

“DESIGN OF THREE WHEEL HANDICAPPED PROPULSION CYCLE”

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ABSTRACT

Mobility of physically disabled persons is a concerning social issue nowadays. Various hand driven tricycles, wheelchairs, retrofitted vehicles etc. are commonly available for disabled people as a mode of transportation. The basic Tricycle is a three-wheeled design, pedaled by disabled persons in the side and seat in the middle for sitting arrangement. They use only one hand to steer the handle because other hand is used to rotate the pedal. Our aim is to design and fabricate a low cost tricycle for the handicap people to be propelled by the novel link mechanism attached to the steering column converting into cranking, using the advantage of leverage, with proper balance and distribution of mass and center of gravity to crank the wheel shaft for propelling. As he can use both the hands on the steering, better control of the vehicle is ensured.

Keyword -wheelchair, Backaches, Hand and finger blisters, Exhaustion

1. Introduction

There are lot of technological advancement, in wheel chair propulsion other than manual wheel turning. A normal wheel chair used for handicap and the tricycle users for normal people use hand drive or propulsion or foot pedal propulsion. The manual propulsion has become increasingly important because the population of propulsion of individuals using wheelchairs is growing and requires efficient mobility to maintain a quality of life equivalent to the general population. Several attempts have been made at improving manual wheel chair propulsion, such as changes in the wheels and tires, adding gears and designing alternative propulsion systems. Still, experts and consumers generally agree that innovation in propulsion is still needed. Improved propulsion technologies will reduce physical fatigue and effort maneuverability. Pain and upper extremity injury is common among manual wheel chair users. Shoulders related injuries have been shown to be present in up to 51% of manual wheel chair users. In addition, the prevalence of elbow, wrist and hand pain has been reported to be 16% . During wheel chair propulsion, users must exert large forces in order to propel the chair forward. In addition, the component of force that is directed in towards the hub does not contribute to forward motion but is necessary in order to provide friction between the hand and the push rim. There are two popular types of propulsion assist devices on the market today. One is a manual assist that uses gear ratios to reduce the effort required to propel the vehicle and the other is a power assist that uses a battery powered motor to reduce the effort. Mechanical advantage is a measure of the force amplification achieved by using a tool, mechanical device or machine system. Ideally the device preserves the input power and simply trades off forces against movement to obtain a desired amplification in the output force. An ideal mechanism transmits power without adding to or subtracting from it. This means that ideal mechanism does not include a power source, and is frictionless and constructed from rigid bodies that do not deflect or wear.

1.1 Problems with current propulsion systems

Manual wheelchair propulsion has a major impact on social life of the user as it determines to a great extent the range of environments in which the user can move in. At the same time many hygienic, safety and security issues are related to manual wheelchair propulsion. There are several problems associated with the current propulsion

system. These are highlighted below. Most of these problems apply to all types of propulsion systems being used today, though some of them may be specific to some propulsion system.

A. Common environments that cause difficulty in propelling a manual wheelchair:

- Soft services, (gravel, sand, grass)
- Carpeting.
- Side walks that are uneven,
- Wintry and wet conditions
- Hills

Note: These environments are especially difficult for persons having the use of one upper limb.

B. Problems that people experience when propelling a manual wheelchair:

- Backaches
- Hand and finger blisters
- Exhaustion.
- Shoulder, wrist, elbow pain,
- Rotator cuff disease,
- Carpal tunnel syndrome.
- Burning of the hands on the rims
- Dirty clothes,
- Calluses on the hands
- Dirty hands • Perspiration
- Over heating

C. Safety issues when propelling a manual wheelchair:

- Difficulty in controlling the chair when the user's hands slip
- Small sharp objects pack into the wheelchair's tires and can cut the user's hands when they are propelling the wheelchair
- The wheelchair tends to unbalance rear-ward when propelled
- The wheelchair is difficult to maintain balance when the casters get caught in drains and potholes
- User's hands can be injured when braking with the wheelchair's wheel-lock
- User's hands can be injured when braking or stopping the wheelchair
- A wheelchair user's foot could drag on the ground without user knowing it and get injured
- Controlling the manual wheelchair's speed up and down inclines or rapid speed changes on level surfaces is a safety issue.
- Faulty brakes/wheel-locks can cause the wheelchair to roll unexpectedly.

Other Comments:

- If footrests become loose they can drag or catch against objects.
- The lack of push handles can contribute to head injury or whiplash if user tips or falls backwards.
- Lack of wheelchair visibility to motorists is a safety concern.

- When personal items are hung from the back of the chair, they are difficult to reach, out of sight and subject to theft.
- Disassembly and lifting of the manual wheelchair into the auto can be a difficult.

1.2 Aim of the project

- To design and fabricate the three wheel base chair for the handicap people to be propelled by the link mechanism converting into cranking, using the advantage of leverage.
- To design and fabricate the chair with proper balance and distribution of mass and balance and center of gravity and the steering column which is pivoted and effecting the link mechanism to crank the wheel shaft for propelling.
- To design and fabricate the steering column, the steering mechanism being operated and through links controlling the front wheel to effect the proper steering as required and controlled by hand held steering wheel.

1.3 Working Principle

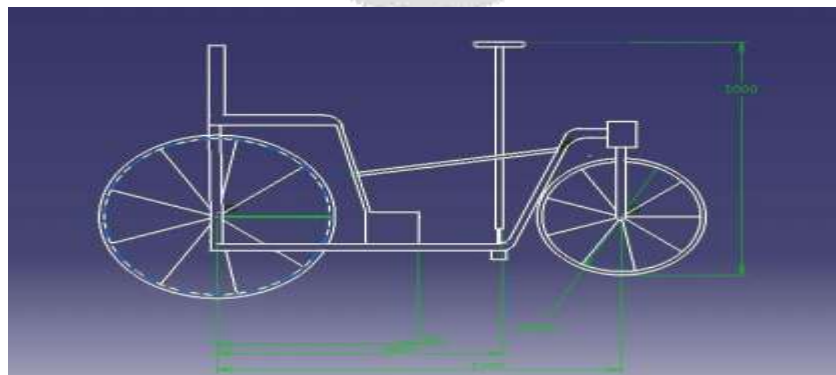
This is a single seater three wheeled vehicle with front wheels being steered by the steering column. The steering column has the outer tube which is hinged at the base and the other side extension of the steering column is pulling and pushing the cranking mechanism of the rear wheel. The internal rod of the steering column is hinged to the link mechanism to the front wheel to steer the wheel as the steering handle is being rotated which is held at the top side of the steering column. The steering column is holding the steering rod within the bearings. The cranking mechanism is on one of the rear wheel axle. The rear wheels are held on two different axles. The bearing housing of the rear axles are welded to the frame. The entire frame is made of mild steel square tube . • The steering column when pulled or pushed, the steering column pivoted at the base from a distance. This is termed as a lever that pivots on a fulcrum attached to the fixed frame. The lever operates by applying force at the steering handle, at distance from the fulcrum or pivot. As the lever pivots on the fulcrum, points further from this pivot move faster than points closer to the pivot. The power into and out of the lever must be the same, so forces applied to points farther from the pivot must be less than when applied to points closer in. • If a and b are distances from the fulcrum to points A and B and let the force F_A applied at A is the input and the force F_B applied at B is the output, the ratio of the velocities of points A and B is given by a/b , so we have the ratio of the output force to the input force, or mechanical advantage is given by

$$MA = \frac{F_B}{F_A} = \frac{a}{b}$$

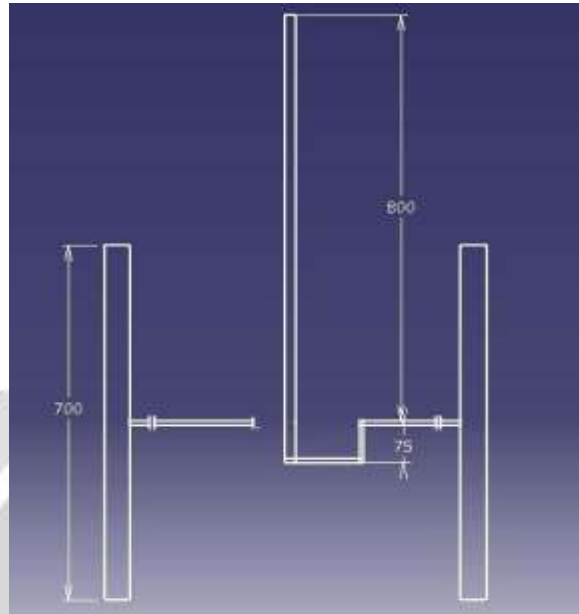
2. Project design

Project layout

A) Side view



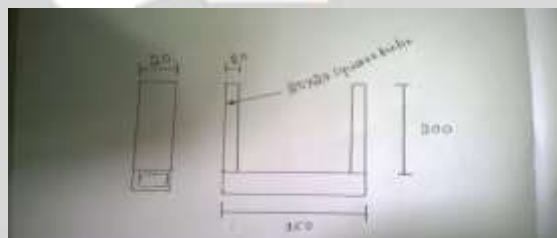
B) Top view



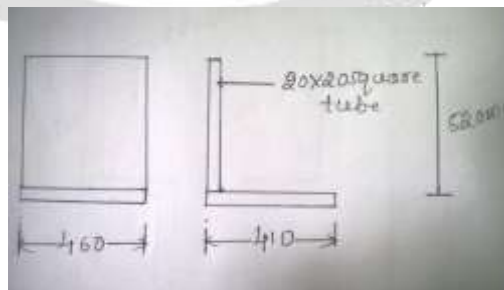
2.1. Design of various parts

- **Seat**

This is made out of mild steel cold rolled closed annealed square tube of size 20mm x 20mm cut for the lengths of 520mm---2nos, 460mm---4nos, 410mm 2nos, all are cut and straightened by hammering and then corner ground for removing sharp corners and right angle is made and then welded to each other to make



two number of rectangular frame of size 520mm x 460mm and another frame of size 410mm x 460mm. Both are then ground for the corners and edges for sharp corners and then hinge bushes are welded as hinges to make the seat rest and the back rest to support the tilting of the seat.



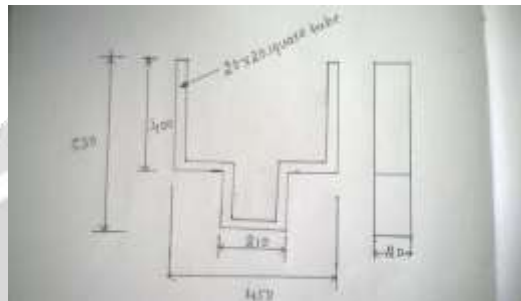
- **Rear support**

This is made out of CRCA (cold rolled and closed annealed) steel square tube of size 20mm x 20mm cut for the length of 300mm---2nos, 150mm---1nos and then flattened by hammering and then corner grinding

is done and then all three are joined, the base as 150mm and the vertical legs as 300mm at both the end of 150mm. This is then welded of the front support to make the main frame of the vehicle.

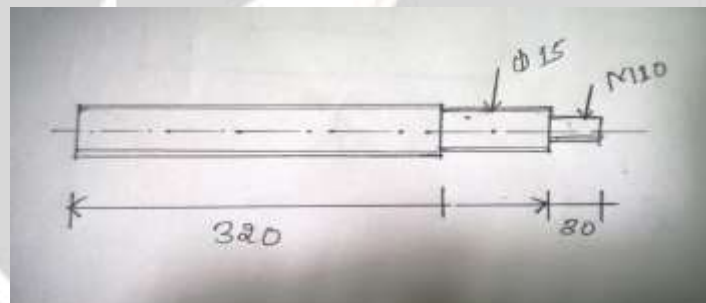
- **Front support**

This is made out of CRCA (cold rolled and closed annealed) steel square tube of size 20mm x 20mm cut for the length of 400mm---2nos, 120mm---2nos, 130mm---2nos, 210mm----1nos and then flattened by hammering and then corner grinding is done and then all are joined, the base as 210mm and the vertical legs as 130mm at both the end of 210mm, again 120mm lengths are joined at both the ends of 210mm and then vertical legs of 400mm are joined at both the ends as per the sketch. This is then welded to the rear support of the vehicle



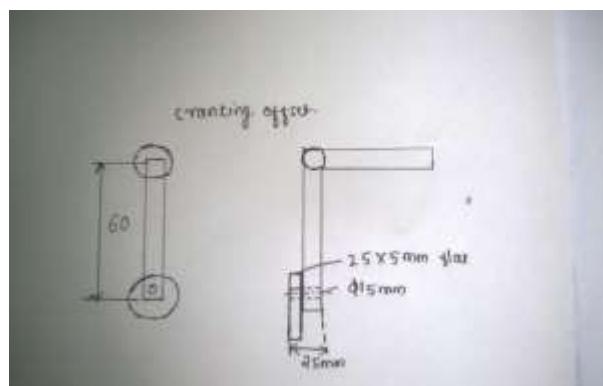
- -----Rear axle

This is made out of C30 steel cut from the round material of 20mm for length 355mm---2nos and then turned on lathe machine to make the diameter as 15mm for the length of 320mm and step turned and threaded to suit the M10 standard nut. It is faced from the opposite side to make the entire length as 350mm. Such two number of axles are made for this project.



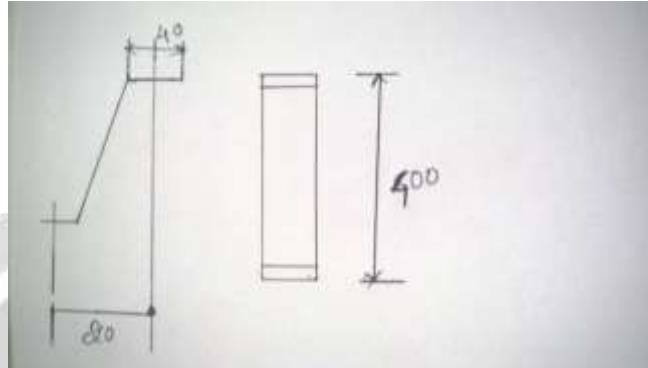
- **Cranking offset flat**

This is made out of mild steel flat of size 25mm x 5mm thick being cut for the length of 70mm and flattened by hammering and then marked for the distance of 60mm from one end and then drilling for the hole diameter of 15mm is done and then welded to the one rear axle. On the hole made, a round pin of diameter 15mm of length 25mm is welded to create the offset cranking pin.



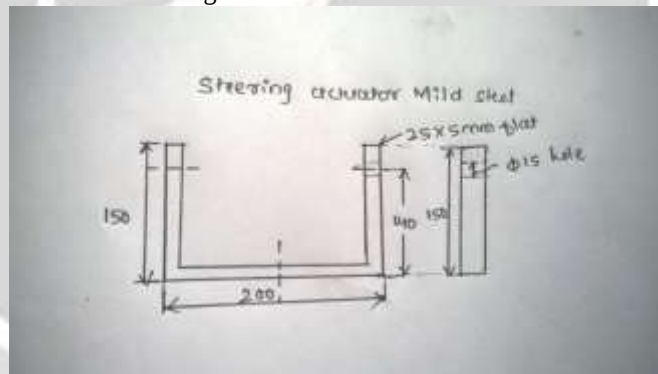
- **Steering arm**

this is made out of mild steel flat of size 20mm x 4mm thick being cut for the length of 500mm 2nos and then flattened by hammering and then marked for the drill of hole size 8mm at both the ends and then marked for the bending at 40mm distance at both the ends as per the sketch. Such two number of arms are made for this project.



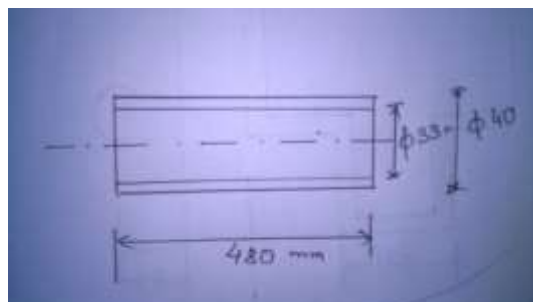
- **Steering actuator**

this is made out of mild steel flat being cut from the material of 25mm x 5mm thick cut for the length of 150mm---2nos, 200mm--- 1nos, and then flattened by hammering and then joined together keeping 200mm as base and 150mm as verticals at both the ends. 15mm round bar of length 35mm are taken and welded at both the ends as per the sketch. This is welded to the steering rod at the base.



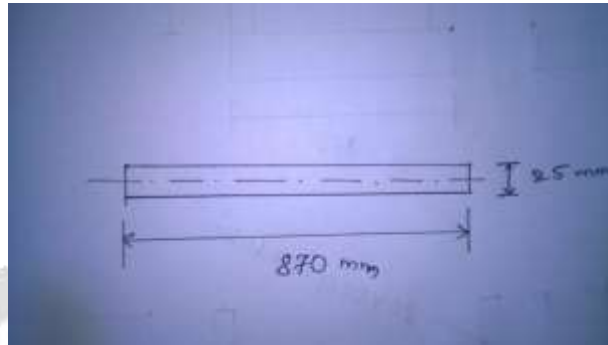
- **Steering support**

this is made out of mild steel tube of size 40mm with inner diameter as 33mm cut for the length of 480mm and then faced at both the ends to make the parallel and then this is welded to the bearing housings at both the ends to form the steering support.



- **Steering column rod**

This is made out of C30 steel round bar of diameter 25mm cut for the length of 875mm and then turned on lathe machine to make the diameter as 20mm for the entire length of 870mm to suit the ball bearings of inner diameter 20mm.



2.3 Advantages

1. Adding a power assist unit to a three wheel base chair will increase the weight and may offset the distribution of mass or balance and center of gravity possible making it more difficult for the user to propel when power assist is disengaged, the present innovation eliminates all these and simplify the propulsion.
2. This unit can be used for handicap and normal people also.
3. Individuals who have lower extremity weakness, paralysis, or amputation making walking unsafe or difficult, patients, can use this propulsion which is easy to operate and will be not require more effort.
4. This is inexpensive, portable unit, light weight and easy carried or shifted.
5. This becomes a best alternate to powered propulsion or hand push propulsion, which has good control with less energy expenditure.
6. Here we are using the mechanical advantage of the lever using the fulcrum., which is amplifying the input to output, using less effort the required drive.

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