



DEVELOPMENT OF HYBRID TRICYCLE

Sumit A. Gedam
Assistant Professor,
Department of
Mechanical
Engineering PRMIT
&R, Badnera,
(Amravati)
sumitg448@gmail.com

Parag B. Jawanjal
Assistant Professor,
Department of
Mechanical Engineering
PRMIT &R, Badnera,
(Amravati)
parag22j@gmail.com

Chetan R. Bundele
Assistant Professor,
Department of
Mechanical Engineering
PRMIT &R, Badnera,
(Amravati)
bundelechetan@gmail.com

Dr.Satish G. Bahaley
Professor,
Department of
Mechanical Engineering
PRMIT &R, Badnera,
(Amravati)
satishbahaley@gmail.com

Abstract-

Mobility being an issue for the handicapped people, there has been an introduction of many different kinds of vehicles. The options are limited as very few automobile industries focus on them. The cost of these vehicles is another issue. Some of these people cannot afford the vehicle. Also, after buying the maintenance of these vehicles is very high and periodic. Therefore, keeping these issues in mind, an eco-friendly tricycle has been designed. This work aims to reduce the cost, increase the speed. Safety of the handicapped has been taken care of by means of various safety measures. This tricycle is manufactured with an intention that it could be used in the college premises as well as for long route of travel up to few kilometers by a handicapped person & a normal persons.

Keywords— Tricycle, Physically Handicapped, Eco-friendly, Electric Motor.

INTRODUCTION

Mobility plays a vital role in social life of a human being. For that sake different vehicle have been developed but almost all of them produced for normal person. As far as a physically handicapped person is concerned, there are limited vehicles available for personal use. Vehicles for a disabled person either of custom made or conventional hand operated tricycle. They meant to fulfill basic functional need and seldom put the emphasis on other factors. Most of listed options have poor aesthetics or cost issues. A conventional mechanical tricycle makes it hard to drive in poor road condition or on a gradient. A modified scooter require regular maintenance and operating cost is comparatively high. Smart wheelchairs is also an option but it is suitable for short distance and cost associated with such chair is higher. Even though Previous options has given different design which are sophisticated but failed to consider many factors like weight, cost, simplicity, emission and operational cost. This project aims to mitigate the above listed problems by designing and fabricating a tricycle which will be driven by an electric motor with simplified electric drive system. The transportation of handicapped within the premises of hospital as well as large other premises of colleges is possible with this tricycle. It could be a convenient and time saving alternative for physically challenged peoples & there caretakers.

LITERATURE REVIEW

There are various different types of vehicles developed for physically handicapped persons like Modified Scooter driven by IC Engine, Scooter operated by Solar Power, Smart Wheelchair; cost of latest scooter is around 65000Rs. Solar tricycle requires photovoltaic cells which are expensive. Following are the few tricycle models which were considered in the literature

Upendra S. Gupta *et. al* developed tri-cycle which can be powered by two humans simultaneously and also by a 373 Watt Geared PMDC. It is an eco friendly human powered vehicle with a compounded electric drive system.. The tadpole type of trike has two wheels in the front and one wheel in the rear. A Tadpole trike's front-end exhibits less acceleration than the rear end when turning. This allows the trike to negotiate corners at great speed and stability. The concept used in the innovation is programmable position control of gear shifter using stepper motors. Position of motors is controlled with respect to speed by programming which in turn controls the position of gear shifter. This technology is used in robotics & position controlling of robotic arms. It has got a wide scope in automotive industry as it reduces the efforts of driver & provides more automatic control of the vehicle.

Ajit Mohekar *et. al.* designed a retrofitted tricycle by modifying the existing scooter. He also design special platform arrangement so a wheelchair occupant can easily hold or leave the tricycle. This trick can be used for a long distance making it suitable for long journey too.

Ravikumar Kandasamy *et. al.* have developed solar operated tricycle for physically handicapped person and he made it especially for an NGO started by Baba Amate. Main components of tricycle were Solar panel (Photovoltaic cell) and frame to support panel, PMDC motor, Battery and charger controlling unit. Ravikumar developed a completely pollution free tricycle.

III. DESIGN METHODOLOGY

Weight estimation

The above table shows the weight distribution of the tricycle. The weight distribution is 50:50 front to rear ratio. The weight has been kept low as the speed does not exceed 25kmph. The vehicle below 25kmph does not require registration.

TABLE I

Weight of Chassis:	56 kg
Weight of Battery:	11 kg
Weight of Accessories:	28 kg
Weight of Tricycle:	90 kg
Miscellaneous:	20kg
Total weight:	250 kg

Component selection

The major components of tricycle are BLDC Motor, Controller, Lithium ion battery, Brakes, Suspension. Based on various considerations like stability, etc. the tadpole design is selected. The solid models are created using the CATIA V5R21 and analyze on ANSYS. The iterations are done for steering system to get the required turning radius. The dimensions of the steering system component are done by iteration on the CATIA V5R21.

Drive Train- Electric

In electric drive the power of motor is given to the rear wheel by the chain drive. The motor has a torque of 10Nm and 500rpm the power is 600W. To drive the vehicle at a speed of 35 kmph and provide a rated torque about 10 N-m. Standard available motor is in capacity of 600 watt. Thus we have taken a Brushless DC motor.

Specification of selected hub motor.

Type: Brushless DC Motor

Power:600 Watt

For velocity, $\text{Power} = F_{\text{level}} * v$,

$v = 8.3463 \text{ m/s} = 30.047 \text{ km/hr}$

And $v = r_w * \omega$, $\omega = 27.3831 \text{ rad/sec}$

$N = 261.4893 \text{ rpm}$

$\text{Torque} = F_{\text{level}} * r = 57.5099 * 0.3048 = 17.52901 \text{ Nm}$

The gear ratio for motor is 2 and hence the torque obtain on rear wheel is 20Nm approx.

Acceleration:

$\text{Tractive force} = (\text{Torque} * \text{Gear ratio} * \text{transmission efficiency}) / 0.3048 = 64.304461 \text{ N}$

And total resistance is 57.5099N.

(1)

(2)

Thus,

$$\text{Acceleration} = (64.3044 - 57.5099) / 250 = 0.02717 \text{ m/s}^2$$

Steering System

The steering system is used to steer the vehicle on road. The mechanical advantage is given to the steering system it will minimize the effort required to the driver. The four bar chain mechanism is used and the geometry used is Ackerman's Geometry which reduces the complexities in the system. The steering handle is provided with the steering column which is connected to the intermediate link which is plate. The motion is given to the secondary link through which the motion is transferred to the steering knuckle and hence to the wheels. The iterations are made on the CATIA V5R20 to reduce the improper dimensions of the links and hence the dimensions are taken from the iteration. The turning radius is found to be 2.81 m. The turning angle for inner wheel is 35 degrees and for outer wheel is 20.832 degrees.

TABLE II

Specification	Values
Left steering arm	150 mm
Left upper arm	100 mm
Right steering arm	150 mm
Tie rod length	1040.10 mm
Secondary link length	845.61 mm
Handle length	467.2 mm
Turning radius	2.81 m
Outer wheel angle	35 degrees
Inner wheel angle	20.83 degree

Suspension System

REAR SUSPENSION: The two suspensions are provided to avoid the high spring rate. It may be discomfort while using the single suspension. The maximum weight is transferred at the rear side.

FRONT SUSPENSION:

The front suspension used is rigid suspension and the fork is avoided. The following are some advantages over the fork: i) The forces on the wheels are from various directions they can be sustaining on the knuckle. ii) The bending is avoided. iii) The weight of the vehicle is reduced because the side frame is not included.

$$\text{Deflection of Spring} = 55.974 \text{ mm}$$

$$\text{Pitch} = 18.26 \text{ mm}$$

$$\text{Free Length of Spring} = 164.37 \text{ mm}$$

$$\text{Spring Rate} = 58.82 \text{ N/mm}$$

$$\text{Stiffness} = 58 \text{ N/mm} = 331.18 \text{ lbs/inch}$$

Wheels & Tyres

The rear wheel is responsible for the top speed and torque required. Therefore according to the best condition the rear wheel selected is of 24 inch diameter. For the effortless steering the wheel diameter is selected as 20 inches. Because of selecting the rear wheel of 24 inches the optimum speed we get and reduce in torque requirement

Breaking system

Types of braking system used are disk brakes on all the three wheels. The major advantage of disk brakes is as follows: i) They provide excellent and reliable braking. ii) The problems with brake fading and sensitivity to the moisture have both been remedied by the advent of the disk brake system. iii) The disk brake applies a set of flat pads on opposite sides on revolving rotor. Since both brake pads and rotor surface are flat, the brake is infallible to fading or moisture buildup. So they can be used in wet weather condition as well. They have good heat dissipation property and high torque transmitting

capacity. One of the main perks of the mechanical disk brake is that the cable are far easier to install. Replacements to the cable can be found very easily, at any bike shop around the globe, because the same cable is used.

Seats

Two recumbent seats inclined at 28 degrees are provided in the vehicle for each driver. Seats are fabricated from plywood and cushion is provided for the comfort of drivers. Seats are mounted on the vehicle frame using quick release bolts.

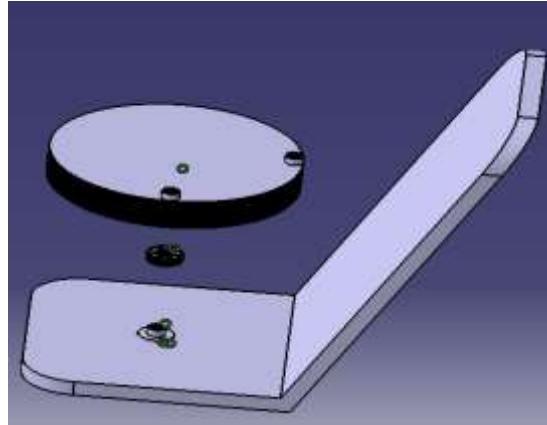


Fig.1 Seat

Safety features of vehicles

Chassis Safety: Upon analysis of the vehicle under front, side and rollover impact the roll cage of the vehicle was not affected hence reiterating the feature that the drivers will be safe under important driver safety. 1) The 3 point seat belt system will be employed. 2) OEM seat belts will be used. 3) The roll cage as in analysis is also safe from heavy front, side and roll over impact. Driver safety: 1) The 3 point seat belt system will be employed. 2) OEM seat belts will be used 3) The roll cage, as in analysis is safe from heavy front, side and roll over impact Miscellaneous:

- 1) All sub-systems are properly covered by metal sheets.
- 2) Proper lubrication of chains will be done at regular intervals. 3) A kill switch has been given between the driver and easily accessible to both of them in case of emergency.

Ergonomics & Comfort

Comfort features provided for drivers:

Seats reclined at 28 degrees for an optimum ease in ride and proper visibility.

Easy entrance and exit from the vehicle.

Easy steering handle provided.

Rear suspension increases ride comfort and reduces the effect of the bump



Fig.2 Hybrid Tricycle

IV CONCLUSION

In the present work major design considerations of a hybrid tricycle are discussed, such vehicle aims of helping people with physical disabilities to move in college premises and large institutions. Various tricycles are available in the market & new varieties are been continuously designed and fabricated but the one discussed above can prove one of the cheapest. The model has been tested successfully for its endurance. The vehicle is a cost effective solution to reach institutions big or small. The maintenance is negligible. Various modifications based on requirements can be made.

REFERENCES

- Upendra S. Gupta, Sumit Chandak, Devashish Dixit, "Design of Efficycle - Human Powered Hybrid Tricycle with inbuilt Programmable Position Control Gear Shifter using Stepper Motor"; International Journal of Engineering Trends and Technology (IJETT) – Volume 19 Issue 3 – Jan 2015
- Dr. V.K. Saini, Prof. Sunil Kumar, Amit Kumar Shakya, Harshit Mishra, Design Methodology of Steering System for All-Terrain Vehicles, International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 05 | May -2017
- SAENIS Efficycle rulebook season-09.
- Hardikkumar Gadher, Tejashkumar Patel, Chirag Modi, Zeel Bhojani, Design and Optimization of Steering, International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 10 | Oct -2017
- A.A. Mohod, Design of an innovative retrofitted tricycle for a disabled person, IJARSE., vol. 4, Issue 07. 2015, pp.275–288.
- R. S Khurmi, J. K. Gupta, A textbook of Machine Design, S.Chand Publications, 2005.
- Dr.Kripal Singh, Automobile Engineering Vol-I & Vol-II, S.Chand Publications,2014.

