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A Vehicle for Physically Challenged

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Abstract - **The aim of this project is to make a vehicle especially for people who have lost their hands due to some accidents in some point of time in their lives but this vehicle can be upgraded for people who have lost their legs as well with some modifications in the initial design. The specialty about this vehicle is that the steering, acceleration as well as the braking system is designed to be operated using the legs of the driver. This project has been an attempt to change the lives of the above mentioned section of the society. Changes have been done in the steering of a vehicle. A customized fork bolt has been designed for front wheel. The fork bolt is of larger length than usual and over this accelerator and brake pedals are placed on each side of the extended fork bolt. The pedals are attached to a foot rest for the comfort of the driver. The comfort of the driver has been taken care of by providing a comfortable seat and other safety precautions which shall protect the driver from any accident, etc. Through this vehicle a purpose is given to the physically challenged as using this vehicle, they would be able to help in transportation and give their contribution for the development of the society in the larger scale.**

I. INTRODUCTION

There are several types of wheelchair accessible vehicles. Many of these can accommodate wheelchair-bound people as passengers, but require someone else to drive. Some of these vehicles, however, can also accommodate a wheelchair-bound driver. To accomplish this, some modifications must usually be made to the vehicles.

Wheelchair accessible vans are the vehicles that most people think of when they hear about handicapped accessible vehicles. These are often modified so that a handicapped individual can enter the van easily. Ramps or lifts are usually attached to the vans to make this possible. These can be lowered and raised either by hand or by a small motor.

Purchasing or modifying wheelchair accessible vehicles can be quite expensive. Because of this, most towns and cities have wheelchair accessible vehicles available to the public. These buses or vans may travel around town on a designated route, or some services will go to a person's home to pick them up. These vehicles can often be rented for a small fee. Some organizations, such as churches or government agencies, may also provide access to these vehicles at no charge for low-income individuals. With today's technology, individuals in wheelchairs are not just restricted to being passengers in handicapped accessible vehicles. It is also possible for them to drive certain vehicles.

Therefore, there are certain modifications that must be made to a vehicle before this is possible. In wheelchair accessible cars and wheelchair accessible trucks, the driver's seats are often removed. This allows a wheelchair bound individual to simply maneuver the wheelchair in the driver's position. Some vehicles, however, have seats that make it easier for a handicapped individual to get into them. In this case, there is usually an area for storing and transporting a wheelchair until it is needed again. Since a paraplegic is not usually able to use regular pedals on the floor, other modifications must be made as well. A joystick is the most common. This can be used for acceleration and sometimes for steering.

Vans, cars, and trucks are not the only type of wheelchair accessible vehicles available today. Handicapped individuals can now even ride motorcycles. These often have three wheels instead of two, or they may have a side car attached. Like other types of handicapped vehicles, wheelchair accessible motorcycles are also operated using hand controls, or joysticks.

The project has been an attempt to make a vehicle exclusively for people who don't have hands. It is impossible for such people to steer the vehicle as they are deprived of hand control, so this vehicle which was made was to eliminate this problem by making suitable changes and the steering was brought under the control of legs. After steering, acceleration and braking are the other two important criterions. This was too solved by providing a accelerator and brake pedal nearby legs which shall be accessible to the driver. This concept is similar to a scooter where major controls are under the control of hands.

II. STEERING

Steering is defined as the collection of components, linkages, etc which allows an automobile to follow the desired course. It is a very important component in any automobile. The most conventional steering arrangement is to turn the front wheels using a hand operated steering wheel which is placed in front of the driver, via the steering column or rod which may contain universal joints which helps the vehicle to deviate from the straight line and thus

initiates in taking a turn either to the left or to the right depending upon the discretion of the driver.

2.1Counter steering

Counter steering is the technique used in two wheelers. In two wheelers when the rider has to initiate a turn, handle bars are used to steer in the desired direction. During this action the rider applies a momentary torque at the seats using the legs which causes the bike to lean towards right. This lean towards the right is called counter lean. This intensity of this lean depends on the mass moment of inertia of the vehicle, the amount of force applied by the driver on seats and speed of the vehicle. Now as counter steering occurs when the vehicle has to turn towards right, ground contact moves towards the left side of turn of the centre of mass and since vehicle is going straight, there is a generation of leftward lean which initiates the left turn and if the rider continues to lean further towards right which causes the ground contact more towards left thus reduces the rightward lean and thereby the intensity of turn is reduced and rider has straightened back out of the turn.This is the principle of counter steering.

III. COMPONENTS IN VEHICLE

3.1Brake

Brake is an important safety factor for any vehicle. As mentioned earlier, both front as well as rear brakes are necessary. Front brakes are useful to stop a vehicle with heavy load but to avoid skidding of the vehicle rear brakes are also employed. In the brake system, a common pedal for both front and rear brake has been used

Front brake - Drum brake (Mechanical type) Back brake - Disc brake (Hydraulic brake). The front brake was fixed right side pedal in front axle

Fig 3.1 Brake pedal

3.2 Steering System

A steering of a two wheeler with telescopic suspension was procured for the front wheel. Initially it was found that the diameter of the steering shaft was slightly big, so using spanner the telescopic suspension was removed and the shaft was machined according to the requirement and again assembled in the steering system. Using balls of size 14 the steering system was installed for free movement. Figure below shows the installation of the steering system.

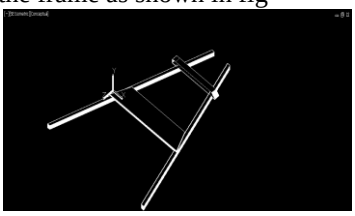
Steering system

CAD model of steer column

Fig 3.2

3.3 Frame

Frame is an important part in a chassis of a vehicle as it is in this part that all other components must be assembled in the end. Thus this part must be able to withstand all kinds of load applied to it. M.S. steel rectangular channel frame is used to make the frame as shown in fig



Frame

Fig 3.3

3.4 Engine Specifications

109cc, 4-stroke engine
Max power 8.00 Bhp at 7500 rpm
Max torque 8.74 Nm at 5500 rpm

3.5 Transmission drive

A Continuous Variable Transmission drive (CVT) was used as the transmission drive from engine to the shafts. Therefore the necessity of gear shift is avoided. The front and rear axle were made from M.S. rods whereas the bearings were bought from the market. The bearings are made out of cast iron

IV. DESIGN CALCULATIONS

4.1 Transmission System-Design Calculation

4.1.1 Sprocket

Diameter = 120mm
Mass, p = 0.5 kg = 4.90 N
Velocity, v = 20 m/s (assumed)

4.1.2 Engine

Weight = 200 kg = 1962 N
Torque, T = 0.5 X D X w =117720 N-mm
Power, P = 12.32 KW (assume N=1000 RPM)

4.1.3 Chain Drive

- Selection of Transmission Ratio
  i = N_1/N_2 = 2
  N_1 = speed of driven shaft = 2000 RPM
  N_2 = speed of driving shaft = 1000 RPM

- Select The Number Of Teeth
  Let z_1 = 27, therefore z_2 = 54

- Selection of Standard Pitch
  P_{max} = a/30 = 600/30 = 20
  P_{min} = a/50 = 600/50 = 12 (assuming centre distance a= 600 mm)
  Standard pitch = 15.875 mm

- Selection Of Chain
  Roller chain DR-50 IS SELECTED

- Calculation of Total Load Acting On the Sprocket
  P_T = (tangential force due to power transmission p_t) + (centrifugal tension due to speed of the chain p_c) + (tension due to chain sagging p_s)
  p_t = 1020 N/v=1020 x 12.32/20 = 628. 32 N
  $p_c = mv^2$ = 712 N
  m = mass of roller chain =1.78 kg/m
  v = 20 m/s
  P_S = Kwa =64458 N
  k = 6; w = m x g = 17.905 N/mm; a = 600 mm
  Total load acting on the sprocket = (p_t) + (p_c) + (p_s) = 65798.32 N
- Calculation of Service Factor
  $K_1 = K_2 = K_4 = K_6 = K_5 = 1$
  K_3 = 1.25
  K_5 = 0.8

- Calculation of Design Load
  Design load = p_t x k_s = 65798.32

- Calculation of Working Factor of Safety
  f_{sw} = breaking load/design load = 44400/65798.32 = 0.674

Since f_{sw} < FOS, design is unsafe so we increase the diameter of the roller thus the design load increases, hence the design becomes safe
S = 65798*1/140 = 469.98 N/mm^2
As we increase the roller diameter, the allowable shear stress increases then
Bearing stress < allowable shearing stress

- Actual Length of Chain
  $L_P = 2a_p + ((z_1+z_2)/2) + (((z_2-z_1)/2)^2/a_p)$ = 122 mm
  Length of chain = 122 x 15.875 = 1.93 m

- Calculation of Exact Centre Distance
  $a = (e+ (e^2-8m)^{(1/2)})*p/4$ = 630.9 mm
  $e = l_p-((z_1+z_2)/2)$ = 79.5 mm
  $m = ((z_1-z_2)/2)$ = 1.24 mm
  Decrement in centre distance = 0.01 x 630.90 = 6.30 mm
- Exact Centre Distance = 630.9-6.3 = 624.5 mm
- Calculation of Pitch Circle Diameter
  $d_1 = P/ (\sin 180/z_1)$ = 136.70 mm
- Diameter of Large Sprocket
  $d_2 = P/ (\sin 180/z_2)$ = 273.21 mm
  $d_{o1} = d_1+0.8d_r$ = 144.8 mm
  $d_{o2} = d_2+0.8d_r$ = 281.33 mm

"The Sprocket used is a Centrifugal Sprocket"

4.2 Steering Calculation

4.2.1 Outer Steer Angle

$(1/\tan\beta a) – (1/\tan\beta i) = (s/lkt)$

Now here since there is only a single wheel at the front we thereby neglect the inner steer angle and hence we calculated

Outer steer angle = 57.70 deg

4.2.2 Turning Radius

rs = lkt/ sinba

Here we neglected the scrub radius and deviation of the outer steer angle and we calculated

Turning radius = 2.115 m

4.3 Braking Distance

Assuming average force applied to brake pedal (F_{bp})
F_{bp} = 360 N
By linkage mechanism the force is multiplied to 3600N
Average deceleration = force on wheels/weight = 3600/ (150 x 9.81) = 2.44m/s^2
Velocity of the vehicle (v) = 1000rpm = 10.5m/s
Stopping distance = $v^2/(2 \times g \times a)$
= $(9.5^2)/ (2 \times 9.81 \times 2.04)$
= 2.30m (approx)

V. FABRICATION OF THE VEHICLE

- MS steel was procured to make the frame as it was readily available .Tools such as cutter etc were procured and arc welding was selected for welding
- After designing the dimensions of the frame and completed with the calculation, steel rod of square cross section 6x6 cm^2 was cut according to the required dimensions and welded using arc welding as per design
- Now the rear axle was machined according to the given dimensions and was welded along sprocket and attached to the frame using bearings.
- Later the fork belt was specially machined with a extended length than usual
- Then HONDA-DIO engine was mounted to the vehicle
- The transmission system was installed next, then wheels were attached to the vehicle
- Brakes and Accelerator pedals were fixed at the front through the fork bolt
- Seat was inserted, body was covered using sheet metal and painted to give a aesthetic look
- Seat belts and other safety precautions were taken care of after the above procedure

Welding include	cost (in rupees)
chases	2000.00
Body	1000.00
steering	600.00
engine	3000.00
Front suspension	700.00
Braking system &pedal	500.00
Accelerator system and pedal	500.00
seat	100.00
paint	50.00
Chain transmission and wheel	200.00
sprockets	100.00
General Costs	1000.00
TOTAL	9750.00 RUPEES

Budget Table
Table 5.1

VI. FUTURE DEVELOPMENTS

6.1 Electric Vehicle For Physically Challenged:

These days the pollution levels are rising at an alarming rate and this is leading to global warming, etc which potentially has drastic effects on human society as well our planet at a larger scale. Hence in our future development of our vehicle we want to bring out the electric version of our car which will be eco- friendly and also shall be a part of the changing times.

We plan to keep a DC motor operated by a battery with proper speed control facilities to the driver. The design specification for the motor and battery are done and are as follows.

6.2 Solar Physically Challenged Vehicle

Electricity generation has also been a major problem in our country. Power crisis is a major problem in our country. Sun is the primary source of energy. Living forms derive their energy from sun either directly or indirectly. Henceforth we even plan to bring in a solar powered vehicle. The concept of this is very simple. We shall make some design changes in our frame such that we can accommodate solar panels. These solar panels shall absorb the light rays from the sun and using this solar energy shall be converted into electrical energy using electrical circuits and shall be stored. This stored electrical energy shall be the power drive of our vehicle. India is very rich in solar energy and so we plan to implement it in future. Additional source of power like a battery will also be placed in case of emergency situations

6.3 Accessories

Presently, the vehicle is started using the kicker available. But for the easy convenience, we plan to keep an electric start or self start system which shall consist of a button kept in such a way that it will be comfortable to press using legs. If possible we would like to have a voice controlled start which is mostly found in high end cars. Safety is always the prime importance for any vehicle and since it is a vehicle for specially challenged people we shall try to improve our ergonomics of our vehicle by keeping a cushioned seat so that the driver can leisurely sit and drive. We even plan to keep an electronic system consisting of a GPS. this system shall help the driver during breakdown as once any situation arises, the system shall send a message or automatically call up nearby mechanic sheds who can help the needy and since people without hands can't put up seat belts we even plan to keep a system which shall ensure the seat belts of the driver are put on at a press of a button. This prevents the driver from the inertial effects. Many small innovative ideas can be so implemented so as to improve the driving experience as well as increase the safety of the driver.

CONCLUSION

A Vehicle is designed and fabricated especially for a person who has lost his hands but with further improvement in designed it can be upgraded for people who can't walk properly as well. The vehicle was found to be in perfect control even as steering was done by legs. Initially the engine has to be started using a kicker but that can be eliminated by using a electric start as available in many

automobiles. An attempt has been made and all the drawbacks were studied in detail and for future development all necessary actions will be taken to overcome all the drawbacks and provide a vehicle to the physically challenged people which will not only be beneficial for the society but also improve the self-confidence in such people.

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