

Folding Bicycle with Trolley Mechanism

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Abstract - Bicycles have evolved much over the past decades in pace with technological advancement. It has been better option for controlling pollution, also for easy transportation with health maintenance. Short distance travelling is tedious, time consuming and expensive task. It is very difficult to reach the nearest public transport facility, since the destination will be very far from the main roads. Folding bicycle being conventional provides the ease for carrying it to different places. However the comfort of cyclist has been attempted in many designs up to large extent. The currently available models are heavy, expensive and difficult to fold. Many of them are not foldable in a proper geometrical order, because of which their transportation becomes very difficult. Folding bicycle allows individual ability to board transport vehicle. The bicycle is one which recognized as a transportation solution helping to improve various environmental conditions, economic factors and social aspects. Many countries are using bicycles for transportation purpose considering environmental damage caused due to the fuel residuals of automobiles. Presently available models in market are expensive and heavy to carry. This problem is the main basis of design consideration. Over so many designs available in global market this project provides light weight, safe and low cost design which provides the ease of folding handling and maintenance. The main objective is the design and development of folding bicycle which is economical and comfortable. We have tried over different designs of bicycle and joint provided for folding of bicycle. Unlike the conventional bicycles, this bicycle will occupy very less space and is very easy to carry it.

Key Words: Trolley mechanism, Feasible, Functionality, Transportation, Drag Mechanism.

1. INTRODUCTION

From past few years Bicycles with an additional feature of folding have been witnessing an upsurge in demand. Better comfort and mobility of travelling is offered during daily commute by folding bicycles when compared to conventional bicycles. Folding bicycles are also packed with multiple features such as flexibility for mixed commute, less possibility of bicycle theft, carrying them up a flight of stairs and easy storage along with the functionality. For the activities such as touring and adventure biking, with different frame material, wheel

size and gear variant, several bicycle manufacturers have offered variety of folding bicycle. Along with reducing cost and commute time, riding bicycles plays a vital role resulting in enhanced travelling efforts.

1.1 Overview

As a mode of transportation in nearby vicinity multiple factors have provoked urban commuters to choose option of bicycle. Endless stream of traffic and long walking distance between home, subway stations and workplaces have encouraged people to adopt bicycle as their daily mode of commutation. Benefits of bicycle have motivated people to prefer cycling growing awareness towards environment coupled with health and fitness. The use of conventional bicycle in big cities offers numerous challenges for mixed modes of transportation including metros and subways. Consumers have started preferring folding bicycles in order to counter the issue, which has boosted the overall folding bicycles market. Additionally, folding bicycles are lightweight, durable and require minimum storage space to compensate for limited residential spaces in modern urban homes. Nevertheless, folding bicycles still have to face stringent competition from conventional bicycles in terms of speed and performance thus affecting the growth of folding bicycles.

1.2 Evaluation of existing models

In this work, the existing foldable bicycle is evaluated to understand the limitations in it. Generally, in a typical product development process, the product is evaluated depending on a specific set of design criteria. The design criteria are framed concerning cost, functionality, safety, maintenance, durability as well as a specific set of criteria depending upon the product being considered. In this study a specific set of criteria are formulated for the foldable bicycle and the existing bicycle designs are evaluated to understand their limitations. Depending upon the shortcoming of the existing product for the criteria, new designs are proposed to overcome the limitations. The design criteria for the foldable bicycle in this work for evaluation are dependent on several factors: the folding methods, portability, ease of transportation, compactness, material used, tire size, weight, quickness to fold etc.

1.3 Aims of research work study

Designing a folding bicycle and joint for folding with more feasibility and efficiency along with trolley arrangement is the main aim required to be fulfilled by this project. We are designing the bicycle having easily folding and unfolding mechanism. Research work being carried out has undergone through different processes and testing being carried out on different designs through which we have reached to the most affordable and feasible solution. Main motto of the project focuses on the working principle of the design with the two folds which make it easy to carry along at any place with fewer efforts. Previous available designs in the market have so many faults and difficulties in the folding mechanism and transportation of folding bicycle.

2. EXPERIMENTAL INVESTIGATION

2.1 Basis of Experimental Investigation

Experimental investigation is required to validate the design being manufactured through different experiments. It provides the working principle for design which defines its working, process and use. To validate the design calculation based on the material and forces has been carried out theoretically. Working Principle of the design provided in report validates its proper required for successful design completion and testing. Folding occurs in two steps with 90° fold at each step.

2.2 Working Principle

We have used two sleeve joints in our design for folding purposes. Sleeve joints make it very easy to fold and unfold the bicycle. Also, the locking system becomes very simple to operate. The folding process is explained in detailed with respective images. The image shows the running position of the bicycle in which all the sleeve joints are in a locked position so that the bicycle can remain in fixed position.



Fig -1: Straight position of bicycle

Step no.01: This is the step to folding in which the first sleeve is unlocked and the front wheel is folded through 90 degrees as shown in the figure below. The first sleeve is given freedom to rotate in 180 degrees but is actually rotated to 90 degrees as from this position the second sleeve is unlocked.

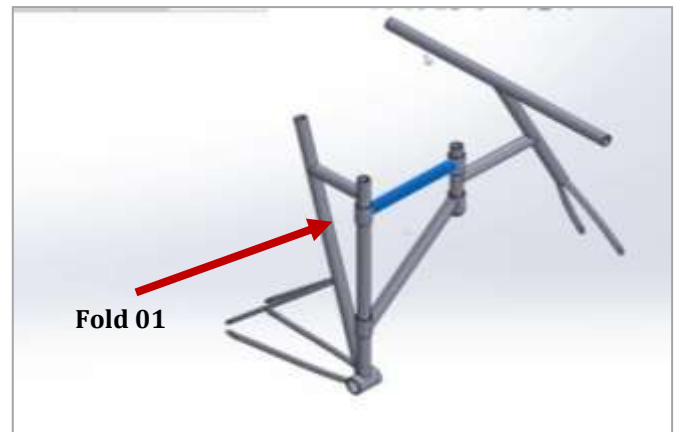


Fig -2: Single 90° folding Position

Step no. 02: This is the final folding step in which the second sleeve is unlocked and the wheel is rotated again by 90 degrees as shown in the fig below. After folding the wheels get aligned in parallel axis and are locked with each other so that the two wheels remains aligned in their axis. Then the handle of bicycle is used to drag or lift the bicycle.



Fig -3: Double 90° folding position

Step no. 03: After the folding of bicycle from two joints the front wheel and the rear wheel gets aligned in parallel axis as shown in fig. 4 which provides the drag mechanism. It is used to drag the bicycle smoothly and also acts as a support. The wheel used in our design is of 500mm diameter made of polyurethane material which is tough and durable.



Fig -4: Parallel position of both wheels

2.3 Trolley mechanism

The design of bicycle has been made by taking into consideration that the rider must be a local traveller it means that he is going to have an average size handbag or a school bag. So in our design we have provided a space to place the bag which can be seen in the fig. 5 below while the user can drag the bicycle. So there is no need for the rider to worry about his bag or luggage. It becomes very convenient for the rider to just hang the bag and drag the entire thing along.



Fig -5: Trolley Mechanism

3. FABRICATION

The fabrication of the folding bicycle is done with help of various manufacturing process. This includes the processes which are used to develop the realization of design model on the computer software. The design of the folding bicycle is done with help of various computers software like solid works, CATIA etc. The various folding

mechanism will be used to folding bicycle like knuckle joint, sleeve joint etc. Knuckle joint consists of single eye, double eye end and knuckle pin it will be manufactured by using the basic manufacturing process. While fabrication the folding mechanism will consider the all factor which will affect on the feasibility of the bicycle. It will also consider the design factor which affects on the life of mechanism.

During the fabrication of knuckle joint for folding bicycle the motions restriction problem was occurred. The motions restriction is a big issue in knuckle joint hence the folding mechanism we used is a sleeve joint. Sleeve joint consist of one hollow pipe inside another pipe which will be free to rotate. To manufacture the sleeve joint, firstly boring of solid bar was carried out. In sleeve joint one end of pipe connects to the outer of boring solid bar and another end connect to the two end of pipe which is inside the boring solid bar. The end of the sleeve joint connects such that they are free to rotate inside the boring solid bar. The size and materials selection is a very important before going for fabrication because the material should have machinability property. The various manufacturing process such as end cutting, boring, welding etc. is required to be performed on the different machine tools.

The accuracy and precision is important during the fabrication of sleeve joint. After the manufacturing, sleeve joint connects such that the bicycle folds in two joints. The locking of folding mechanism is also important because there they are free to rotate anytime to restrict the motion at specific angle the locking will be used. In locking mechanism the cotter pin will be used for perfect motion restrictions through hole drilled in a sleeve joint. In the sleeve manufacturing, the suitable welding should be selected such that joining of two parts occurs perfectly. For joining of two metallic dissimilar parts the arc welding is mostly used. The sleeve is used to join the two end of the pipe such that tightness between the boring pipes is to be maintained. After the welding the inspection of welding part is to be done by weld test.

To maintain the clearance between two parts, while performing the boring operation accuracy is required. The inner surface of sleeve makes it very smooth to rotate through pipe inside it. The pipe is to be installed in boring hole by using the bearing to free the rotation. The number of bearing used inside the boring sleeve depends on the length of the sleeve. The selection of bearing depends upon the OD and ID of the boring length. The loading

capacity of the bearing it also important while selecting the bearing according to the capacity the proper bearing is to be selected. To increase the bearing life and reduce the friction between the two parts the grease is required to be filled.



Fig -6: Folding Bicycle Side view

4. METHODOLOGY

A methodology is a model, which project managers employ for the design, planning implementation and achievement of their project objectives. There are different project management methodologies to benefit different project.

- **Study of Literature:**

The first step in methodology is study of literature it help us understand references made in more modern literature because authors often reference old tests and some assumption. The various literature study for folding bicycle if available.

- **Identification of Problem:**

In second step identification is related to folding bicycle which is recently present in market. During the study of literature the various problems will be found out related to folding bicycle.

- **Literature Review:**

Literature review is a scholarly paper that presents the current knowledge including substantive finding as well as theoretical and methodological to a particular topic. In this stage we are going to give overview of present knowledge related to folding bicycle. After these

stages it will gives the problem will present in existing model.

- **Gaps in Literature:**

To identify literature gap is need to go through the review of existing literature in folding bicycle.

- **Objective of the work:**

The main objective is to design and develop a foldable bicycle which is comfortable to ride and economical. In the present day, a folding bicycle is designed to fold into compact form, facilitating transport and storage.

- **Design of the Model:**

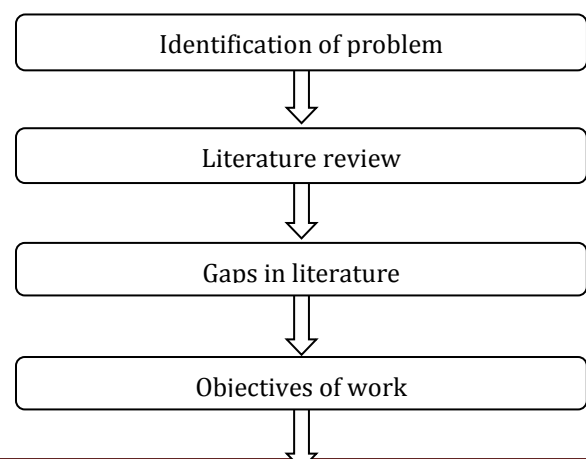
The design model is an object model describing the realization of use cases and serves as an abstraction of the implementation model. A Folding bicycle designed to fold into a compact form facilitating transport and storage. The design it should be folding ease, compactness, ride, weight, durability, etc considered.

- **Fabrication of Model:**

After the designing of the model next step is of fabrication. The fabrication of folding bicycle should be done with various manufacturing processes. During fabrication all the factors affecting folding mechanism will be considered.

- **Testing and validation of Model:**

Model based testing is an application of model based design for designing, also executing artifacts to perform software testing. The testing and validation are important phases in any model after the design phase. In these step testing and validation of folding bicycle is carried out.



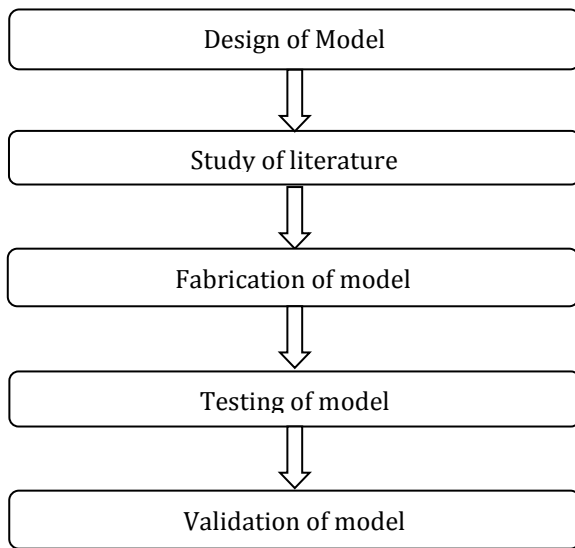


Chart -01: Methodology

5. FUTURE SCOPE

The folding bicycle market has been sub-grouped into product type, wheel size, application, and price range. The report studies these subsets concerning the geographical segmentation. The strategists can gain a detailed insight and devise proper strategies to target a specific market. This detail will lead to a focused approach leading to the classification of better opportunities. Folding bicycle has scope for research work in future for making it affordable and light weighted. More research can be carried out on electric foldable bicycle. In global market presently China is dominant in terms of sales and manufacturing for foldable bicycle. Owing to the increasing tourism and health concerns North America, Middle East and African Countries are expected to grow at a significant pace over the coming decade owing to the high demand for folding bicycle from bicycle users.

6. CONCLUSIONS

After above study we got the feasible design for folding bicycle with less weight, easy folding mechanism and less cost. Different experiments were carried out on type of joint, its location, material used etc. Manufacturing processes carried out were very simple. Bicycles have trolley mechanism to temporarily store the luggage. Drag mechanism formed by wheels which becomes parallel after two folds provide the ease of transportation. Sleeve joint provided with the bearing makes the rotation in plane very easy and grease provided in between gaps reduces the friction between two thus reducing wearing of the joint. Locking is provided with clamp locking system with nut and bolt arrangement. Thus, we got efficient design for folding bicycle.

RESULT

Foldable bicycle with new design and greater efficiency was been manufactured by overcoming the flaws and difficulties in existing design. Locking Mechanism provided by clamping method provides the ease of locking and unlocking. It has been found that Feasibility depends upon type of folding Mechanism and type of joint provided, manufacturing processes being applied during fabrication are simple and thus helps to reduce the manufacturing cost of folding bicycle.

REFERENCES

- [1]. Arunachalam M., Arun Prakash R. and Rajesh R "Foldable bicycle: evaluation of existing design and novel design proposals", ARPN Journal of Engineering and Applied Sciences (Asian Research Publishing Network - 2006-2014)
- [2]. Paras Kanasagara, Jatin Mandliya, Kalpesh Bhatt and Raj Bhandari, "Design and Fabrication of Tribicycle Fold Around the Bag and Utilized as a Trolley", International Research Journal of Engineering and Technology – Volume: 05 Issue: 11 | Nov 2018 (IRJET)
- [3]. Ankush M. Hatwar, Sharad P. Bargat and Bhavesh A. Bohra, "Design Of Single Fork Of Folding Bicycle", International Journal Of Modern Engineering Research, Vol. 6 Issue 5 | May 2016 | (IJMER)
- [4]. Shishir S, Manjunath P , Pavanasudan R and Ravi Sathyajith, "Design and Fabrication of Foldable Bicycle", SSRG International Journal of Mechanical Engineering– Volume 2 |Issue 6 |June 2015 | (SSRG – IJME)
- [5]. Ranjith P N and Dr. Haris Naduthodi, "Development of Ergonomic Design Procedures for Bicycle Manufacturer", (International Journal of Science and Research -Volume 4|Issue 8|August 2015) (IJSR))
- [6]. Dr.A.K.Jouhri1, Kushal Sharma , Vibhum Dixit, Baashi Abbas and Vanshaj Shukla, "Designing and Fabrication of 4-Fold Foldable Bicycle", (International Journal of Engineering Science and Computing-Volume 6 |Issue No. 6|2016)(IJESC)
- [7]. Saravanan. M, "Design and Fabrication of foldable bicycle", Research gate publication -may 2017
- [8]. Prof. Mayur Shelke, Abhinav Tingne, Sajal Chandrakar, Prathamesh Bharti, Vishal Meshram, Tejas Dahikar, "Design Methodology to Fabricate Foldable Bicycle", (International Journal for Research in Applied Science & Engineering Technology -Volume 6 |Issue III| March 2018) (IJRASET)