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# Semi-Automatic Stair Climbing Wheel Chair

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**Abstract:- One of the basic problems of user on manual wheel chair is overcoming architectural barriers. Even though many research and studies have been reported in different field to increase the in-dependency of the wheel chair, but the question of overcoming of obstacles by a wheel chair always remains as a topic of discussion for many researchers.Current scenario, 7.3% of the people are disabled to walk. Most of them have normal wheel chair which could not run on improper surfaces (like stairs and abrupt path). The one which are available with automation are very costly.To avoid this problem, we have introduced the foot step wheel arrangement in our wheel chair. The major part of our paper focuses on the proposal of creative design concept and physical working model which will be powered by a geared motor.**

***Keywords:-*** *Climbing, Footstep, DC Motor, Design, Modeling, Testing.*

## I. INTRODUCTION

Wheelchair is a device used by disabled people to enhance their personal mobility. There are many types of wheelchairs available in the market like manual or powered wheelchair and the choice of wheelchair depends upon the physical and mental ability of the user. One of the basic problems of user on manual wheelchair is overcoming architectural barriers (kerb, stairs etc.) on its way. Even though many research studies have been reported in different fields to increase the independence of wheelchair users, the question of overcoming obstacles by a wheelchair always remains as topic of discussion for many researchers.Though there are many improvements in this field but still there are people who are not so economically strong enough to afford the existing inventions. If we take a rough estimate then we could see that an Automated Wheelchair in any market cost approximately Rs 100000 not only this, with its usage it also incurs some maintenance cost too. In India there are many physically challenged people (from legs) who will So we have come up with a plan to design a Semi-Automatic Wheelchair, which will perform all the functions of a normal wheel chair and on the other hand will also endeavor to overcome the architectural barriers. We will also try to make this project as cost effective as possible because our main focus will be on middle class people.

## II. OBJECTIVE

Though there are many improvements in this field but still there are people who are not so economically strong enough to afford the existing inventions.

If we take a rough estimate then we could see that an Automated Wheelchair in any market cost approximately Rs 100000 not only this, with its usage it also incurs some maintenance cost too.

In India there are many physically challenged people (from legs) who will never be able to purchase an automated wheelchair if it is going to cost this much.

So we have come up with an idea to design a Semi-Automatic Wheelchair, which will perform all the functions of a normal wheel chair and on the other hand will also endeavor to overcome the architectural barriers in the following ways.

- To apply the logic in the preexisting wheelchair to make it Semi-Automatic.
- To check its feasibility in the outer world.
- To make it cost effective so that mass of people can go for it without hesitation.
- To make the mechanism simple so that it requires less maintenance.

## III. COMPONENTS NEEDED FOR WHEEL CHAIR

### *A. Y shaped wheel*

Material Study: The foot step wheel is made up of PlyWood. The properties of plywood while loading

condition are better than the steel properties. The plywood, while moving on stairs it should be capable of absorbing sudden damping vibrations. Plywood is a product made of pieces of wood known as veneer.

*Mechanical Properties:*

Ultimate tensile strength=30 MPa,Compressive yield strength=31-41MPa,Shear modulus= 0.17-0.7 GPa,Shear strength=1.9-6.2 MPa, Modulus of rupture=0.6 GPa.

*B. Shaft*

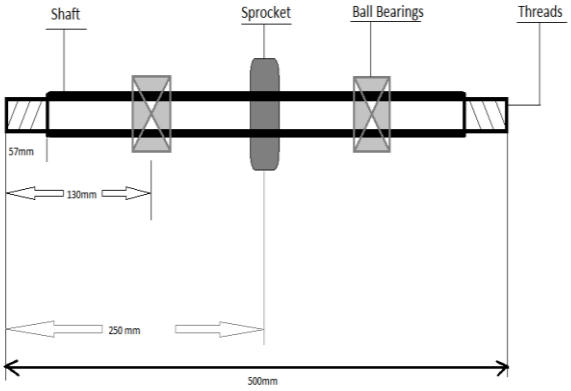


Fig 1:- Diagram of the shaft showing various machine components.

Material Study: The material of the shaft is Mild Steel. It has good load carrying capacity even under dynamic conditions. It is cheaper than chromium steel and easily available.

Mechanical Properties: Modulus of Elasticity= 200-250GPa, Yield Strength = 250-395 GPa, Tensile Strength=345-580MPa, Elongation = 26-47%, Hardness-107.5-172.5 HV.

*C. Motor*

Material Study: The motor used is a DC servomotor which has an advantage of high starting torque.

Rating: Torque=7Nm, Speed=1500 rpm, Voltage-24 V,Current-29 A.

## IV. DESIGNING VARIOUS MECHANICAL COMPONENTS FOR WHEEL CHAIR

- *Design of shaft:*

Bending Moment:

$(M_b)$= W * L

$(M_b)$= 65*9.81*130

$(M_b)$= 82810 N-mm

$(M_b)= \pi/32 * \sigma * D^3$

$82810 = \pi/32 * 155 * D^3$

D= 17.5 mm

Torsion Equation:

$$T / J = \tau / r$$

Yield Strength ($\sigma_{yt}$) = 450

Factor of safety = 2 (assumed)

Allowable Stress ( $\sigma$ ) = $\sigma_{yt} / 2$ = 225 N/mm$^2$

Shear Stress ( $\tau$ ) = 112.5 N/mm$^2$

So, the diameter of shaft from torsion equation = 20 mm

- *Motor Calculations:*

Friction Force (F) = $\mu$* m*g ($\mu$ = 0.7, C = 0.02)

F = 892 N

Rolling Resistance (Fr) = C x mg

(Fr) = 25.506 N

Required Speed = 32 rpm

So we are taking a reduction ratio as 30:1

Motor rpm = 32* 30 = 960 rpm

Torque (T) = F x R= 165.28 N-m

Torque at motor = 165.28/30= 5.5 N-m

So the approx. required torque of the motor after reduction = 6 N-m

Power (P) = 2*$\pi$*N*T/ 6

P = 628 W

## V. WHEEL CHAIR MODELLING

We are using CATIA for modeling of the wheel chair, because it offers various modified tools due to which it becomes slightly easier to design any model rather than going for other design softwares. Commands involved in CATIA are like-pad,pocket, and shaft.

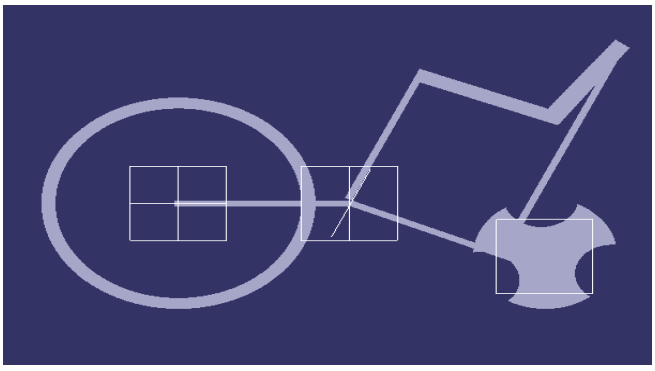

Fig 2:- Modeling of various mechanical components of the wheelchair (2D view).

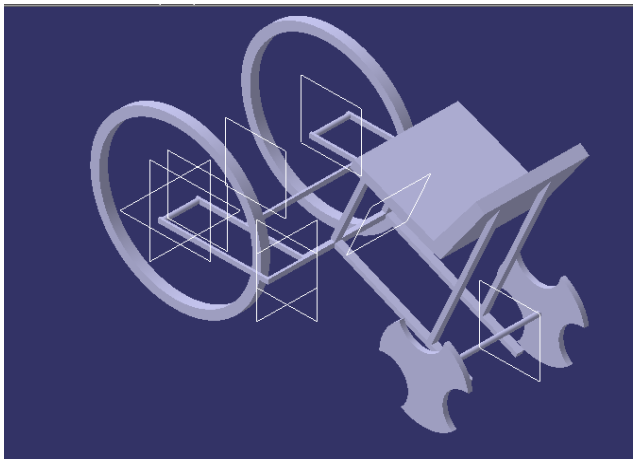

Fig 3:- 3D view of various mechanical components of the wheelchair.

## VI. FABRICATION AND WORKING MECHANISM

First we read the government norms of the stairs and then we made a calculation for dimensions of frame. Then we draw a 2D model of the wheelchair with the help of CATIA application. Then we studied about the footstep wheel and calculated its all dimensions. We made calculation of required ratings of motor and the required gear reduction unit too based upon the load and loading conditions. We also made thorough calculation of required diameter of shaft based on both type of failure theories.

We studied about the material to be chosen for the frame and the footstep wheel. Finally, we chosen plywood for the footstep wheel because the mechanical properties required by us are fulfilled by plywood. We choose Mild steel for the frame because it has required load carrying capacity and it's cheaper too.

The footstep wheel and shaft are made with the full dimensions. A hub is manufactured to hold and support the footstep wheel. The frame is made same as the designed model with proper dimensions.

The application of motor is also involved in it, so a motor with a required reduction gear box is bought from market. The motor is connected to with the gear box and mounted on the frame. The gearbox contains worm and worm wheel gear which stops the backward motion of the motor.

The power is transferred from motor to shaft with the help of chain and sprocket mechanism. A 24-volt battery is used to drive the motor. All the units are mounted on the frame and the testing of wheel chair is started.

## VII. CONCLUSION

The footstep wheel deforms only at highly loading conditions. The foot step wheel is an emerging way of climbing the stairs and with the application of motor and gears it is now becoming more convenient and affordable for all the disabled people. The cost of our wheelchair is lot cheaper than the fully automated wheelchairs. With a little more improvement and application, our wheel chair will have great advantage and usage.

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