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Design And Development of Speed Reduction Kit For Hybrid Cycle Rikshaw

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Abstract

Most of the transport (Specially in the crowded area and Short Distance Travel) vehicles prevailing in the cities of developing countries(Mostly India and Pakistan)are accountable for noise and air pollution, with the exception of human powered vehicles (HPV). However the human powered vehicles running commercially need a lot of physical effort to drive. A motor assisted battery driven Hybrid rickshaw can provide a relatively comfortable non-polluting and a silent transport system for urban and rural areas of India. The primary focus of this research was to develop an Electric Hybrid Rickshaw without requiring significant changes to the structure of widely popular existing rickshaws. In fact, it is a combination of a battery operated motor driving system with the existing pedal arrangement. This would allow the use of relatively smaller motor and storage batteries for automation as well as reducing human effort while keeping the option of full human- power drive readily possible. The performance test revealed that the hybrid vehicle provides satisfactory speed, easier motion control and a good scope of manipulating the shares of human effort and motor power. Besides reducing air and sound pollution, such rickshaws–demanding less physical effort, may provide large scale employment in urban and rural areas of India.

Keywords—*Hybrid , Cycle Rickshaw ,Battery, Employment, Urban , Rural.*

1. INTRODUCTION

E Rickshaws Are Small Vehicles With 3 Wheels & Use Electrical Power From Battery. To Run. The first cycle rickshaw introduced in India by Reverend J Fordyce. Cycle rickshaws are often hailed as environment-friendly and an inexpensive mode of transportation. It is considered as Indian traditional ride they are almost used in each and every part of India which includes villages, small towns, metros, heritage sites etc. In metros these are used inside institutional areas, market places and also in narrow and crowded lanes where there is accessibility problem for vehicles.In conventional Cycle Rickshaw, It is found that sometimes the continuous pedal forces can cause fatigue on human body and this will effect in reduced efficiency of vehicle.As per current scenario regarding cycle rickshaw by increasing motor power speed of the vehicle also increases which is not desirable and because of high speed CG gets unbalanced.

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2. Literature Review

MADELINE R. HICKMAN Desribes that

Bicycle rickshaws impose significant physical burdens on their drivers. Used throughout India for transportation, these rickshaws are not designed for driver comfort and safety. Instead, traditional rickshaws are only single-speed, with an extremely high gear ratio that makes it difficult for drivers to pedal with large loads. Particularly in India, many rickshaw drivers are undernourished, and the physical exertion required to pedal passengers over rough roads and uneven terrain leads to serious health consequences. A power assist could go a long way towards improving rickshaw comfort and ease of use for drivers by easing the burden on the driver. Despite this, the cost and other constraints on modifications to the rickshaw severely limit which solutions are feasible. Measurements and analysis from the test setup will help determine how much power is needed to develop an effective assist, and which methods of assist can achieve that while staying within the cost constraint and other constraints on the design. The lack of gearing system and high gear ratio on the current Rickshaw Bank model make pedaling passengers incredibly difficult for rickshaw drivers. There are a number of potential solutions to this problem, ranging from an improved gear ratio to a power assist to aid the driver. Thus he presents an overview of the various ways to improve on the current single- speed rickshaw design, with various gearing and assist options like fixed gear ratios, changing gear system, two chain system, power assist, electric assist, mechanical assist.

Mr. Atul Anant Deshpande Describes that

At present many exciting development in electric vehicle technology are taking place. Some of these have advanced sufficiently to be commercially available, whilst others remain for the future. The first demonstration electric vehicles were made in 1830s and commercial vehicles were available by the end of the 19th century. Today's concerns about the environment

particularly noise and exhaust emissions, coupled to new developments in batteries, fuel cells, motors and controllers may swing the balance of electric vehicles. There are many types of electric vehicles such as railway trains, ships, aircrafts, cars, bikes, bicycles, wheel chair and many more. But in this project is focused on electrical powered tricycle which is categorized under Low Speed Vehicles (LVSs) are an environmentally friendly mode of transport for short trips. This vehicle is particularly targeted at fairly active retired people, who still want to get about to see their friends, but who do not travel so hurry and can be used inside a institution like large factories. The objective of the project is to design and develop a concept battery powered tricycle for multipurpose use and to choose the best concept to reduce the mass expensive batteries required. Besides that, to design a tricycle with high efficiency and greater flexibility to place components in tricycle to optimize weight positioning and minimize aerodynamic drag.

M RAGHA LAN. M RAMAKRISHNAN, K R RAMAKRISHNAN, M DEVASAHA YAM, P VEERAMANI, K R EHAMBARAM, P L SANKA R, M PANDIAMMAL and K I VASU Describes that

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The world is facing the problem of scarcity of fossil fuel, and 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 . 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 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 fuels has become must in the near future. In this Institute, 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 bat- assisted cycle rickshaw which is suitable for suburban road conditions

3. Design And Modelling

3.1. Speed Reduction Through Worm And Worm Wheel:-

A worm drive is gear arrangement in which a worm meshes with a worm gear .the two elements are also called the worm screw and worm wheel. The terminology is often confused by imprecise use of the term worm gear to refer to the worm, the worm gear, or the worm drive as a unit.

A gearbox designed using a worm and worm-wheel is considerably smaller than one made from plain spur gears, and has its drive axes at 90° to each other.In early 20th century automobiles prior to the introduction of power steering, the effect of a flat or blowout on one of the front wheels tended to pull the steering mechanism toward the side with the flat tire. The use of a worm screw reduced this effect. Further worm drive development led to recirculating ball bearings to reduce frictional forces, which transmitted some steering force to the wheel. This aids vehicle control and reduces wear that could cause difficulties in steering precisely.

Worm drives are a compact means of substantially decreasing speed and increasing torque. Small electric motors are generally high-speed and low-torque; the addition of a worm drive increases the range of applications that it may be suitable for, especially when the worm drive's compactness is considered.

Worm drives are used in presses, rolling mills, conveying engineering, mining industry machines, on rudders, and worm drive saws. In addition, milling heads and rotary tables are positioned using high-precision duplex worm drives with adjustable backlash. Worm gears are used on many lift/elevator and escalator-drive applications due to their compact size and the non-reversibility of the gear.

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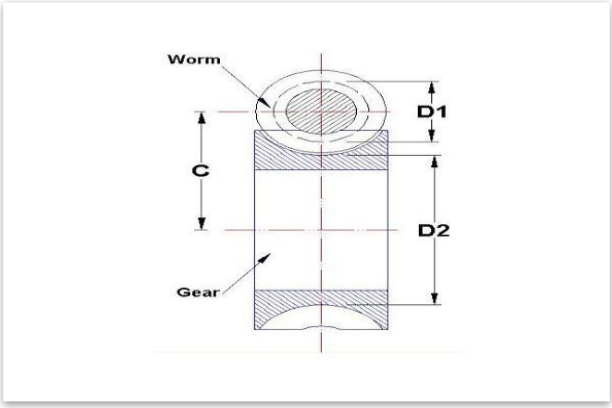

fig.1. worm and worm wheel

Element 1:-

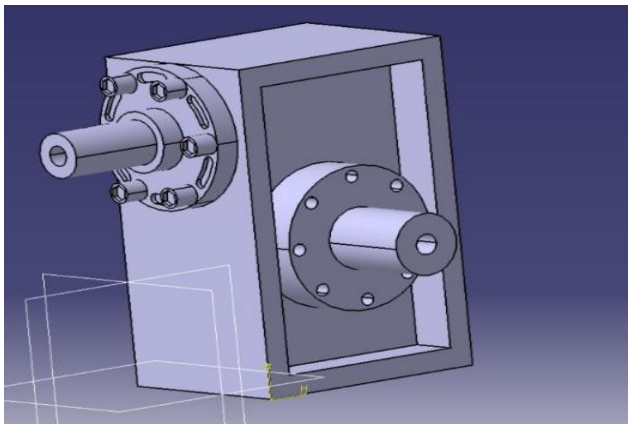

fig . 2..overall view of speed reduction method

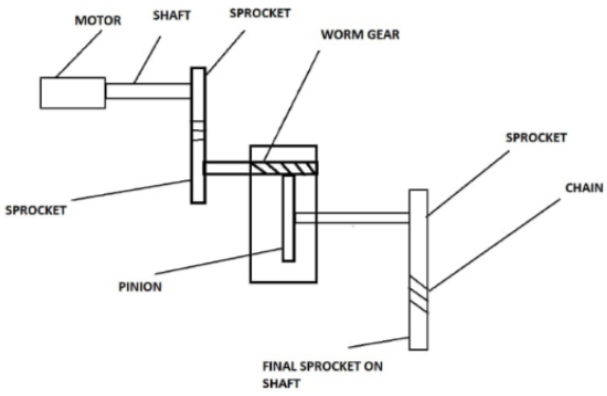

fig. 3 ..actual drive of worm gear

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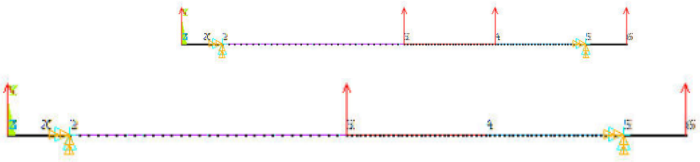
Element 2:-

fig. 4.designed shaft for the transmission

Shaft Design



For Vertical Loading

$\Sigma f_y=0$

$R_A+R_B=-2793.8N$

$MR_A=0$

$1370*95-53.83*425-R_B*850-1370*1040$

$R_B=-1550N$

$R_A=2793.8-1550=-1643.8N$

$R_A=-1643.8N$

$R_B=-1550N$

$M_E=0$

$-1370*520+1643.8N*425=0$

$M_E=-13746.75N$

For Horizontal Loading $R_A+R_B=-6045.3$

$MR_A=0$

$1370*95-305.29*425-3000*637.5-R_B*850-1370$

$R_B=-3925.76N$

$R_A=-6045.3+3925.76$

$R_A=-2119.54N$

$R_A=-2119.54N$

$R_B=-3925.76N$

$M_E=0$

$-3000*212.5+3925.76*425-1370*500$

$M_E=318.54*10^3$ N-mm

$M_E=0$

$-1370*520+1643.8N*425=0$

$M_E=-13746.75N$

$M_F=0$

$-1370*-307.5+3925.76*212.5$

$M_F=412.949*10^3$ N-mm

Resultant Bending Moment

$R_B=\sqrt{[(412.949*10^3)^2+(13746.75)^2]}$

$R_B=413.16*10^3$ N-mm

$0.5*S_{yt}/1.5 =16/ \pi d^3 \sqrt{[(kb+mb^2)+(kt+mT^2)]}$

$0.5*400/1.5 =16/ \pi d^3\sqrt{[1.5*(413.16*10)^2+1.5*(18000)^2]}$

$133.33 =16/ \pi d^3*506.335*10^3$

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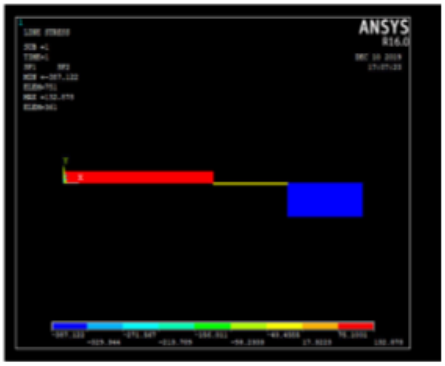
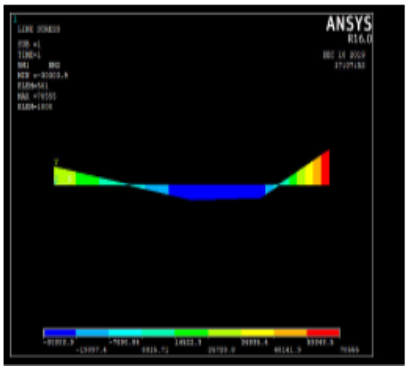
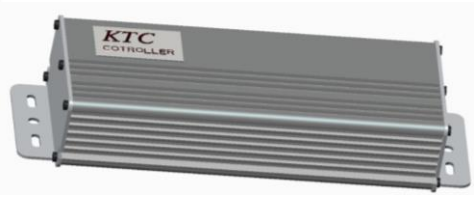
d=27mm





Motor Specification:-



Type	Permanent Magnet BLDC
Power	Rated-600W , Peak -1400W
Rated RPM	500
Torque	Rated 10-Nm
Voltage	48V
Current	Rated-13A, PEAK -32A
Efficiency	~80% on full load and full RPM
Protection	IP 33
Dimensions	223mm x 171mm x 146 mm
Shaft Diameter	Sprocket- 60mm, Shaft-12mm
Weight	Controller- 0.55kg, Motor- 4.60kg

Table .1 motor specifications

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Battery Specification :-

Rated Voltage(V)	48V
Rated Capacity(A-h)	26A-h
Battery Dimensions(mms)	300*170*60
Battery Weight(Kg)	8

Table. 2. battery specifications

Overall Layout Of Transmission System:-

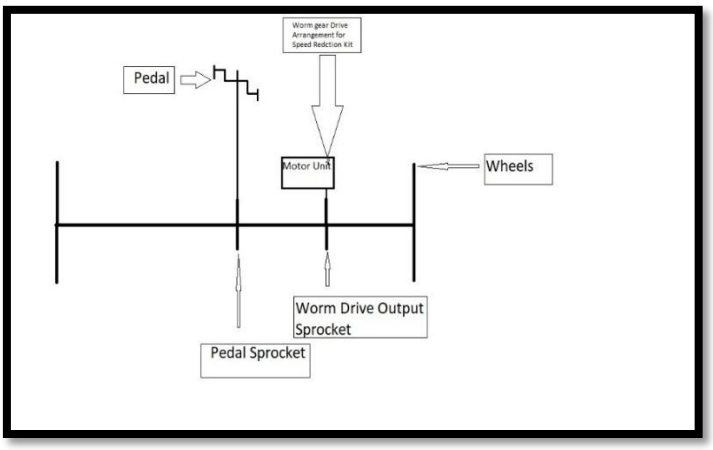

Fig 5. system layout

4. Methodology

1. Market survey:-

For obtaining the required torque we have selected 1 KW power motor.

For supplying power to the motor we have selected Lead acid battery with 48 volt.

2. Selection of Speed Reduction gear:

From multiple available speed gears in market, We have chosen worm gear and worm wheel more suitable for reducing speed and obtaining more torque.

And also due to its more compact size it is more appropriate for our cycle rickshaw.

3. Gear Design & Analysis:

In gear designing of worm and worm wheel we assumed the standard parameters to calculate the output power & output torque.

For Analysis Purpose, We are using ANSYS APDL Software.

4. Implementation In Final Design:

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First of all, From Motor we are driving worm gear shaft by belt drive then further driving is, Worm engages with worm wheel and worm wheel shaft having one sprocket which engages with chain and finally chain drives the wheel.

5. Final Assembly For Speed Reduction Kit:

In Final Assembly, We have assembled motor, battery, controller, gear drives on rear axle of cycle rickshaw.

We are locating the battery under the passenger seat by providing proper insulation .

SUMMARY OF PROPOSED SHAFT, SPROCKET AND GEAR BOX

Component	Dimensions	Material
Shaft	27 mm (dia) ,1200 mm (length)	EN 19
Sprocket	14,14,28,28,51(no of teeth, total 6 Sprocket)	Mild Steel (by Laser Cut)
Gear Box (worm Gear)	30:1	Alloy

Table.3. summary

Total Torque on Shaft by Motor:- 300 N-m (BY Sprocket Gear Ratio Of 2:1).

Pedal Force – 150N (Torque 360 N-m)

Final RPM On Tyre :- 10 RPM.

Tyre Diameter :- 22''

5. Advantages

1. Newly Design Transmission System deals with Easy Driving and Two Mode Of Transmission i.e. Mechanical and electric . Rider can be use both mode at a time in heavy load condition.
2. Human Efforts get Reduced due to use of electric drive ,which can be also responsible for moderate speed in heavy load condition.
3. Use of worm gear box also reduces Space comparing other gear box.
4. Efficiency is high.
5. Rider can adjust the Speed by throttle and another sprocket of different gear ratio (cycle gear system)

6. Conclusion

The newly developed battery powered hybrid (Human Power + Electric Power) tricycle rickshaw as per this improved transmission and design are suitable for suburban and rural use. They are economically feasible on mass production. The hybrid system was found to work satisfactorily. The system could be

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fitted in existing conventional rickshaw at a small conversion cost. It allowed reduction of human effort as well as use of small capacity of motor and battery.

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