Foot Operated Vehicle for Handicapped Person

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Abstract - In day today life we have seen number of cycles, tricycles or wheel chairs for disabled person. But there is not a single vehicle or cycle made for handicapped person without hands. So here is design for electrically operated vehicle for disabled person without hands.

Keywords: Foot operated steering mechanism, braking mechanism, power mechanism.

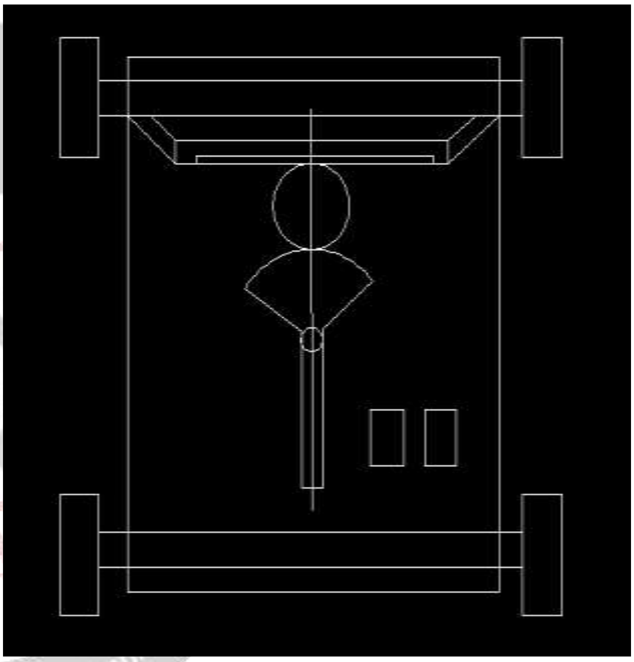
1. Introduction

Worldwide, 100-130 million people need wheelchairs, but less than 10% either own or have means of obtaining one because most of these people live in developing countries where wheelchairs are not available. Current wheelchair technology is relatively well established in that there is not a great deal of variation in the wheel chair market, which can create difficulties for individuals whose needs are not met by currently available model. Wheelchair design and functionality as a whole has been greatly improved over the past several decades, but there is still a need for new technology and innovative designs. So the goal of this project is those people who have not their hands but they have their legs so we are designing the vehicle which is useful for these peoples & to be installed on a standard wheelchair, which would allow full control of the wheelchair.

In today's life, there is no such cycle/wheel chair/ vehicle for handicapped person without hand. The person without hands can apply force with the help of his/her legs but can't operate steering mechanism as he/she has no hands. So, first challenge while designing the vehicle is to design the steering mechanism for such person who can operate the same with the help of his leg.

Besides steering system, we have to consider all other mechanical systems like power system for vehicle, braking system and all other corresponding system which will make the person to ride the vehicle comfortably.

Another challenge while designing was the force applications for different mechanisms and simultaneous operations of these systems at a same time during different conditions.



2. DIFFERENT SYSTEMS OF THE VEHICLE

The vehicle for handicapped person without hands mainly consists of following systems:

i. Steering system
ii. Power system
iii. Braking system

i. Steering System:

There are different mechanisms used for steering purpose. For example, worm and worm wheel steering mechanism, Rack and pinion mechanism, etc.

For this vehicle we are using Rack and pinion steering mechanism for steering purpose. Rack and pinion system provide less backlash and greater feedback or steering feel. Hence the rack and pinion mechanism are more suitable for this vehicle.

Steering mechanism for vehicle mainly consists of following parts:

Sector gear with lever

Pinion Gear

Rack

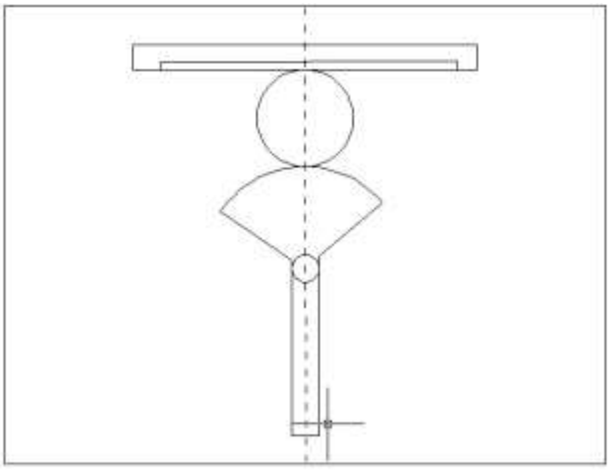


Figure.2 Rack and Pinion Steering System of the Vehicle

Construction:

The steering system consists of Sector gear with lever pivoted at the side of sector. Sector gear is meshed with pinion and pinion with rack.

Working:

When force is applied at the end of the lever it rotates about its pivot as shown in fig which in turn rotates the sector. This sector is meshed with intermediate pinion. When sector is rotated, it will rotate the pinion around its axis. Thus, pinion is meshed with rack and rack is mounted on the tie rod which will rotate the wheel.

ii. Power System:

Power system consists of following parts:

Motor

Belt and Pulley drive

Operating Mechanism

Working:

Power supplied by the battery to wheel is controlled by foot pedal given at the right side of the frame. The power is supplied by the motor to the first pulley and then transmitted to the second pulley by belt. Second pulley is mounted on the rear axle of the vehicle. Centrifugal clutch is used to allow free rotation. Centrifugal clutch engages

When speed of the motor increases and disengages when the speed of the motor is reduced.

iii. Braking System:

Braking system consists of following parts:

Braking Pedal

Braking Wires

Braking Pads

Working:

Braking system is provided to all wheels of the vehicle. When braking pedal is pressed braking action takes place at all the wheels at the same time depend on force of action of pressing.

3. DESIGN

Load on tyre:

Total load = chassis weight + person weight + motor weight

= 30+100+20

= 150 kg

For safety taking as 200 kg i.e. 2000 N

Using four wheels, so weight on each wheel

=2000/4

=500 N

On front wheels= 1000 N

Fr = 0.5*1000

= 500 N

Hz Force = 500 COS (45)

= 353.55 N

So, net force acting on the rack will be 353.33N so rounding up for 360N.

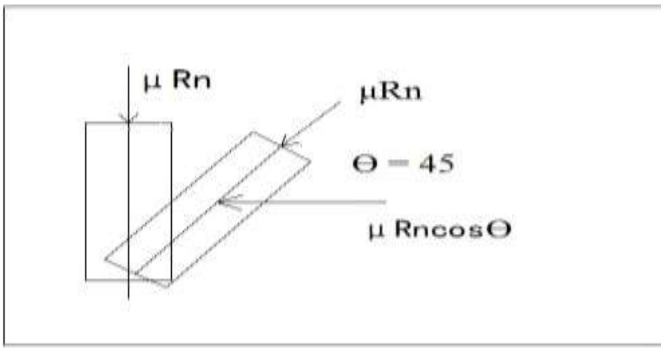


Figure.3 Wheel alignment and force

Lever Design of Sector:

Designing for both circular and rectangular cross section and taking the suitable one.

Considering lever length 25 cm = 250 mm

A man can apply 300 N by leg.

Torque

Mt= 300*250

= 75000 N-mm

Bending moment on lever:

Mb =Force*length of the lever

=300*250

= 75000 N-mm

Checking for Circular cross section by Flexural formula:

$$\sigma_b = \frac{\text{Mb y}}{\text{I}}$$

$$200 = \frac{75000 * \frac{d}{2}}{\frac{\pi}{32} * d^3}$$

d = 7.17 mm

d = 10 mm

Checking for Rectangular cross section by the flexural formula:

Considering width to thickness ration as 3

.$\frac{W}{t} = 3$

w=3t

$$\sigma_b = \frac{\text{Mb y}}{\text{I}}$$

$$200 = \frac{75000 * \frac{t}{2}}{\frac{1}{12} * 3t * t^3}$$

t = 9.65 = 10 mm

w= 30 mm

Cross section of the circle is less than the cross section of rectangular cross section. Hence space required for

Circular one will be less than the rectangular cross section. Hence selecting CIRCULAR cross section of the lever.

Rack Design:

Based on calculations for turning action of the tyre through 450, the length of the rack should be 500 mm total.

Considering the full left or right turn of the tyre that's mean the rack should move half of the full length

Length of rack =500 mm

Half of the length of rack =$\frac{500}{2}$

= 250 mm

Pinion Design;

To move the 250 mm length of rack the pinion diameter should be 80 mm

πD1= 250

D1= 79.57 mm

D1 = 80 mm

Full rotation of this 80 mm diameter pinion is not possible by sector gear. So, mounting smaller diameter pinion (P2) on the first pinion (P1).

Considering the ratio of the two pinion 2.

So, diameter of the second pinion will be,

D2= $\frac{80}{2}$

D2=40 mm

Sector Design:

Diameter of the pinion 2 = Arc length of sector

Consider angle of the sector gear = 600

We have,

S = r θ

260 = r * $\frac{\pi}{180} * 60^0$

R = 250 mm

R = 25 cm

Gear Design:

Torque transmitted by gear:

Mt=Force*Radius

=360*40

=14400N-mm

Let I=Gear Ratio=2

α=Pressure Angle=20^o

Zp =Number of teeth on pinion=24

Zg = Number of teeth on Sector =40

Lewis Factor for 24 teeth = γ =0.24……………. From table of values of Lewis form factor for 20o full length involute system

Let, Cs=$\frac{Started\ Torque}{Rated\ Torque}$=1.5

V=velocity Factor = 1m/s

Cv= $\frac{3}{3+V}$= 0.75

Let,

$\frac{b}{m}$=10

Power=P=$\frac{2\pi NT}{60}$ =90.47 Watt

$$m = \left[\frac{60 \times 10^3}{\pi}\left(\frac{\text{KW } C_s \text{ (FS)}}{Z \times \text{nCv (b/m)(Sut/3)}}\right)\right]^{1/3}$$

m=3.33

Pitch circle diameter of pinion 1= m*Zp1= 80 mm

Pitch circle diameter of pinion 2= m*Zp2= 40 mm

Pitch circle diameter of sector= m*Zs= 128 mm

b= face width= 33.33mm

Checking for Design,

Pt= $\frac{2Mt}{d\prime p}$

=$\frac{2*14400}{80}$

=360N

V=$\frac{\pi d*p*n_p}{60*10^6}$=1.8=3 m/sec

Cv= $\frac{3}{3+V}$=0.6

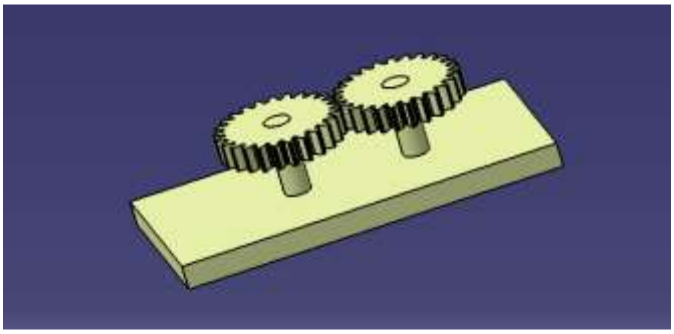
Peff= $\frac{Cs*Pt}{Cv}$= 1050N

Sb= m*b*σb *γ= 5540.452N

FOS=$\frac{Sb}{Peff}$= 5.27

So, the design is safe.

4. CATIA MODELS:



Figur.4 Spur Gears

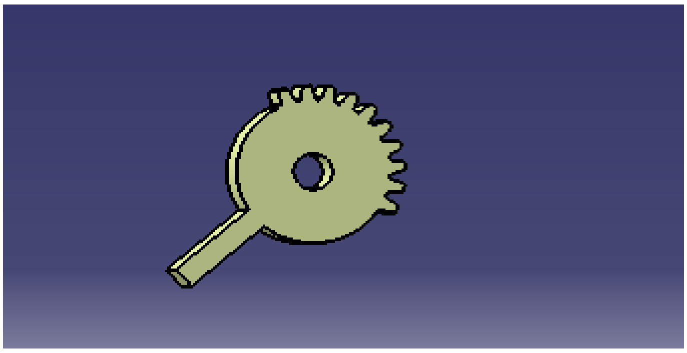


Figure.5 Sector Gear

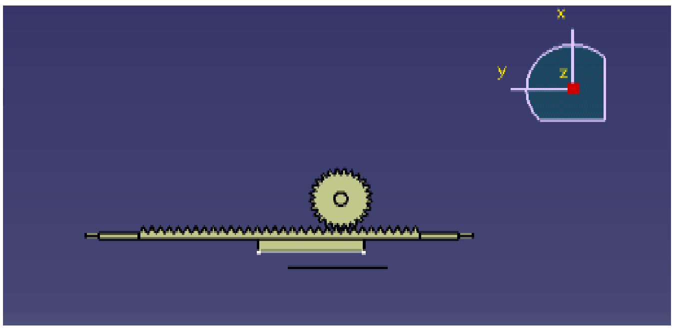


Figure.6 Rack and Pinion

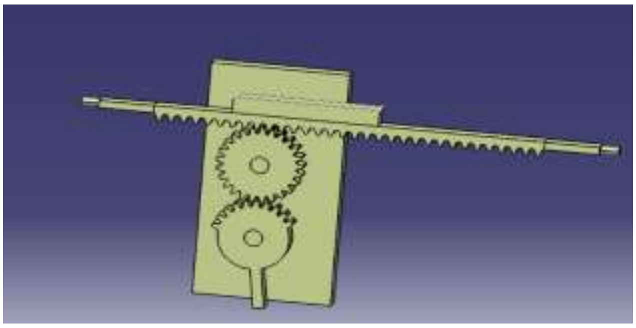


Figure.7 Assembly

5. STUCTURAL ANALYSIS:

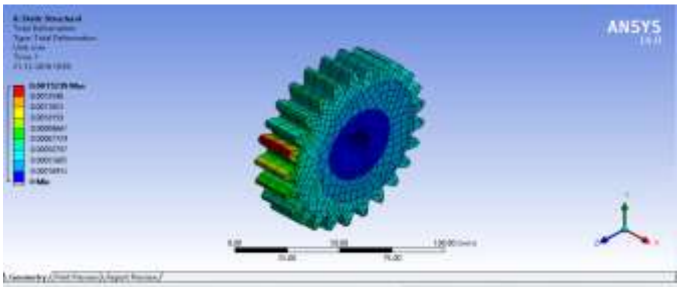


Figure.8 Deformation Analysis of Pinion

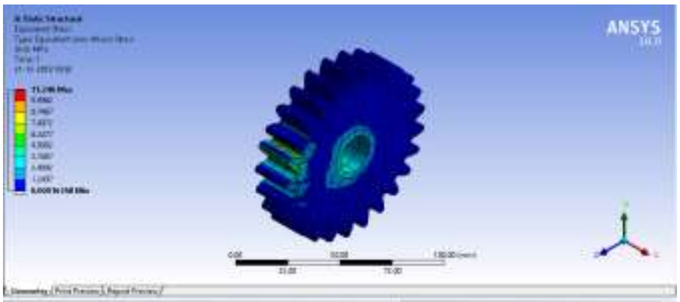


Figure.9 Stress Analysis of Pinion

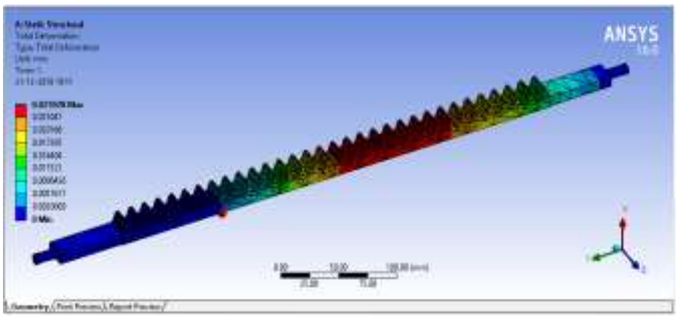


Figure.10 Deformation Analysis of Rack

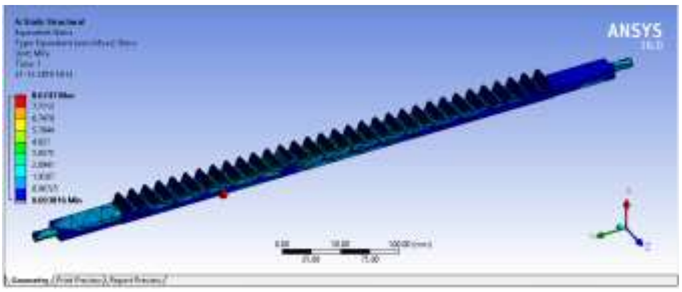


Figure.11 Stress Analysis of Rack

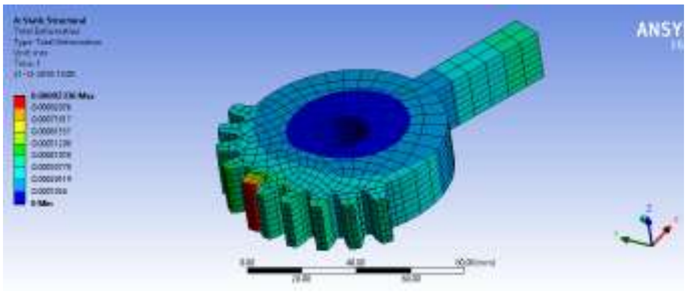


Figure.12 Deformation Analysis of Sector Gear

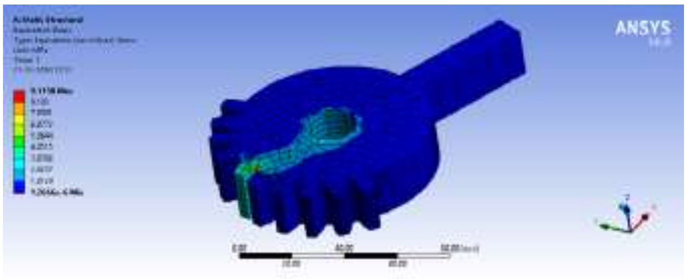


Figure.13 Stress Analysis of Sector Gear

6. CONCLUSION:

It is difficult for disabled person to apply total force for driving the vehicle even he/she has legs.

So, to reduce the effort required by disabled person, we designed the vehicle which will be powered by electric motor.

Steering mechanism will be operated by leg of the person.

From the structural analysis we can see the maximum stress induced in the part and accordingly we have selected the material.

7. REFRENCE:

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