International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.03, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

FOOTSTEP STEERING

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ABSTRAC

Transportation has become an integral part of people's everyday life. At certain times, in large countries like India, people are forced to travel more than 200 km from their work place to their place of residence. People with disabilities in lower extremities and hands have difficulties in travelling and cannot travel these long distances. They use devices such as wheel chair, crutches and artificial limbs for mobility. These however cannot be used for long distance outdoor transportation. Therefore, the aim of this study is to design and fabricate 'Foot operated system' for armless people.

Keywords: **Mobility, Artificial Limbs, Crutches.**

I. INTRODUCTION

Now a days transportation has become great difficulty to and individual to reach the destination on time. Everyone has their own vehicle and people with all body parts are fortunate. But it is unfortunate for partially disable people with hands. Disability is the repercussion of an impairment which can be mental, physical, emotional, vision, sensory. Disabilities can occur in upper extremities as well as in lower extremities. Thus these people become more dependents and lose their confidence. Due to this effect, they stand a great disadvantage in using public as well as private transportation facilities. A national level survey conducted in India by the Central Government of India once in ten years revealed that, around 27 million people which are about 2.21% of the Indians are differently able. Among them, around 14.98 million were men while 11.84 million were women. Thus, the percentage of disabled people in rural area was higher than those in urban areas. A total of 5.43 million people were identified with disabilities in movement which was the highest among other categories such as hearing, seeing etc. in terms of numbers of people affected.

1. First step is to search an idea for project development

2. By consulting over multiple ideas we select the topic of hand brake release which would be helpful for automobile sector.

3. After finalizing the idea we go for literature review and survey multiple international journal papers of various authors mentioned below. By doing this we get idea about multiple possible options of how we can develop our idea. Then we select the arduino microcontroller based DC motor powered and key switch operated braking mechanism.

4. The next step is to design and develop the model. In this by using standard textbook formulae's we design shaft, frame, and force required for braking etc. after finalizing the dimensions of components we go for software designing.

The design of model is done using modeling software. In this first part design is done of various components and then assembly is done using .

5. The next step was we gone for market survey of required components. We check multiple components and their prices and bought required components.

6. The next step was fabrication and assembly in this first we fabricated frame using L angle Mild steel channel. Electrode welding is done to attach it to form rectangular frame.

Then the brake lever is fitted with linking mechanism to the DC motor. And DC motor is fitted onto the base frame.

With the help of electrode welding shaft is welded to base frame which is inserted through the wheel having drum brake.

7. The next step is electronics connections and wiring. In this the key switch is connected to the microcontroller board. Whose output is given to the relay which triggers the DC motor clockwise or anticlockwise.

8. the final stage is testing and finalizing the project in which we test the model to check it is properly working or not.

II. SYSTEM DESCRIPTION

Frame

WE design a basic frame for a prototype by mild steel channel (L beam),

L Channel- MS Angles are L-shaped structural steel represented by dimension of sides & thickness. For e.g. 25x25x3 means, both the sides of angles are 25 mm & thickness is of 3 mm. There are various sizes of angles which are as follows :-(there are also equal & unequal angles). Equal angles: - They are angles having both the sides of equal dimensions. For e.g. refer below given diagram, in which both the sides are of dimensions "a".

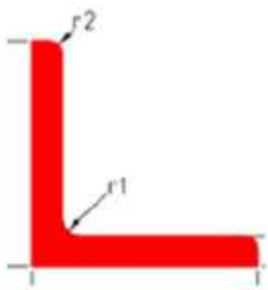

Fig.1 L-angle bar dimensions

SIZES WITH SECTION WEIGHT OF EQUAL ANGLES

Size	**Weight in Kgs.**	**Gauge**	Thickness
in mm	**Per Feet**	**Per Mtr.**	
20x20x3	0.274	0.900	3mm
25x25x3	0.335	1.100	3mm
25x25x5	0.548	1.800	3mm
31x31x3	0.390	1.300	3mm

By standard available sizes we select the 25 mm so because that will be easily available and have appropriate size for frame.

Sprocket

The sprocket is a very vital component in the transmission of power and motion in most motorcycle; there is always a pair (rear and front) in a motorcycle. The front sprocket drives the rear sprocket via chain connection. They exist in various dimensions, teeth number and are made of different material.

The tooth form of a sprocket is derived from the geometric path described by the chain roller as it moves through the pitch line, and pitch circle for a given sprocket and chain pitch. The shape of the tooth form is mathematically related to the Chain Pitch (P), the Number of Teeth on the Sprocket (N), and the Diameter of the Roller (Dr). The formulas for the seating curve, radius R and the topping curve radius F include the clearances necessary to allow smooth engagement between the chain rollers and sprocket teeth.

Fig. 2 Sprocket Wheel

Chain

Drive ratios greater than 10:1 should not be used. In order to achieve higher ratios it is good practice to create multiple drives using two drives in series. This will be explained in more detail in the section on gears. The drive ratio between two sprockets is specified by the relationship between the number of teeth of the Driven Sprocket to the number of teeth of the Drive Sprocket. It is therefore important to understand that power is transferred through a drive train from one sprocket to another through the tension created on the chain.

Chain drives, gear drives and belt drive systems are all effective power transmission choices.

Each offers advantages and disadvantages with respect to the other.

The advantages of chain drive systems are as follows:

1. Shaft center distances are relatively unrestricted. Whereas gear drive center-to-center distances are restricted to specific dimensions for a given set of gears, the center distances between two chained sprockets can vary anywhere from 50% to 300% or more of their pitch diameters.

2. Chain Drive are relatively easy to install. Assembly tolerances are not as restrictive as those for gear drives. Chain drives are a better choice for less experienced builders working with a minimum of machine tools.

3. Chain drives can be readily redesigned and reconfigured in comparison to gear drivesystems.

4. Chains perform better than gears under shock loading conditions.

5. Chain drives spread operating loads over many teeth whereas the operating loads acting on gear drives are concentrated on one or two teeth.

6. Chain drives do not require tension on the slack side (Belt drives do) thus bearing loading is reduced.

7. Chain drives require less space for a given loading and speed condition than pulleys and belts.

8. Chain drives systems are (usually) less costly to build and maintain than an equivalent gear drive.

While chain drives offer many advantages, there are good reasons to choose a gear drive system, particularly when:

1. Compact drive requirements demand the shortest possible distance between shaft centers.

2. High speed ratios are required.

3. High rotating speeds (RPM) are required. 4. High horsepower AND high speed loading is required.

Chain Types:

1. Transmission chains

- Chains to transmit rotary power between shafts
- Bush roller chains are transmission chains

2. Conveyor chain

- Rollers sit proud of links and can roll along supporting surface
- Can be used for transporting materials, as rollers can support weight
- Can also be used just to support weight of chain if transmitting power over long distances.

3. Inverted tooth (or silent) chain:

- Sprocket teeth mesh with shaped links instead of rollers on chain
- Joints between links use rolling rather than sliding contact
- Profile of links are more like involute gear teeth
- Overall effect is to reduce noise

4. Leaf (or lifting) chain:

- Designed for lifting rather (than power transmission)
- Do not have to mesh with sprockets, hence no rollers

- Therefore can narrower than roller chain with equivalent strength

4. Rack and Pinion

- A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack"; rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion.
- For example, in a rack railway, the rotation of a pinion mounted on a locomotive or a railcar engages a rack between the rails and forces a train up a steep slope.
- For every pair of conjugate involute profile, there is a basic rack. This basic rack is the profile of the conjugate gear of infinite pitch radius. (I.e. a toothed straight edge.)
- A generating rack is a rack outline used to indicate tooth details and dimensions for the design of a generating tool, such as a hob or a gear shaper cutter.

Fig. 3 Rack & pinion mechanism

Application of Rack & Pinion:

Rack and pinion combinations are often used as part of a simple linear actuator, where the rotation of a shaft powered by hand or by a motor is converted to linear motion.

The rack carries the full load of the actuator directly and so the driving pinion is usually small, so that the gear ratio reduces the torque required. This force, thus torque, may still be substantial and so it is common for there to be a reduction gear immediately before this by either a gear or worm gear reduction. Rack gears have a higher ratio, thus require a greater driving torque, than screw actuators.

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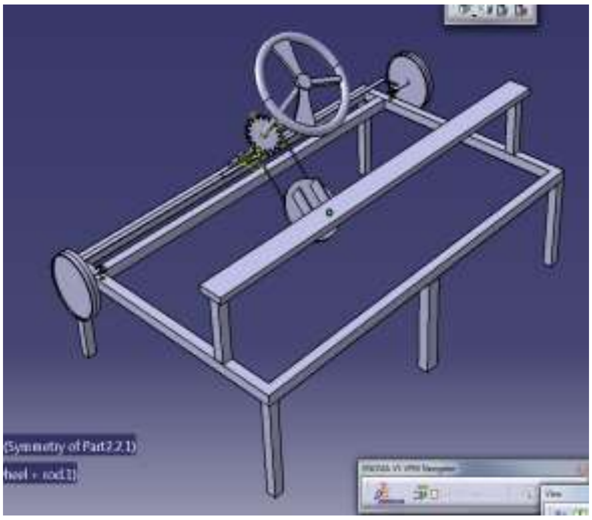

Fig.4 Catia Model

III. WORKING

The steering mechanism with rack and pinion is used in this project.Steering wheel is replaced by chain and sprocket mechanism.steering wheel is replaced by chain and sprocket mechanism.The disc which is connected to the shaft of sprocket is operated by using foot.

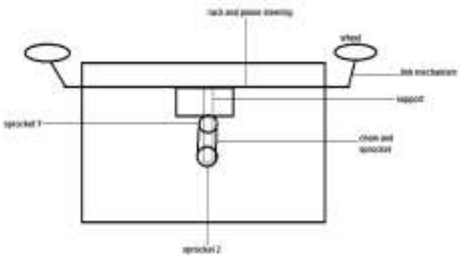

Fig.5 BLOCK DIAGRAM

IV. CALCULATIONS

Frame calculation

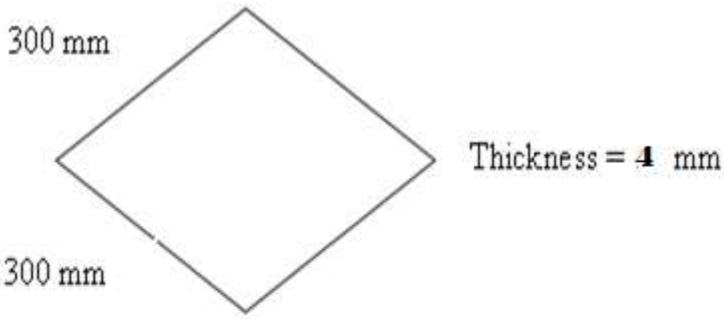

Fig.6 Frame

1. $\frac{M}{I} = \frac{\sigma}{Y}$ **……………………………………………………..(1)**

- **M=force*perpendicular distanmce**

=(60*9.81)*150…………………(force=human weight considered)

M=88290 Nm

- **Y**=$\frac{D}{2}=\frac{4}{2}$=2 mm……………………….(thickness of frame=4mm)

- **For I =** $\frac{bd^3}{12}$

$= \frac{300 \times 4^3}{12}$

I = 1600 mm^4

Therefore,

Using equation no.1

$\frac{88290}{1600} = \frac{\sigma}{2}$

σ_b=110.3625 N/mm^2

$\sigma_b << \sigma_{allow}$ i.e, $\sigma_{allow} = \frac{210}{1} = 210$

So design is safe.

OUTPUT POWER CALCULATION

Here consider 5 different weight of human being (60kg, 65kg)

CASE 1:

NET WEIGHT = 60KG

The mass of a body = 60 Kg (Approximately)

Height of speed brake = 20 cm

Work done = Force x Distance

Here,

Force = Weight of the Body
= 60 Kg x 9.81
= 588.6 N

Distance traveled by the body = Height of the prototype(spring)
= 20 cm
= 0.20 m

Output power = Work done/Sec
= (588.6 x 0.20)/60

Output power = 1.962 Watts

(For One pushing force)

However, this much power produced, it cannot be tapped fully. From the above purpose we have select to generate electricity by permanent magnet type D.C generator and store it by 12V lea d-acid battery cell.

CASE2:

Consider weight = 65kg

Work done = Force x Distance

Here,

Force = Weight of the Body
= 65 Kg x 9.81
= 637.65 N

Output power = Work done/Sec

= (637.65 x 0.20)/60

Output power= 2.1255 Watts

Rack And Pinion Calculation:

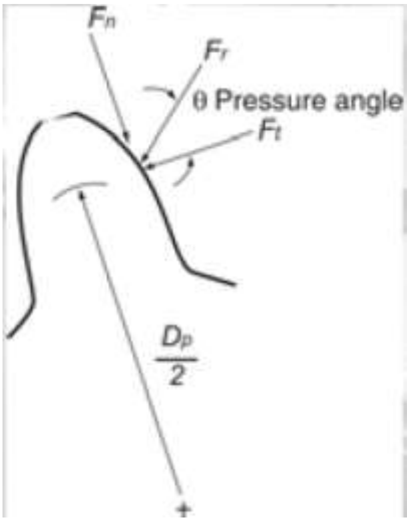

Fig.7 Tooth Profile

Nomenclature:

f_t = transmitted force

f_n = normal force

f_r = resultant force

θ = pressure angle

Pressure angle = 20^0

1. Fn = Ft tan θ……………………………………….(1)

f_t = tangential force (weight of human=60kg………this is the standard value.Considerd from net)

f_t = 60 x 9.81

f_t = 588.6 N

f_n = 588.6 x tan 20^0 ....using equation (1)

f_n = 214.23 N

2. $f_r = \frac{f_t}{\cos\theta}$ ………………………………………………………….(2)

$= \frac{588.6}{\cos 20}$

f_r = 626.38 N

3. **Power (P) = $\frac{\text{Work}}{\text{time}}$ ……………………………………………….(3)**

$$P = \frac{\text{Force x displacement}}{\text{time}}$$

$$P = \frac{588.6 \times 0.050}{1}$$

P= 29.43 watt

4. **P = $\frac{2\pi NT}{60}$ ………………………………….(4)**

$$T = \frac{P \times 60}{2 \times N}$$

$$T = \frac{29.43 \times 60}{2 \times 3.142 \times 30}$$

T = 9.3 N.m.

5. **T = f_t x r** …………………………………………..(5)

$$r = \frac{T}{f_t}$$

$$= \frac{9.3}{588.6}$$

r = 0.015

r = 15 mm So D = 30 mm

6. **Using Lewis form factor:**

$\sigma_t = \frac{f_t \times P_d}{y.b}$ ………………………………….(6)

Let,

P_d = diametrical pitch

• $P_d = \frac{T}{D}$ ……………………………….(7)

$= \frac{17}{30}$

P_d = 0.6 mm^{-1}

Then,

$\sigma_t = \frac{f_t \times P_d}{y.b}$ ………………………………………**using equation(6)**

$= \frac{588.6 \ X \ 0.6}{30 \ X \ 0.308}$

σ_t = 38.22 N/mm^2

7. $\sigma_{allow} = \frac{S_{ut}}{fos}$ ……………………………….(8)

$= \frac{210}{2}$

σ_{allow}= 105

So $\sigma_t << \sigma_{allow}$

So design is safe.

8. m = $\frac{D}{T}$ ………………………….(9)

$= \frac{30}{18}$

m= 1.66

Then the module of pinion = 1.66=2

Also The module of rack = 1.66=2

9. Pinion dimension:

Outer Dia. = d_0 = 2m + D …………………………………………(10)

= 2 x 2 + 30

d_0 = 34 mm

10. Root dia. (d_r) = D – (2m + 2C) ……………………………………………..(11)

= 30 – (2 x 2 + 2 x 0.25)

d_r = 26.5 mm

11. Addendum,

Ad = m ………………………………………………..(12)

A_d = 2

12. **Dedendum,**

D_d = m + c ………………………………….(13)

D_d = 2 + 0.25=2.25

D_d = 2 mm

13. Linear displacement of rack for one rotation of piston,

L = πm x T ………………………………………(14)

= π x 2 x 17

= 94.44

L= 106 mm

Maximum length of rack is 106 mm.

Width of rack is 10 mm

V. COST ESTIMATION

SR. no.	component	quantity	Manufacturing cost/quantity	Market cost (overall)	total
1.	Raw material (angles, square pipe…		-	3200	5600
2.	Bearings hub	3	400	600	1200
3.	bearings	3	-	240	240
4.	Steering wheel	1	-	900	900
5.	Wheels	2	-	1200	2400
6.	Linkage (steering.	2	-	900	1800

	.				
7.	Sprocket	2	-	300	600
8.	chain	1	-	150	150
9.	Leg holding assemly	1	-	400	400
10.	Brake and acc.	1	-	900	900
11.	Steering rod	1	-(4fit)	1100	1100
12.	Assembl y				1600
13.	fabricatio n				3700
	Total				20090

VI.CONCLUSION

We have designed the system which is usefull for handicapped person.and can reduce the spece required for steering.this system can also reduce the weight of overall system which is replaced by chain and sprocket mechanism.

VII. SCOPE FOR THE FUTURE SCOPE

We can implement more compact and light weight system which can reduce the overall system weight

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