

Design of Cluster Bike - A 5 Person Peddling Social Bike

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ABSTRACT

Consumption of energy and resource conservation are the major concerns in today's world. There is also a greater emphasize for the usage of renewable energy sources. In this context, this work provides a way of a travelling group of people in a single-vehicle which is a peddle operated. In a Cluster Bike, 5 persons will be seated in a circular manner and all will simultaneously pedal to propel the bike forward. Steering is provided to one person who is in-facing with the vehicle movement direction. The braking control will be given to the same person who will be steering the bike. The mechanism for power transmission is a bevel gear system. A flexible drive system is included in the transmission to transfer power from five different shafts to a single shaft which is in turn linked to the rear wheels. The main intention of this project is to bring in people to interact with others while traveling. A cluster bike will be a good alternative for people who travel in groups and they just do not have use any other source of energy to do so. Thus this bike can be the best choice in an in-campus traveling where students in the universities or employees in the company can move around the campus in groups. A ride in a cluster bike is not only joyful but it is also a test of coordination between the riders. The vehicle is designed to provide an environmentally friendly bike and to make people associate with others in a free while even in a busy routine.

Key Words: Cluster bike, Power transmission, Flexible drive system, Bevel gear, Coordination.

1 INTRODUCTION

Transportation has become a major part of our life. Movement of any vehicle can be made easy with the mechanics which will be used for travelling. But, utilization of man power is getting depleted day by day. With these aspects, we can say that in future there might be no proper usage of our own power. Implementation of modern technology with the help of little amount of man power can be a complete trailblazing in today's world. One easy way to bring people together is by Cluster bike. A cluster bike is a 5-person pedal operated positive drive vehicle and requires no special skills as well. It is an absolute revolutionary bike for transportation as well as a plan to get associated with the people who are within the cluster bike and a better tool to build up the network. Cluster bike can be used as a tour bike for the tourists as well as to look around the bigger campus and universities such as Google, Apple, IIT's.

2 LITERATURE SURVEY

- IDC IIT Bombay, "Quadracycle"

Quadracycle is basically a 4 person peddle operated cycle but are seated almost in-line. It emphasis on the comfort of the person riding the vehicle. The seats are semi-reclined which provides a much broader distribution of the body weight. They have also used the concept of agile motion which is dynamic state of motion. The suspension used provides great comfort for the rider as per the tests conducted.

- Bambang Iskandriawan, “Tandem bikes to reduce pollution”

As the population of the Nation is increasing day by day, the number of vehicles per kilometer of pathway is also increasing. Due to which there will be an increase in air pollution. Air pollution and can be reduced with the use of tandem bike as more than two number of people can travel without any hassle and annual production is also increased at the same moment.

Conclusion of literature survey : From the above literature surveys, we got to know that the efficiency of the vehicle is a bit low when load increases and also when comfort of the rider is concerned .A simple mechanism which will provide greater transmission efficiency is what is focused.

3. METHODOLOGY

Case Study: The literature survey was carried out which included the survey of projects of mechanical propulsion vehicles.

2-D Drafting: 2-D drafting is done hinge on the simple 2-D sketching done. Drafting was carried out in the software named SOLID EDGE. Which is a brief outlook design of the project.

3-D Designing: 3-D design is purely developed by the 2-D draft with some additional accessories. The design was accomplished in the software named CATIA V5.

Selection of raw materials: Selection of raw materials depends on many factors like-mechanical properties of the material, machinability of the material, cost etc. Considering all the above factors the material is suitably selected.

Fabrication: Fabrication is carried in stages like- fabrication of frame, transmission system, other supporting structures etc.

Assembly: With all the fabricated products the assembly will be carried out and static testing is accomplished on the model simultaneously.

Testing: The final assembled product is tested in the actual working conditions.

4 DESIGN AND CALCULATIONS

Force applied on the pedal:

By neglecting the losses due to friction, ie considering the components to e working under ideal condition, the force applied on the pedal is-

$$F = \frac{T \times R}{L_c} \text{ ----- (1)}$$

Where, T = Tension in the chain=Inertia force(I_m)

R = Radius of crank

L_c = Length of crank

F = Force applied on the pedal

$$I_m = \frac{W}{g} \times a \text{ ----- (2)}$$

$$= \frac{3120 \times 5}{9.8}$$

$$I_m = 2000 \text{ N}$$

$$\text{Therefore, } F = \frac{2000 \times 9.1}{17}$$

$$F = 1070.58 \text{ N}$$

Stresses in the chain:

Tension on the chain is equal to the inertial force I_m ,

The stress distribution in chain depends on the cross section of the chain and is not uniform, therefore stress concentration factor K , needs to be considered.

The maximum stress induced in the chain ,

$$\sigma_{max} = \sigma_{nom} \times K \quad \text{-----} \quad (3)$$

Where; = maximum stress in the chain

K = stress concentration factor (Assumed to be 2.4)

σ_{nom} = nominal stress in the chain

A = cross sectional area of the chain

F = tension in one arm of the chain

$$= 2.4 \frac{\left(\frac{1000}{2}\right)}{(2.5 \times 10^{-3}) \times (8 \times 10^{-3})}$$

$$= 120 \text{ MPa}$$

Stress in pedal wheel

The stress induced in the wheel is due to resistance of the chain for the movement which induces the stress in the spike of the wheel ,The area on the base of each spoke is roughly $3.175 \times 10^{-3} \text{m}$ by $9.525 \times 10^{-3} \text{m}$.

$$\tau_{xy} = \frac{F}{A} \quad \text{-----} \quad (4)$$

$$= \frac{2000}{(3.175 \times 10^3) \times (9.525 \times 10^3)}$$

$$\tau_{xy} = 66.14 \text{ MPa}$$

Length of chain:

$$L = K \times P \quad \text{-----} \quad (5)$$

where ,

$$K = \frac{T_1+T_2}{2} + \frac{2x}{P} + \left(\frac{T_2-T_1}{2}\right)^2 \frac{P}{x} \quad \text{-----} \quad (6)$$

where, L = length of chain

x = Center distance between the two sprockets

P = Pitch of the chain

T_1 = no of teeth on the smaller sprocket

T_2 = no of teeth on the bigger sprocket

Here let $T_1 = 32$ and the ratio of $\frac{T_2}{T_1} = 1.5$ (say) then $T_2 = 48$

$$K = \frac{32+48}{2} + \frac{2 \times 50}{12} + \left(\frac{48-32}{2}\right)^2 \frac{12}{50}$$

$K=50.25$

$L=50.25 \times 0.012$

$L=0.603 \text{ m}$

Stresses in the pedal crank

$$\sigma_y = \frac{32FL_c}{\pi d^3} \text{ ----- (7)}$$

$$= \frac{32 \times 1070.58 \times 170}{\pi 20^3}$$

$\sigma_y = 231.72 \text{ N/mm}^2$

$$\tau = \frac{16FL_p}{\pi d^3}$$

$$= \frac{16 \times 1070.58 \times 130}{\pi 20^3}$$

$\tau = 88.60 \text{ N/mm}^2$

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \left(\frac{\sigma_x - \sigma_y}{2} + \tau_{xy}^2 \right)^{\frac{1}{2}} \text{ ----- (8)}$$

here, $\sigma_x = 0$. Therefore

$$= \frac{231.72}{2} \pm \left(\left(\frac{231.72}{2} \right)^2 + 88.60^2 \right)^{\frac{1}{2}}$$

$\sigma_{1,2} = 261.71 \text{ N/mm}^2, -29.99 \text{ N/mm}^2$

$$\tau_{max} = \frac{\sigma_1 - \sigma_2}{2}$$

$$= \frac{261.71 - (-29.99)}{2}$$

$\tau_{max} = 291.7 \text{ N/mm}^2$

Torque transmission Capacity

$$T = S_s \pi \frac{d^4}{16} \text{ ----- (9)}$$

where S_s = Shear strength (Assumed to be 360 MPa)

$$= (360 \times 10^6) \pi \frac{0.02^4}{16}$$

$T = 11.3 \text{ N-m}$

Turning radius and steering angle

Considering the turning angle $\theta = 45 \text{ deg}$

$$r = \frac{s}{\left(2 - 2 \cos \left(\frac{2\theta}{n} \right) \right)} \text{ ----- (10)}$$

where, n = Steering ratio (let $n=1$)

S = Wheel base

θ = Steering angle

r = turning radius

$$r = \frac{1.8}{\left(2 - 2\cos\left(\frac{2 \times 45}{1}\right)\right)}$$

r = 1.27 m

5 MODELLING



Fig1: Isometric view

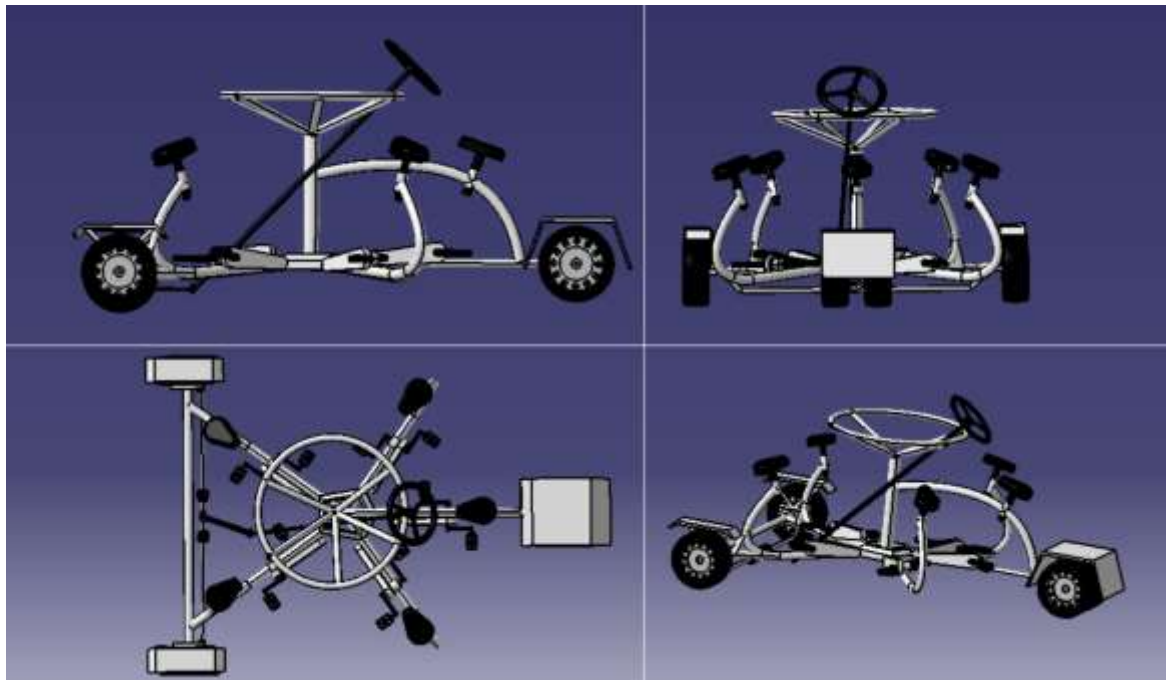


Fig2: Design views

6. SCOPE

Transportation can be made easier and economical with the help of cluster bike. With that, a good mode of communication can be made with different employees/people.

<i>Cluster bike</i>	<i>Individual bicycle</i>	<i>Motored vehicle</i>
No fuel is required for travelling.	No fuel is required for travelling.	Fuel is required for travelling.
5-persons can travel at a time.	Maximum 2 persons can travel at a time.	Maximum 2 persons can travel at a time.
Little amount of man power is required.	More amount of man power is required.	Use of fuel to propel the vehicle.
Cost is low as 5-persons are travelling at a time.	Cost is a bit higher.	Cost is high
Efficiency of the vehicle is high.	Efficiency of the vehicle is a bit low compared to cluster bike.	Efficiency is low.

7. CONCLUSION

- The vehicle provides a way of traveling in a group with an eco friendly bike.
- Based on design it can be stated that less amount of human power is required.
- Cluster bike can be used in tourist spots to move around in groups.

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