Design & Fabrication of Amphibious Bicycle

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Abstract
Man has, since early times, conceived in fanciful illusions of a device that would travel on both land and water. Such devices were soon created in the form of bicycles and were in fact patented and constructed with varying degrees of success. Amphibious cycle is a transport that can move on the land or surface of the water, both .Usually people ride it for entertainment or exercise purpose. It applies the cycling principle or mechanism to move the bicycle. People will cycle on the pedal and this will move the propeller which is connected with it. By this, the water bicycle will move forward. The present work is intended to substantially reduce, if not obviate, certain of the more prevalent disadvantages and shortcomings explained hereinabove with respect to prior art aquatic cycles. Specifically, this work is directed to an aquatic cycle which is of amphibious capability and which may be as easily and reliably operated on land as on water. In the present thesis, attention is focused on developing a new product which is named as Amphibious Bicycle The present work is intended to substantially reduce, if not obviate, certain of the more prevalent disadvantages and shortcomings explained hereinabove with respect to prior art aquatic cycles. Specifically, this work is directed to an aquatic cycle which is of amphibious capability and which may be as easily and reliably operated on land as on water. In this paper an attempt was made to design and fabricate a model of amphibious bicycle which will allow smooth transition from water to land during transportation. After that several test has been performed on the fabricated model to check it feasibility in real life.

Keywords: Renewable, Amphibian Vehicle, Water-Bike, Drag Force Test, Buoyancy

Introduction

Amphibious cycle is a means of transportation that can move on both land and surface of the water. Usually people ride it for entertainment or exercise purpose. It applies the cycling principle or mechanism to move the bicycle. People will cycle on the pedal and this will move the propeller (Blades) which is connected with it. By this, the water bike will move forward.

Man has, since early times, conceived in fanciful illusions of a device that would travel on both land and water. Such devices were soon created in the form of bicycles and were in fact patented and constructed with varying degrees of success. Early works bear evidence to man's such early desires. Devices such as these, though illustrating a reduction to practice of man's interest, fell far short of a both practical and commercially feasible cycle construction. Such devices were, for example, incapable of aquatic guidance. Aquatic stability was hazardous. Deployment of pontoons and retraction thereof upon re-entry to land was complex, time consuming, and frequently frustrating. Moreover, mobility in the water was unsatisfactory as power transmission mechanics was crude and inefficient. In addition to all these shortcomings, few if any of the prior art aquatic bicycles were capable of either or both land and water operation and by no means could they, in reality, be considered so readily convertible as to be termed "AMPHIBIOUS". It is with these shortcomings in mind that we were conceived, in the form of the present work, a Design and Fabrication of Amphibious Bicycle.

Literature Survey

There are many types of amphibious vehicles that exist around the world. For example, the design which has probably received the most coverage is Saidullah's Bicycle. The bike uses four rectangular air filled floats for buoyancy, and is propelled by using two fan blades which were attached to the spokes.

Fig 1: Dwarka Prasad amphibian bicycle

Fig 2: Saidullah's amphibian bicycle (Noor Bicycle)

Research Gap/Findings

The present work is intended to substantially reduce, if not obviate, certain of the more prevalent disadvantages and shortcomings explained herein above with respect to prior art aquatic cycles. Specifically, this work is directed to an aquatic cycle which is of amphibious capability and which may be easily and reliably operated on land as on water.

A principal feature and object of the work therefore is to provide a readily retractable and deployable flotation mechanism which is adapted to be carried by the cycle in retracted position when the cycle is operated on the land and in the deployed position when operated in water.

Another object of this work is to provide a readily deployable flotation mechanism which imparts reliable stability to the vehicle when it carries a passenger in the water.

A still further feature and advantage of the work is the provision for an amphibious bicycle in which the conventional pedal type propulsion system used on land is readily converted to and utilized for the motive power in water.

1. To design such an amphibious bicycle which will allow smooth transition from water to land during transportation.

2. To optimize the speed requirement of the bicycle.

3. To design such attachments (Floats) which should not hinder driver while driving on the land and water.

Methodology

Design of the model for amphibious bicycle can be done by making such attachments in the normal bicycle which should not cause any hindrance while running on land and should support smooth motion in the water. As per the design aspects few things should be primarily taken care of like buoyancy forces exerted by water on the body and easy handling of attachments. After number of brainstorming sessions, we finalized a design which has four different sections to be designed like Front float, Rear float, Frame and Blades.

1. Design

When Bicycle will be taken in water then buoyancy force will acts over it. To balance the weight of the body one float on each side of bicycle should be attached. However, while running in the water, some provisions (Blades) are required for forward motion of the bicycle. Hence, taking care of all these aspects design of proposed model is divided into three different sections as: 1. Shape of Float 2. Design of the Float 3. Design of Blades

1.1 Shape of Float

Before finalizing the dimensions of floats, consideration of the shape of the floats is obvious. Thus we know while running vehicle in land or water some drag force will act on floats, to minimize this resistance to motion of the bicycle, aerofoil shape bodies are the best but due to manufacturing difficulties, we selected triangular shape at the front edge of the front float.

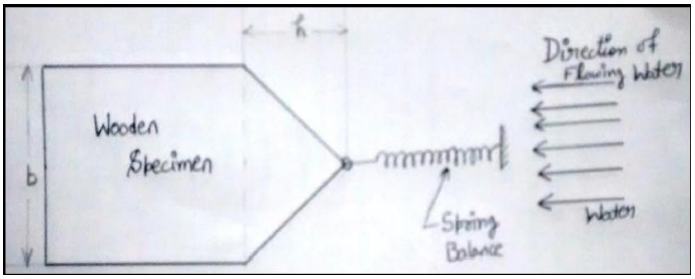

Fig 3: Schematic diagram of setup for the testing of shape of float

To perform the test, wooden specimens of different shape are placed in a water flowing channel as shown below table .We attached the specimen with a spring balance at front side of the specimen so that we can easily measure the drag force. Drag force calculation is purely relative in terms here, so that we can have the clear idea about the shape of the front float which will give minimum drag force.

Table 1. Drag Force calculation on different wooden specimen

S.N.	Ratio of width & height (b/h) of wooden specimen	Shape of Woode specimen
1	--------	Rectangular
2	45/15	Circular
3	45/20	Circular
4	45/10	Triangular
5	45/20	Triangular
6	45/30	Triangular

As shown in the table 1, result of drag force analysis test, Triangular shape of the front float will give minimum force. Among the triangular shape, b/h= 45/30 ratio shape can be chosen for the Front Float as it gave very less drag comparatively to others.

1.2 Design of Float

For finding the dimensions of the float, it should satisfy the Archimedes's Principle of buoyancy which stated that "Any object, fully or partially immersed in a fluid, is buoyed up by a force equal to the weight of the fluid displaced by the object".

Estimation of weights

Weight of the Bicycle = 15 - 20 kg
Weight of the Driver = 80 - 90 kg
Weight of the Float = 25 - 30 kg
Total Weight = 130 – 140 kg

Calculations

According to Archimedes's Principle;
Buoyancy Force = Weight of Fluid displaced
Volume of the water Displaced by the Bicycle = Total Weight / Density of water = 140 / 1000 = 0.14 m3

As we know Pugh criteria for design selection is the best method ever to choose the best design among several ideas. This is a method for concept selection using a scoring matrix called the Pugh Matrix. A design selection matrix, also known as a Pugh chart or Pugh matrix, is a table for helping a design team to systematically compare alternative design concepts against the design criteria and document the evaluation.
Design selection matrices are typically used in conceptual design to compare alternative ideas created through concept generation techniques, such as brainstorming. Design Selection matrix (Pugh Criterion) Design selection matrix needed some criterion to be selected which will affect the working and quality of the proposed model like ease to attach float, ease of manufacturing etc.

Table 2. : Design selection matrix for evaluation of best design (Pugh Criterion)

Description		Design A	Design B	Design C
Sketch				
Criterion	weight	Design A	Design B	Design C
1.Ease to attach	5	3	2	4
2. Ease of manufacture	5	3	2	3
3.Ergonomic consideration	5	4	4	5
4. Flexible to use on both land and water	5	3	3	5
Net Score (20)		13	11	17

After considering all the criteria from the above Pugh Matrix it is concluded that **Design C** is the most appropriate design among the ideas generated during brainstorming. So final design for the floats will be Design C.

1.3 Design of blades

Blades are attached on the spokes of rear wheel to provide the motion in forward direction while running on the water. To design the blades we made one assumption that Air drag and friction/viscous/skin drag are negligible in comparison to the pressure/form drag.

Drag force on the bicycle = F_D=1/2 $C_D \rho A V^2$

where C_D=Coefficient of drag = 1 (Ideal)

ρ=Density of water=1000kgm3

A=Projected area of both floats=0.2250 m2

V=relative velocity of the body in the water=1 kmph

F_D = 1×100060×60 = 0.277 m/sec

F_D=12 ×1000 ×0.2250×0.277 ; **F_D=8.6805 N (Relative)**

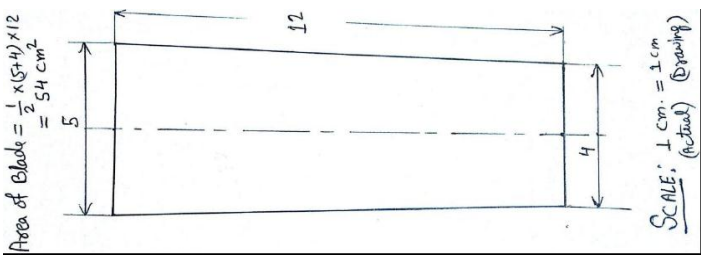

Fig 4: Shape of the blade

Drag force accompanied by one blade = F_{D1}=1/2 $C_D \rho a v^2$

where C_D=Coefficient of drag=1

ρ=Density of water=1000 kgm3

a=Projected area of blade=0.0054 m2

v=linear velocity of the blade = 0.29 × 2π×2060

= 0.607 m/sec

F_{D1}=1/2 ×1000 ×0.0054×0.607=0.9966 N≈1 N

Number of blades required for the motion in water =F_D/F_{D1} = 8.68051 ≈9

Hence for the motion of bicycle in the water, 10 blades should be attached on the rear wheel spoke of estimated projected area as shown in figure 4.

2 Fabrication

Fabrication of proposed model is very crucial and important part of the work. Fabrication of the proposed model is based upon the selection of the material for Float. As per the requirement of the proposed model, Galvanised Iron Sheet (G.I.Sheet) is chosen for fabrication of floats, because G.I. sheets are having less volume to weight ratio, easily available and easy to fabricate the required shape of the floats. Fabrication part divided into two sections to complete the whole fabrication of proposed model. These two Fabrication sections are described as below:

2.1 Fabrication of floats

Basically fabrication of floats relies on two basic point, first one is Fabricated Floats should be leak proof because if they are not then bicycle may get submerged in water. Secondly, Manufactured Floats should meet the proper dimensions and shape of the float designed for the proposed model of the work.

For leak proof joint in the Floats, Soldering (Soldering is a process in which two or more metal items are joined together by melting and flowing a filler metal (solder) into the joint, the filler metal having a lower melting point than the adjoining metal. Soldering differs from welding in that soldering does not involve melting the work pieces.) is the best suitable process for joining G.I. sheets. With the help of soldering all sides of Floats are joined to make leak proof joints in the floats. To achieve proper balancing of the bicycle, during fabrication the weight of the floats on both the sides are considered to be same. For the triangular shape in the front float, proper care was taken to get the exact shape and dimensions of the floats. Similarly for the other parts of the floats, exact shape and dimensions were achieved as designed in the proposed model to fulfill the criterion of designing of the work.

2..2 Fabrication of attachments/frame

To attach the floats to the bicycle wheels some special attachments /frames are required to be fabricated. These attachments should be such that they withstand the load while running in land or on the water. Initially we tried with a simple frame made up of steel rod of diameter 6 mm. to reduce the overall weight of the frame. But it got failed while running in the water because strength of the rod used in frame, was less and could not counter the forces exerted on it. Hence, frame got bent and redesigning of frame was needed at that point.

3 Validation

3.1 Flotation test

Before going for the final testing inside the running water, we have to check it once that bicycle should float on the water. During this floatation test, bicycle should also remain stable so that it could balance the weight of the whole body (proposed model). To conduct this test we immersed the bicycle in the water and leave that. After some time it was stable and float on the water as shown in the figure 5

Fig 5 : Floating bicycle during floatation test

3.2 Driving test

It was the major part of the testing on the model to conduct the driving test on the model fabricated. This test was conducted into two steps as initially it was tested on the land followed by testing it in the water. As shown in the figures 6 and 7, it was smoothly running over the land and water.

Fig 6: Driving test on the road

Fig 7: Driving test inside the water

Hence at the end we can say that proposed model can easily move on the land as well as on the water also. In this way proposed model satisfies the main objective of the work, i.e. smooth transition of bicycle from land to water during transportation.

Summary and Conclusions

The project is taken in accordance to overcome the problems faced by the poor people in flood prone areas. The project keeps in view the economical factors and is made so as to be easily accessible by the common man of India. India is a country which is rich in monsoon. There are various parts in India that receive rain in abundance and get flooded. The majority of India lies below the poverty line and as such has to face major problems during any of such natural calamities. During floods a vast section of Indian community has to suffer from breakdown of transportation services. In case of floods generally boats are used and no solution as such has come up to overcome the problem. This solution is one of it's kind and far better than rowing boat amidst flood. The amphibian bicycle can provide solution to this problem. An amphibian bicycle is meant to navigate in water and run on land. It can be a boon for the flood prone regions. In last few years, the frequency and intensity of floods have increased in India. Due to the crippled transportation means caused by floods the evacuation process becomes quite difficult and sometimes barely impossible. The amphibian bicycle can be proved an ingenious, economically viable and easily available solution.

By using certain appendages to the existing normal bicycle, it can be made to move in water. These attachments are not expensive and can be fabricated with ease and this modified version of bicycle can be used in flood prone areas and removed when it is not necessary. The fabricated model is simple and has easy installation. It can also be used in daily life by the low income population to cross any water body everyday in order to do their work and in this way they can save their expenses. It can also be used for adventure and water games. In India 40% population is below poverty line and in last 10 years floods have caused thousands of deaths. In July 2005, flood in Mumbai choked the whole city and left over 7000 dead. People were not able to move from their houses for days; in this situation amphibian bicycle would have been a great problem solver.

India is grappling with two problems namely, poverty and frequent floods. As it is known fact that poor are the worst affected by natural calamities. In India also, most of the people died by the floods are poor. So poor need a solution which is both affective as well as within their reach. The fabricated model of amphibian bicycle is the culmination of both.

Overall, this design had been successful in its main objective which was to design and fabricate an amphibious bicycle. The basic concept that had being selected to be used in this kind of study for developing an amphibious bicycle was design of floats and propulsion system for it. This concept is more practical based on the selection technique used during the design process. From the design, float dimensions were calculated based on hydrostatic calculation to estimate the buoyancy size that need for support an amphibious bicycle. In case of float design, the shape of the float was made nearly

aerodynamic and fabricated in accordance with bicycle dimensions. Meanwhile, for material selection had been done by using light weight material and can wind stand from surrounding environment. The propulsion system used in this design is blades attached to the rear wheel. This system was being selected because of its high efficiency during moving and maneuvering on water.

Finally, the outcomes of the present work are as follows:

1. The fabricated amphibious bicycle has allowed smooth transition from land to water during transportation.
2. It has optimized the speed requirement of the bicycle.
3. The fabricated model has been made to such perfection that it didn't hinder the rider.

Therefore, as a conclusion, the design for an amphibious craft had been successful produced thus fulfilling the criteria, objective and primary target of the study. A still further feature and advantage of the work is the provision for an amphibious bicycle in which the conventional pedal type propulsion system used on land is readily converted to and utilized for the motive power in water.

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