

Design and Fabrication of Wheelchair cum Tricycle for Physically Challenged and Elder People

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Abstract— This paper is about the development of traditional manual operated wheelchair cum tricycle is rear wheel drive in which chain drive mechanism replaced with single slider drive mechanism. The design concept of this model is taken from manually operated tricycle and railroad car. This wheelchair cum tricycle is useful for handicapped person. This modified tricycle gives the both advantages of wheelchair (for short distance or in-door use) as well as tricycle (for long distance use) in one machine. The transmission power and motion takes place from steering bar to rear wheel through linkages and rotating disc. Modification of this tricycle by single slider drive mechanism is used to transmit power that make the tricycle faster at fewer efforts as compared to existing tricycle. This paper provides the details of components used & designing parameters takes in consideration while designing tricycle. This wheelchair cum tricycle is very efficiently design and can be proved as better replacement for tricycle having chain drive mechanism.

Key words: Single Slider Cranks Drive Mechanism, Steering, Tricycle, Wheel Chair

I. INTRODUCTION

Physical term of every human are not the same and as up to date always. Due some mishap or some medical problem some have to suffer for his rest of the journey with un-comforts. To serve such peoples the project is just a beginning. Due to the enormous number of disabled people in the society, a wheelchair cum tricycle has been fabricated and designed to specification. In response to demand of wheelchair user for equal access, hand-propelled tricycle, electrically controlled tricycle, and automated guided tricycle have been developed. However, because upper body strength is required, a hand propelled tricycle does not permit an older or severely disable person on extensive range of travel. Single slider mechanism works on four bar mechanism. In this mechanism one link is fixed and other is movable. In single slider mechanism there are three parts. First is crank second slider and third is connecting rod. The crank is rotating disc, the slider which slides and connecting rod which joins the parts together [1].

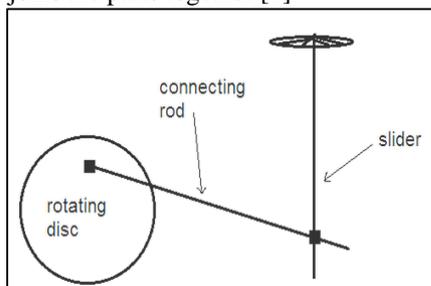


Fig. 1: Single slider mechanism

Author designed by adding an electric power train and control system to the current hand-powered tricycle to provide tricycle users with improved levels of mobility. The

design objectives required a simple and affordable design for the power train and controls, a design that needed to be reliable, sustainable, and functional. The design of the Electric Tricycle is adaptable to the current hand-powered tricycles with little modification. The design consists of an electric motor, a drive system, motor and steering controls, and a power supply [2]. Author embodied the design to ease mobility for the physically challenged and also provide adequate comfort they desire. This is achieved using a specially designed platform that allows the wheel chair to be wheeled up or down. The prototype of this tricycle has been fabricated. The anthropometrics data that need to be considered in the design of the platform and frame of the tricycle have been taken into consideration at the design stage of the tricycle [3]. Author modified a tricycle by the addition of an electric motor and battery to help power the vehicle. The motor controller can adjust the speed in five different settings and the tricycle can be driven forward or backward. The wheels are arranged with one fixed direction drive wheel in front and two pivoting wheels for steering in the rear. Two handles beside the seat are used for hand control of the steering. A large sprocket 25.4 cm in diameter located in front of the driver is connected with two crank handles for the driver's hands to power the vehicle [4]. The final output is a wheel chair which gives multiple options to the user that adjustable back rest, arm rest; leg rest provides comfort for the patient while resting. The adjustable arm rest provide ease of shifting the patient from chair to the bed or to the vehicle. Facility provided for keeping plate while having food, reading and keeping water bottle. Additional to this alarm facility is provided to inform the attendee that there is a need of user presence to the patient. Validation of the prototype is done and usage is found satisfactory [5]. In this paper author used a four bar mechanism is to design climbing wheels for the desired performance output of the machine. A four bar lift can be used by old or disabled person to climb one floor as subjected to lift. Hence a four bar mechanism to be implemented on every wheel to make the frame to be moved and to make synthesis & simulation for same mechanism to track its actual path & to understand its motion [6].

The design of wheelchair cum tricycle is an improvement on the existing ones. It is carried out to benefit the user conveniently, physically, and comfortably such that when a little effort is exerted, a greater output (movement) is achieved as a result of the fast transmission generated by the single slider mechanism. In this project chain drive mechanism is replaced by using single slider mechanism which allows the user much more efficient propulsion than would be provided by the hand pedal wheelchair. This tricycle gives both advantages of wheelchair and tricycle in one machine to handicapped person. The project's goal is to provide a good living condition for people considered to be physically challenged (disabled), to transport themselves around their environment.

II. EXPERIMENTATION AND DESIGN

In the project different mechanical components are used to run the tricycle. The list of components is as Shaft, Bearings, Lever pump with steering links, Connecting rod/plate, Crank and Wheels and tyres. A shaft is a rotating machine element which produces power to a machine. The material used for shafts is Carbon steel SAE 1045 oil quenched at 700 degree Celsius and Size (Diameter x Length): (2 x 21.5) cm, bearing specification are Type: UCFL 204 and Size: 7.1 cm, Lever pump with steering links with diameter of 2.5 cm and thickness of 1 cm and length of 90 cm and plate length : 6.9 cm, Connecting rods size (Length x Breadth x Thickness) : (48 x 3 x 0.4) cm, crank size (Length x Thickness) : (11.5 x 1) cm, Wheel size of 58 cm with Wheel thickness is 4.5 cm and Tyre pressure (PSI): 7.



Fig. 2: Fabricated Prototype of Wheelchair cum Tricycle with Disassembly.

A. Working of Wheelchair Cum Tricycle

The tricycle accelerates to go in forward direction by pulling and pushing the steering rod in backward and front direction as shown in figure 3.

For reverse motion apply the force on steering bar in front direction as shown in figure 4. Then pull the steering bar in backward direction and continue the process of pulling and pushing the steering rod in backward and front direction to accelerate the tricycle in reverse motion as shown in figure 4.

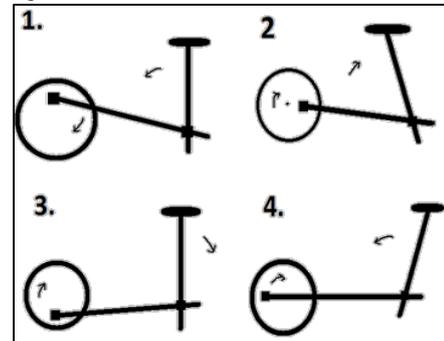


Fig. 3: Different position of single slider mechanism for forward direction.

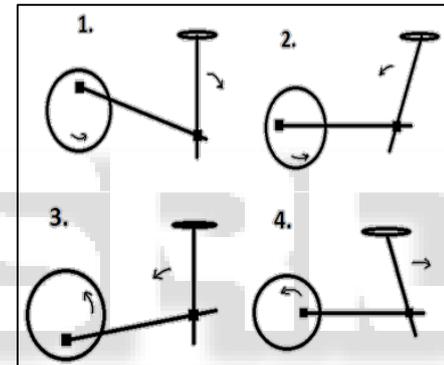


Fig. 4: Different position of single slider mechanism for reverse direction.

B. Design Calculation

1) Calculation for Speed and Power:

a) For Single Slider Mechanism with Total Weight:

Wt. of tricycle = 30 Kg

Wt. of disable people = 60 Kg

Diameter of wheel = 58cm

Velocity of Tricycle,

$$V = \frac{\text{Distance}}{\text{Time}} = \frac{87\text{metres}}{30\text{second}} = 2.9 \frac{\text{m}}{\text{s}} = 10.44\text{km/hr}$$

Also know that,

Velocity = Angular velocity \times Radius of wheel

$$V = \frac{2\pi N}{60} \times r$$

$$\therefore N = \frac{V \times 60}{2\pi r} = \frac{2.9 \times 60}{2\pi \times 0.29} = 95.5\text{rpm}$$

Total force on tricycle = total weight of tricycle =
30 + 60 = 90 Kg = 90 \times 9.81 = 882.9 N

Force on each wheel,

$$F_1 = F_2 = 441.45 \text{ N}$$

Torque = $F_1 \times r = 441.45 \times 0.29 = 128 \text{ N-m}$

$$\text{Power} = \frac{2\pi NT}{60} = \frac{2\pi \times 95.5 \times 128}{60} = 1.28\text{kW}$$

b) For Chain Mechanism with Total Weight:

Wt. of tricycle=40 Kg

Wt. of disable people=60 Kg
Diameter of wheel= 60cm
Velocity of Tricycle,

$$V = \frac{\text{Distance}}{\text{Time}} = \frac{79\text{metres}}{30\text{second}} = 2.6 \frac{\text{m}}{\text{s}} = 9.36 \text{ km /hr}$$

Also know that,

Velocity=Angular velocity × Radius of wheel

$$V = \frac{2\pi N}{60} \times r$$

$$\therefore N = \frac{V \times 60}{2\pi r} = \frac{2.6 \times 60}{2\pi \times 0.3} = 83\text{rpm}$$

Total force on tricycle= total weight of tricycle =
40 + 60 = 100 Kg = 100 x 9.81 = 981 N

Force On each wheel

$$F_1 = F_2 = 490.5 \text{ N}$$

$$\text{Torque} = F_1 \times r = 490.5 \times 0.3 = 147.15\text{N-m}$$

$$\text{Power} = \frac{2\pi NT}{60} = \frac{2\pi \times 83 \times 147.15}{60} = 1.27\text{kW}$$

2) Design of Shaft:

Material for shaft:

SAE 1045 (Carbon steel) oil quenched and drawn 700 °C

$S_{ut} = 579 \text{ MPa}$ and $S_{yt} = 306 \text{ MPa}$(From T.N. II-7 of data book)

For solid shaft,

$$\tau \leq 0.3 S_{yt} \text{ or } \tau \leq 0.18 S_{ut}$$

$$\tau = 0.3 \times 306 = 91.8 \text{ MPa}$$

$$\text{or } \tau = 0.18 \times 579 = 104.22\text{MPa}$$

Consider minimum value of ' τ ',

$$\therefore \tau = 91.8 \text{ MPa} \quad (\text{Without Keyway})$$

According to torsional strength of shaft,

$$T \times K_t = \frac{\pi}{16} \times \tau \times D^3$$

$$128 \times 10^3 \times 1 = \frac{\pi}{16} \times 91.8 \times D^3$$

$$\therefore D = 19.22 \text{ mm}$$

Standard diameter for shaft, $D = 20 \text{ mm}$

.....(From page no. 111 on data book)

C. Specification of Tricycle:

Frame material	Mild steel
Pipes used for frame material	21mm , 25 mm
Wheel size	(58 x 4.5) cm with tyre and tube
Overall length	700 mm
Overall width	300 mm
Overall height	340 mm
Drive	Rear drive
Mechanism used	Single slider crank mechanism
Connecting plate length	480 mm
Seat Width	430 mm
Seat height	400 mm
Tricycle weight	30 kg
Load capacity	100 kg
Maximum Speed	10 -11 km/hr

Table 1: Specification of Tricycle

III. PERFORMANCE RESULT

Considering total weight (wt. of tricycle + wt. of disable people)

Wt. of tricycle with single slider mechanism = 30 kg

Wt. of tricycle with chain mechanism = 40 kg

Wt. of disable people = 60 kg

Sr. no.	Parameters	Tricycle with single slider mechanism	Tricycle with chain mechanism
1	Weight	90 kg	100 kg
2	Force	441.45 N	490.5 N
3	Torque	128 N-m	147.15 N-m
4	Power	1.28 KW	1.27 KW
5	Speed	10.44 Km/hr	9.36 Km/hr

Table 2: Performance Result

IV. TESTING OF MACHINE

Materials used basically in mechanical design and construction seldom requires various test and balance in both its static and dynamic as well as its physical and mechanical properties to enable their state standard and efficient use in load bearing with or without load application.

As a result of the testing factors, static test has confirmed the tricycle stability, properly aligned, since all the extra weights was installed as low as possible to the centre of gravity of the tricycle.

V. CONCLUSION

Chain drive mechanism is replaced by Single slider mechanism is used to transmit power for driving tricycle which is most useful and economical as compared to the other tricycle. This tricycle is mostly useful for elder and handicapped people. Design of tricycle is simple, easy to operate and maintenance is very less. The operational efforts required less and hence single slider mechanism is an advantage of the tricycle. The wheelchair cum tricycle is useful for handicapped person. This modified tricycle gives the both advantages of wheelchair (for short distance use or in-door) as well as tricycle (for long distance use) in one machine.

The purposed of single slider linkage installed on rear wheel of tricycle, which therefore can capable to accelerate with suitable comfortable motion. A single slider mechanism for rear wheel is ensured through an easily controlled motion, and compactness of mechanism design makes it suitable for wheelchair cum tricycle for aiding people with disabilities.

VI. COMPARISON

Sr. no.	Tricycle with single slider mechanism	Tricycle with chain mechanism
1	Required less effort to drive	Required more effort to paddling
2	Only with one hand controlling of tricycle is possible.	Required both hand to control tricycle
3	This tricycle provides the advantage of wheelchair.	Used as tricycle only
4	More speed and power	Less speed and power
5	More economical	Less economical
6	More efficiency	Less efficiency

Table 3: Comparison between Chain drive and single slider drive tricycle

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