ISSN XXXX XXXX © 2018 IJESC

Research Article Volume 8 Issue No.8

Design and Fabrication of Rowing Human Powered Car

Krishna Prasad s[1], Megharaja M L[2], Abhishek M D[3], Chandan S[4], Prashanth N S[5]
Professor[1], B.E. Scholars[2, 3, 4, 5]
Department of Mechanical Engineering
Maharaja Institute of Technology, Mysore, India

Abstract:
Human powered car is a combination of rowing machine and a human powered vehicle. Rowing machine is a device used for exercising purpose to stay fit and healthy. This project deals with developing of a Human Powered Rowing Car that uses human energy to drive the vehicle. The main objectives behind this project is to build a suitable mode of transportation which would utilize human energy in an efficient way to be used for driving the vehicle such as it runs faster than the present day human powered vehicles i.e., pedal operated bicycles, tricycles, row bike etc., Human powered car is a combination of rowing machine and a human powered vehicle. Rowing machine is a device used for exercising purpose to stay fit and healthy. This project deals with developing of a Human Powered Rowing Car that uses human energy to drive the vehicle. It is an impact-free exercise mechanism to stimulate the human gait, primarily used to burn calories at a faster rate to stay fit and healthy. In a world that is running out of fossil fuels, harvesting human kinetic energy will provide an immediate solution to various mechanical challenges and fuel limitations. Also harvesting human energy can also be a tool behind solving the problem. The methodology adopted to achieve the concept are studying the rowing linkages, steering linkages, chain drive and components, design and fabrication of chassis, allocation of parts and experimentation and testing, using this technology has an urban mobility vehicle, thus eliminating all kinds of pollution.

1 INTRODUCTION

Human powered transportation is no match for load capacity, speed, comfort and convenience of current mechanized transportation system, there is renewed interest in human powered transportation. Besides cost, environmental and health benefit, worldwide, bicycle will remain as a popular mode of transportation for indefinite future.
Human powered car is a combination of rowing machine and a human powered vehicle. Rowing machine is a device used for exercising purpose to stay fit and healthy. This project deals with developing of a Human Powered Rowing Car that uses human energy to drive the vehicle. It is an impact-free exercise mechanism to stimulate the human gait, primarily used to burn calories at a faster rate to stay fit and healthy. Recent awareness in energy consumption and environment has generated interest in eco-friendly transportation system in both developed and developing regions of the world. Government and private sectors are encouraging innovative development and use of energy efficient vehicles for transportation of people and goods. Design and development of such systems is a popular design issue in both academia and industry.
HPV may be bigger in size compared to the bicycle. It is been used for many activities to have leisure time around, exercising, hobbies, interests and even going to school or workplace. Other than being environmental friendly, it is also available to be used anytime, anywhere as it does not need any other gas or electrical demand. Furthermore, in urban area, people will not suffer from the boredom of traffic jam.
There is a wide demand for devices that aid in physical conditioning. While there are many hundreds of exercise machines on the market, there is always a demand for new strength training apparatus. Human-powered vehicles may be used to teach teamwork skills, provide strength training, and to provide other tangible benefits. Human powered car is an exercise-enabled vehicle; it is possible for one, two, three or four people to operate the bi-directional human-power interface.

1.1 Indoor Rowing Machine

An indoor rower, or rowing machine, is a machine used to simulate the action of watercraft rowing for the purpose of exercise or training for rowing. The indoor rower is calibrated to measure the amount of energy the rower is using through their use of the equipment. All rowing-machine designs consist of an energy damper or braking mechanism connected to a chain, strap, belt and/or handle. Footrests are attached to the same mounting as the energy damper.
At the current state of the art, indoor rowers which utilize flywheel resistance can be categorized into two motion types. In both types, the rowing movement of the user causes the footrests and the seat to move further and closer apart in co-ordination with the user's stroke.

FIGURE 1.1.1 Indoor Rowing machine

The First type is characterized by the Dreissigacker/ Williams device. With this type the flywheel and footrests are fixed to a stationary frame, and the seat is free to slide fore and aft on a rail or rails integral to the stationary frame. Therefore, during use, the seat moves relative to the footrests and also relative to ground, while the flywheel and footrests remain stationary relative to ground. This type is sometimes referred to as a "stationary" or "fixed head" rowing ergo meter.

The Second type is characterized by the Rekers device. With this type, both the seat and the footrests are free to slide fore and aft on a rail or rails integral to a stationary frame. Therefore, during use, the seat and the footrests move relative to each other, and both also move relative to ground. This type is often referred to as a "dynamic" rowing ergo meter, although "dynamically balanced" would be a more accurate description.

Jing-Shan Zhao, et al [1] focuses on the synthesis of a steering mechanism that exactly meets the requirements of Ackermann steering geometry. this article investigates the turning geometry for steering wheels and proposes a steering mechanism with incomplete noncircular gears for vehicle by transforming the Ackermann criteria into the mechanism synthesis. The pitch curves, addendum curves, dedendum curves, tooth profiles and transition curves of the noncircular gears are formulated and designed. Kinematic simulations are executed to demonstrate the target of design. The generally used steering mechanisms for four wheel vehicles are four-bar linkages which are often called Ackermann-type steering mechanisms. The input motion from the driver at the steering wheel is transmitted via a steering box and the steering control linkage to one of the steering knuckles and then transmitted to the other one through the Ackermann steering linkage. The main kinematic requirement of the steering linkage of a vehicle is to provide the steerable wheels a correlated pivot such that their axes intersect at a point on the rear wheel axis. The objective for the synthesis of steering mechanism is to minimize the difference between the steering centres over the full range of steering angle inputs while fitting into a reasonable space.

Avishek Mishra et al [2] focused on convertible wheel drives using chain sprocket. This mechanism eliminates the need of gearing and rope pulley mechanism to transmit power. A two wheeler is an example of local transport. Many vehicles are designed as to transfer power to rear wheel, forward wheel or sometimes both forward and rear wheel. In two wheelers is most common practice is to use the chain sprocket mechanism to transfer the power from engine to wheels. This paper is study and review of experimental work brought by researchers on drive mechanism of cycle in order to optimize its operating performance. This method of transferring the power is also more suitable than the shaft drive mechanism.

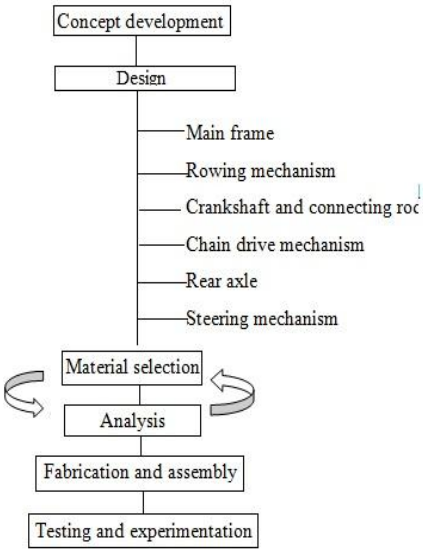
Kazuto Miyawak, **et al [3]** proposed that apparatus consists of a rowing machine and Functional Electrical Stimulation (FES), that can be was actually developed to train rowers and can train the legs and upper body parts most effectively. Move over FES can assist the exercise of the legs by using surface electrical stimulation. An experiment was conducted and the results prove that the developed apparatus can train the muscles of the person of advanced age effectively and can compensate exercise shortage. Development of better rehabilitation machines and equipment is important to resolve this problem and to preserve the health of elderly people in daily life. This study specifically addresses rowing machines. Rowing machines are aerobic exercise machines, as are running machines and bicycling machines. Aerobics exercise can alleviate hypertension, obesity, to sole pressure. Results showed differences among individuals at each examination, demonstrating that a load mechanism requires a load control system.

Alessandro Filippeschi, et al [4] focuses on the dynamic models employed to simulate out rowing, as well as on the modelling of team behaviour, in order to set up visual feedback for team rowing training. These models are employed for controlling the output in the virtual environment, in particular for training the inter-rower synchronization in a team. The proposed system has been evaluated by addressing several aspects of the rowing skill combined with research questions in the domain of training in virtual environment. Looking at the evaluation in terms of skill elements this work has considered the following: Technique of the stroke that is based on motion patterns and timing of actions Energy management at the level of race Coordination among members of the crew in team rowing. A common methodology and implementation has been employed.

2 OBJECTIVES

The main objective of the project is to design and develop an eco-friendly vehicle. To utilize the human effort effectively and efficiently to propel the vehicle forward and to eliminate the Problem of balancing in human powered car.

3 METHODOLOGY



3.1 WORKING PRINCIPLE

The rowing mechanism is made up of 2 individual mechanisms in which four people sit back-to-back on the mobile seats and hold controls on long levers. Both seats and controls connect together with thrust bearings, and they synchronously rock back and forth, much like the manner of seats and oars in sport kayaks. This rocking motion is converted into rotary motion by the use of crank shaft and connecting rod. The rotary motion is transmitted to the rear axle which moves the vehicle forward. The steering of the vehicle is achieved by a handle provided which is interconnected with the steering mechanism working on the basis of the Ackerman steering principle. The braking is carried out by the drum brakes which are housed inside the wheel hubs.

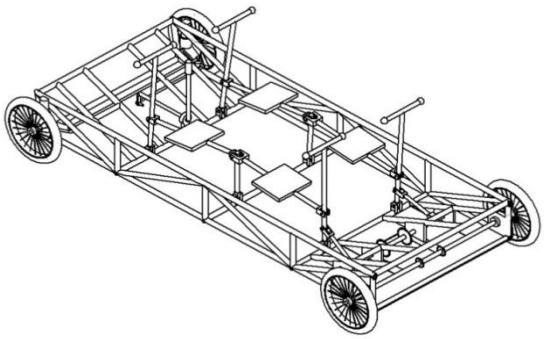


FIGURE 3.1.1 Working principle of Human Powered Car

4 DESIGN AND CALCULATIONS

The main objective of the project is to design and develop an eco-friendly vehicle.

4.1 Rowing mechanism

To find the force exerted at a point on the handle nearer to the pivot point when a force is applied at the far end of the handle, using the leverage equation to find the unknown force.

i.e., $F = \left[\frac{L_1+L_2}{L_2 \cos \varphi}\right] F_{Load}$

$$F = \left[\frac{685+133}{133 \cos 75.52}\right] 242$$

F = **5952.56N**

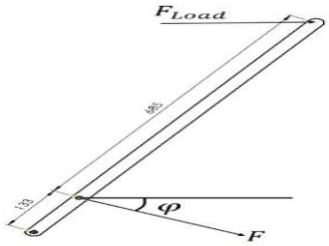


FIGURE 4.1.1 Force analysis on the handle

4.2 Crankshaft and connecting rod

To find the maximum torque available at the crankshaft

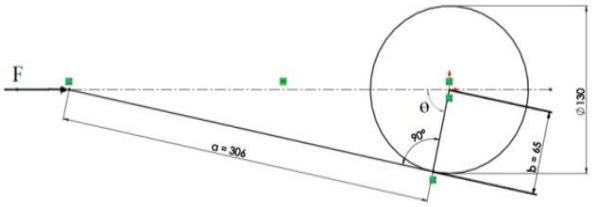


FIGURE 4.1.2 Determination of Torque at the crankshaft

$$\text{Torque} = -F.b.\sin\theta - \left[\frac{F.b^2.\sin\theta.\cos\theta}{\sqrt{a^2-b^2\sin^2\theta}}\right]$$

$$= -5952.56 \times 65 \times \sin 78.03 - \left[\frac{5952.56\times 65^2 \times \sin 78.03 \times \cos 78.03}{\sqrt{306^2-65^2\sin^2 78.03}}\right]$$

= -395550.67 N-mm

= -3955.5 N-m

The maximum torque available at the rear axle will be
Torque available at the rear axle= Torque available at the crank shaft/speed ratio

= 3955.5/1.77

Torque available at the rear axle=**2234.75 N-m.**

4.3 Steering mechanism

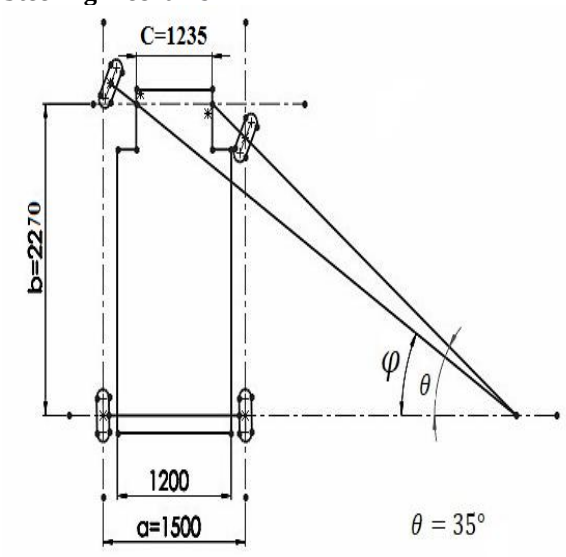


FIGURE 4.3.1 Determination of Turning radius

$$cot\varphi - \cot\theta = \frac{c}{b}$$

$$cot\varphi - \cot 35 = \frac{1.235}{2.27}$$

$$\frac{1}{\tan\varphi} - \frac{1}{\tan 35} = \frac{0.8}{2.244}$$

$$\varphi = 26.88$$

Turning radius:

Inner front:

$$R_{IF} = \frac{b}{\sin\theta} - \left[\frac{a-c}{2}\right]$$

$$= \frac{2.27}{\sin 35} - \left[\frac{1.5 - 1.235}{2}\right]$$

$\boldsymbol{R_{IF}}$ **= 3.825 m**

Inner rear:

$$R_{IR} = \frac{b}{\tan\theta} - \left[\frac{a-c}{2}\right]$$

$$= \frac{2.27}{\tan 35} - \left[\frac{1.5 - 1.235}{2}\right]$$

$\boldsymbol{R_{IR}}$ **=3.109 m**

Outer front:

$$R_{OF} = \frac{b}{\sin\varphi} - \left[\frac{a-c}{2}\right]$$

$$= \frac{2.27}{\sin 26.88} - \left[\frac{1.5 - 1.235}{2}\right]$$

$\boldsymbol{R_{OF}}$ **=5.153 m**

Outer rear:

$$R_{OR} = \frac{b}{\tan\varphi} - \left[\frac{a-c}{2}\right]$$

$$= \frac{2.27}{\tan 26.88} - \left[\frac{1.5 - 1.235}{2}\right]$$

$\boldsymbol{R_{OR}}$ **=4.611 m**

The minimum turning radius of the vehicle is **3.109 m**

5 FABRICATION AND ASSEMBLY

5.1 Chassis and frame mounting

The material used for the construction of the chassis is usually mild steel. The next process in the production line is Welding. Welding provides rigidity, uniformity and high strength to the chassis. A variety of welding equipment available at Pressmark ensures that high volumes of work and short lead times are achieved. Arc welding is used to weld the chassis.

FIGURE 5.1.1 Chassis and frame mounting

5.2 Allocation of crankshaft and connecting rod

The crankshaft is composed of a solid shaft, eccentric plates and drive sprockets. The eccentric plates are drilled at an eccentric radius of 65 mm from there centre. The connecting rod of length 305 mm center to center distance is connected to eccentric plate with fatteners. The other end of connecting rod is pivoted on to the handle bar at a suitable height.

FIGURE 5.2.1 Crankshaft and connecting rod Assembly

5.3 Allocation of rear axel

The rear axle is made up of a solid shaft of mild-steel of 20mm diameter which is step turned to a diameter of 16 mm and keyed to allocate the wheels. the rear axle is threaded on either ends to fasten wheels and break assemble. The rear axle is mounted on the frame with the help of 4 bearings. 2 wheels are mounted on either ends. Also the smaller sprockets of the chain drive mechanism are fastened to the rear axle at the centre, parallel to the bigger sprockets on the crank shaft. The breaks are of drum break type. The wheels are directly taken from TVS-XL super.

FIGURE 5.3.1 Rear axle Assembly

5.4 Steering linkage connection to front wheel

We have used simplified version of an Ackerman steering mechanism, it consist of wheels mounted on king pins and connected together by a tie rod. the turning of the wheel is controlled by the handle provided which when moved right or left, pulls or pushes the drag rod which in turn steers both wheels in the same direction.

FIGURE 5.4.1 Steering linkage Assembly

FIGURE 5.5.1 Final Assembly of Rowing Human Powered Car

6 RESULTS AND DISCUSSION

Each and every part of the vehicle undergoes different loads at different times, these loads will have different effects on each part. The effect may be negative at times, failures can occur at any point on any part. To prevent from these happening we have to evaluate each and every part with the load that will be applied on them using analysis software like ANSYS. The results this of analysis will aid the selection of the materials and their basic cross section and size.

The rowing human powered car based on the required consideration is made ready with all connections and supports on the chassis frame the outcome of the vehicle is expected to run the vehicle using the human effort which will be converted in to the torque required to propel the vehicle forward. This is achieved from the combinations of various rowing linkages, crank shaft and connecting rod, drive mechanism. The crank shaft convert the available rowing motion from the linkages into rotary motion which is further amplified using chain drive mechanisms. This in turn results in the forward motion of the vehicle. The direction control of the vehicle is achieved by the steering linkages.

7 CONCLUSIONS

At the completion of this project we can conclude that we have achieved our primary objectives. As proved by testing the vehicle is capable of withstanding various loads, carry the passengers and transport them from one place to another at the expense of their own human effort. The torque produced from the combined effort of all the passengers is sufficient enough to propel the vehicle forward and the steering mechanism perform is function as expected in the design stage.

This Project work has been carried out to provide people with a new vehicle which is energy efficient, eco-friendly and economical thereby contributing our role in safeguarding the mother earth.

8 REFERENCES

1. Avishek Mishra1, Prabhat K.Singh2, Md. Shahrukh Haque3, Ghanshyam Kurre4, Sandeep Rathor5 , Mr. Chova R. Sahu6, Literature Survey of Convertible Wheel Drives Using Chain Sprocket, Vol-2 Issue-2 2016 IJARIIE-ISSN(O)-2395-4396

2. Kazuto Miyawaki,TakehiroIwami, Goronata.Yoichi, imada Toshiki, MatsunagaMine, YoshiSato, Development of FES-Rowing Machine. Dynamic models of team rowing for a virtual environment rowing training system.

3. Alessandro Filippeschi1, Emanuele Ruffaldi1, Antonio Frisoli1, Carlo Alberto Avizzano1, Manuel Varlet2, Ludovic Marin2, Julien Lagarde2, Benoit Bardy2, and Massimo Bergamasco1 The International Journal of Virtual Reality, 2009, 8(4):49-56 49,

4. Popular science magazine, The Future of Energy-Power from the People Date: March-2009

5. A Futuristic Automobile Innovation (article)Date:April-2009