action. The drive force is transmitted to the rear axle by the pedal-crank movement through chain and sprocket system. The power to the pedal driven cycle rickshaw is obtained from human muscle action. The speed of the cycle rickshaws will be around 8-12 kmph. To increase the speed of the vehicle upto 30 kmph, an assistance by means of a small two stroke engine is employed. The noise from these engines and structural members is always in high level. Hence a noise-free and pollution-free vehicle is required under these conditions.

#### **Utilisation of manpower**

When an electric vehicle (EV) is used for suburban area the manpower may also be used to augment the costly electric power from

batteries. Hence a pedal operated drive system was also included in the design stage itself. The manpower or the driver's muscle energy is used to assist the power from electric motor in extreme conditions like gradient, wind resistance and run down of batteries.

#### **Selection and design of EV**

The major problem in the design of electric vehicles arises due to the increase in gross vehicle weight. To combat this problem, the following modifications may be done. The frame or chassis of the vehicle can be redesigned introducing tubular structural members instead of solid sections. The conventional tyres are replaced by nylon fibre reinforced tyres to withstand additional loads with reduction in wear and tear. Unnecessary peripheral members are eliminated to reduce the overall weight of the vehicle. The speed and range of the vehicle are also selected to suit the lighter structural frames and increased weight of the vehicle. DC series motors are used in the road transport due to the fact that its torque/speed characteristics are ideal for traction duty. Speed of DC series motors is controlled by varying the magnitude of DC voltage across the motor, and by means of SCR chopper, which acts as a semiconductor switch in between supply and motor and operates at a high frequency of 200 cycles per second. A transistorised version of control is also being used to control the applied voltage across the motor terminals. The cheaper mode of control of DC motor is by simple series-parallel logic circuit system. With all these incorporations a suitable design has been evolved for a three wheeled rear axle driven 'battery powered cycle rickshaw'.

#### **Fabrication of chassis**

Fig. 1 shows the schematic diagram of the fabricated battery powered cycle rickshaw. Standard bicycle components available in the market were used for fabrication purpose. The main frame was fabricated out of thin mild steel sheets. The drive motor and batteries were positioned in such a way that they are occupying minimum space. The centre of gravity of the vehicle is well within the three wheel centres. The wheel base was kept same as the conventional pedal powered cycle rickshaws. Depending on the number of passengers i.e two or three, the dimension of track width and seating were changed. The suspension system was provided with flat leaf springs with sufficient damping. The position of

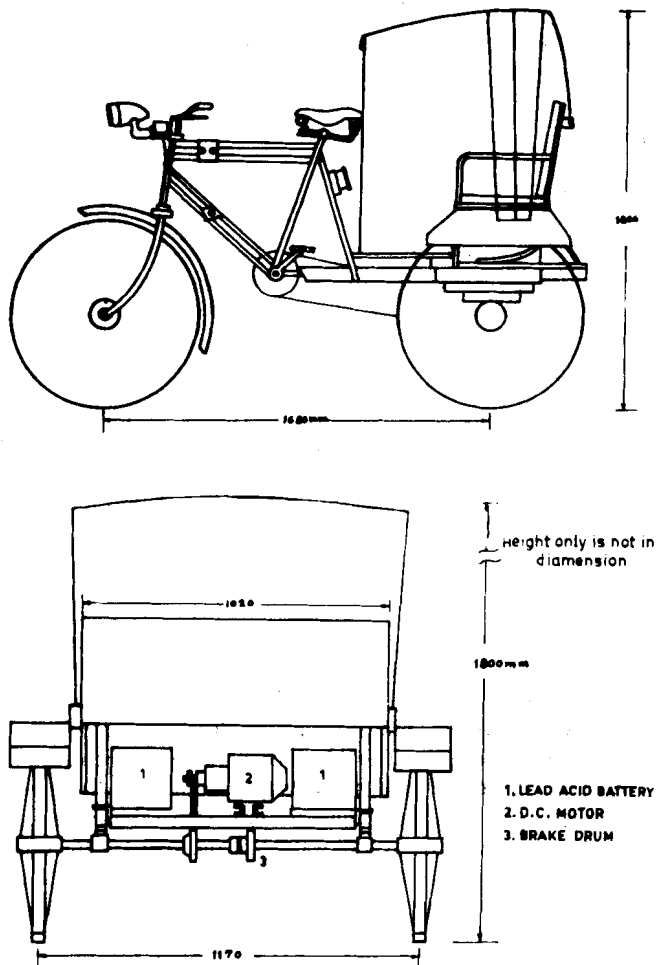


Fig. 1 : Rear side view of battery assisted cycle rickshaw

driver's seat in the layout was followed to be same as the conventional cycle rickshaw. The major dimensions of the vehicle are enlisted in Table I. The material of construction for the seating were FRP, U foam, rexin cloth only.

**Drive system**

A series motor, with specifications given in Table II, was employed for getting the propulsive force. The rated power and speed of the motor shaft are 0.55 kW and 1800 rpm respectively.

A speed reduction in the ratio of 11:1 was achieved by a chain and sprocket transmission in two stages. Heavy duty chains were used for transmission of power from motor to rear axle. In one of the rickshaws, a gear train in the speed ratio of 3:1 was adopted in the first stage speed reduction. Along with the motor drive a pedal operated drive was also provided to power the vehicle in extreme conditions. In case of complete discharge of batteries, it is possible for a driver to operate the vehicle by pedalling upto a distance of 10 kms or even more.

**Details of a battery powered cycle rickshaw**

TABLE-I: Vehicle specification

Wheel base (mm)	: 1680
Tyre radius (mm)	: 350
Overall length (mm)	: 2350
Overall width (mm)	: 1350
Overall height (mm)	: 1720
Pay load (2 passengers + 1 driver + luggage) (kgs)	: 200
Chassis + body weight (kgs)	: 118
Motor weight (kgs)	: 18
Battery system weight 2 Nos. (Kgs)	: 84
Control system weight (kgs)	: 3
Gross vehicle weight (GVW) (kgs)	: 423
Differential ratio motor to wheel	: 11:1 Chain in drive
Transmission	: Chain drive/Gear drive from motor to wheel
Brake	: Mechanical system

TABLE-II: D.C. Motor specification

Type	: Series
kW	: 0.55
Voltage (V)	: 24
Rated current (A)	: 32
Duty	: 1 hour rating
Speed (rpm)	: 1800
Insulation	: Class 'F'
Overload	: 60 A. 24V (nominal) for 90 sec.
Overall length (mm)	: 215
Overall height (mm)	: 205
Weight (kg)	: 18

**Power source**

Two numbers of lead-acid batteries, with specifications given in Table III, were used.

TABLE-III: Lead-acid battery system

Rated voltage (V)	: 24
Rated capacity (Ah)	: 90 (C5)
Battery configuration	: 2 Nos. 12 V module in series
Battery dimensions (mm)	: 510 x 220 x 240
Battery weight (single unit) (kg)	: 42

The vehicles were fitted with different control systems, like

(a) Series-parallel logic circuit (b) Transistorised version (c) SCR chopper version.

The speed of the vehicle can be controlled by a turn-knob operated by the driver. The control systems have been positioned where the vibrational disturbances are minimum. The brake system adopted was a simple band brake type, and is actuated by the pedal-lever arrangement.

Among the six numbers of fabricated battery powered cycle rickshaws, two were having 3-seat capacity and the others 2-seat capacity. One vehicle was having main frame fabricated with solid angle and others were having tubular frames.

#### Performance of the vehicle

Road tests were carried out on the fabricated vehicles. The speed of the vehicle and current demand for the motor were measured using on board fixed speedometer and DC ammeter. Table IV gives the speed and corresponding current demand. The acceleration

TABLE-IV: Speed of the cycle rickshaw and the corresponding current demand

Speed (Kmph)	Current (Amps)
0	50
18	44
19	39
20	38
25	33
28	28

capacity of the vehicle was 0-15 kms/hr in 35 seconds. The range of the vehicle was assessed as 60 kms per charge with a few start and stops.

#### CONCLUSION

The newly developed battery powered cycle rickshaws, as per this improved design, are suitable for suburban and rural use, and they are free from vibration, noise and air pollution. They are economically feasible on mass production.

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